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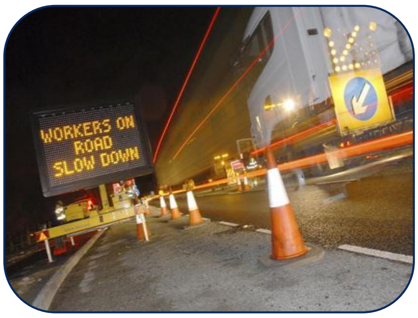


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A study of the implementation of Directive 2007/38/EC on the retrofitting of blind spot mirrors to HGVs

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Contents

Executive Summary

In order to reduce the risk of accidents involving blind spots, the European Union (EU) implemented Directive 2003/97/EC, which substantially increased the field of view available from the mirrors of new trucks and buses sold in the EU from January 2007. The Directive required certain vehicles be fitted with mirrors to cover the blind spot at the front of the vehicle and on the passenger side of the vehicle.

In 2004, a study (O'Brien 2004) found that it would also be cost-effective to require existing heavy goods vehicles (HGVs) already in-service to be retro-fitted with the side view blind spot mirrors, though it was not predicted to be cost effective for light commercial vehicles (LCVs, goods vehicles of no more than 3.5 tonnes) and buses and coaches. Thus, the EU implemented Directive 2007/38/EC requiring goods vehicles to be retrofitted with mirrors intended to meet the requirements of the side view blind spot mirror defined by Directive 2003/97/EC.

TRL was appointed by the Commission to undertake a review of the effectiveness of the retro-fit Directive. The review involved:

- A brief review of recent literature regarding the effectiveness of mirrors and other technologies at preventing blind spot accidents;
- Analysis of the results of a questionnaire sent by the Commission to each of the Member States, and
- Analysis of accident and casualty data supplied by the Commission.

The main findings of the work were that:

- The number of vulnerable road users killed in collision with an HGV has fallen substantially such that in 2009 the number was less than was expected based on the predicted effects of Directive 2007/38/EC.
- This would suggest that retro-fitting blind spots had been successful. However, the overall number of fatalities also fell more sharply in the same time period and the specific data available are limited. It is not, therefore, possible to quantify the extent to which the overall fall in HGV-VRU fatalities was a result of the fitment of the mirrors.
- One of the limitations of this study is that the “after implementation” period was very short because EU data was only available up to 2009, the year in which it became obligatory for vehicles to be failed at annual inspection if they were not equipped with the new mirrors. Thus, future casualty data may provide additional insight, although other limitations may still prevent firm conclusions.
- A wide range of additional technical measures have been identified that have the potential to further reduce the number of vulnerable road users killed in collision with heavy vehicles. These include measures relating to direct field of view, on-board indirect vision aids, roadside mirrors, sensors and warnings and rear steering. However, each will have advantages and disadvantages, the benefits will not be additive and no research has been found that objectively quantifies the relative costs and benefits to identify the most cost effective solution, or group of solutions.

1 Introduction

It has long been acknowledged that large vehicles have blind spots around them which the driver is unable to see into and that this has the potential to contribute to the cause of accidents. In order to reduce the risk of accidents involving blind spots, the European Union (EU) implemented Directive 2003/97/EC, which substantially increased the field of view available from the mirrors of new trucks and buses sold in the EU from January 2007[1]. These included requirements that certain vehicles be fitted with mirrors to cover the blind spot at the front of the vehicle and on the passenger side of the vehicle.

In 2004, a study (O'Brien 2004) found that it would also be cost-effective to require existing heavy goods vehicles (HGVs) already in-service to be retro-fitted with the side view blind spot mirrors, though it was not predicted to be cost effective for light commercial vehicles (LCVs, goods vehicles of no more than 3.5 tonnes) and buses and coaches. Thus, the EU implemented Directive 2007/38/EC requiring goods vehicles to be retrofitted with mirrors intended to meet the requirements of the side view blind spot mirror defined by Directive 2003/97/EC.

Directive 2007/38/EC included a requirement that the implementation of the Directive was reviewed. For this reason, TRL has been appointed by the Commission to undertake this review. The work commenced in September 2011 and was completed in October 2011. It involved:

- A brief review of recent literature regarding the effectiveness of mirrors and other technologies at preventing blind spot accidents;
- Analysis of the results of a questionnaire sent by the Commission to each of the Member States, and
- Analysis of accident and casualty data supplied by the Commission.

This report describes the results of the study in full.

[1] New types were required to comply by January 2006, existing types by January 2007.

2 Research Methods

The Commission wrote to each of the Member States to ask about how they have implemented Directive 2007/38/EC, before this study began and the results were provided to the author. The respondents were asked to provide the following:

- Provide a general overview of the process of implementation of Directive 2007/38/EC. Refer also to the main difficulties encountered during this process.
- Did your country apply any national measure which entered into force before 6 August 2008 requiring the fitment, on the passenger side, of other means of indirect vision covering not less than 95 % of the total field of vision at ground level of class IV and class V mirrors?
- Please communicate to the Commission the list of the technical solutions related to
    - the supplementary mirrors and
    - the equipment, other than mirrors, regulated under Directive 2003/97/EC
    - which could have been retrofitted on
        - vehicles registered before 1 January 2000 and
        - vehicles not exceeding 7.5 tonnes.
- According to art. 4 *"Compliance with the requirements set out in Article 3(1), (2) and (3) shall be established through proof furnished by a Member State in accordance with Article 3 of Directive 96/96/EC".* How were the national periodical technical inspection requirements updated to fulfill the above mentioned obligation?
- In 2007 the note *"Directive 2007/38/EC on the retrofitting of mirrors to heavy goods vehicles"* was circulated by the European Commission (Road Safety Unit) to the Technical Adaptation Committee (TAC) under Directive 96/96/EC. To ensure that the mirrors and other equipment installed are compliant with Directive 2007/38/EC, that note proposed three solutions:
        - *Mirror test areas with markers,*
        - *Release of a certificate of compliance,*
        - *Drawing up a list of permitted mirrors*
    - Which one has been preferred?
- How many vehicles failed the periodic technical inspection due to the fact that they were not compliant with Directive 2007/38/EC?

Most of these questions have non-numeric answers and so the results were subjectively categorised and the numbers falling in each category were identified.

The second main task involved the analysis of casualty data from before, during and after the implementation of the Directive. This data was supplied by the Commission based on analysis of the Community database of Accidents on the Roads of Europe (CARE). The data was not produced in as much detail as was provided for the previous study (O'Brien 2004) partly because of the limited time available and partly because it was anticipated that the trend should be evident in more aggregated statistics. The data was based mainly on the countries in the EU-15 because that is all that was available for the "before implementation" period, thus precluding a comparison for most of the remaining 12 Member States.

The above two tasks were supported by a review of recent scientific literature considering the effectiveness of mirrors and other technologies at preventing blind spot accidents. The review also aimed to identify the actual costs of fitting the blind spot mirrors.

The final task involved undertaking a cost benefit analysis with a methodology consistent with that undertaken in the previous study (O'Brien 2004). This was based upon analysis of registration data to identify the likely numbers of vehicles subject to the retrofitting requirement (as opposed to the new vehicle requirement from 2003/97/EC) for each year analysed and identifying the one-off fitment costs and casualty reduction benefits each year. Benefit to cost ratios and the net present value of benefits were calculated.

3 Predicted casualty reduction effect of the Directive

In 2004, the European Commission instructed Jacobs Engineering to undertake a cost benefit analysis of several policy options relating to the retro-fitment of blind spot mirrors. The resultant analysis (O'Brien 2004) will form the "before" part of the before and after study undertaken as part of this study. TRL does not have access to the original data used in the analysis by (O'Brien 2004) so has attempted to recreate at least a simplified version that approximates the answers originally obtained, based on the data included in the final report (O'Brien 2004) and other publicly available data.

The scope of the analysis undertaken by (O'Brien 2004) was such that cost benefit ratios were calculated for:

- Class IV/V mirrors fitted to HGVs (all N2 and N3);
- Class VI mirrors fitted to HGVs (all N2 and N3);
- Class IV/V mirrors fitted to LCVs (N1);
- Class VI mirrors fitted to LCVs (N1);
- Class IV/V mirrors fitted to buses and coaches (all M2 and M3), and
- Class VI mirrors fitted to buses and coaches (all M2 and M3);

The original intention had been to be able to sub-divide category N2 into those with a gross vehicle weight (GVW) in excess of 7.5 tonnes and those with a GVW of 7.5 tonnes or less, in line with the proposed regulatory requirements, but the data analysed did not allow such a split (O'Brien 2004). It is, therefore proposed that the scope of analysis actually undertaken by O'Brien is what is repeated by this study in order to allow like for like comparison.

(O'Brien 2004) undertook their analysis based on figures for the EU-25 because these were the Member States that the measures would be applied to, if implemented. However, when considering past trends in data from before 2004 there was no data available for the "new" Member States so it was estimated based on the data available for EU-15 states of similar size. The relative size and motorisation rates for the EU-15 countries are such that accident data from the EU-15 form the vast majority of all accidents occurring in EU-27. The fact that the current study is a comparative study combined with the short duration meant that it was considered appropriate to restrict the analysis to data that was readily available for all periods, i.e. that from the EU-15, or where available, the EU-15 plus the Czech Republic, Poland, Slovenia and Romania.

One of the main elements required was to estimate the number of casualties affected by the measure. (O'Brien 2004, T4-12) reported the total number of fatalities by year from 1993 to 2002 and then stated (Page 88) that these were forecast forward on the basis that recent trends would continue at an average reduction of 4% per year[2]. On this

[2] Although 4% stated, analysis of the figures in Table 4-12 (O'Brien 2004) suggests that the average reduction over the most recent three years was 2.75% and extending the period further back resulted in a smaller average reduction.

basis, the total fatality trend from all road accidents in EU-15 was as shown in Figure 1, below.

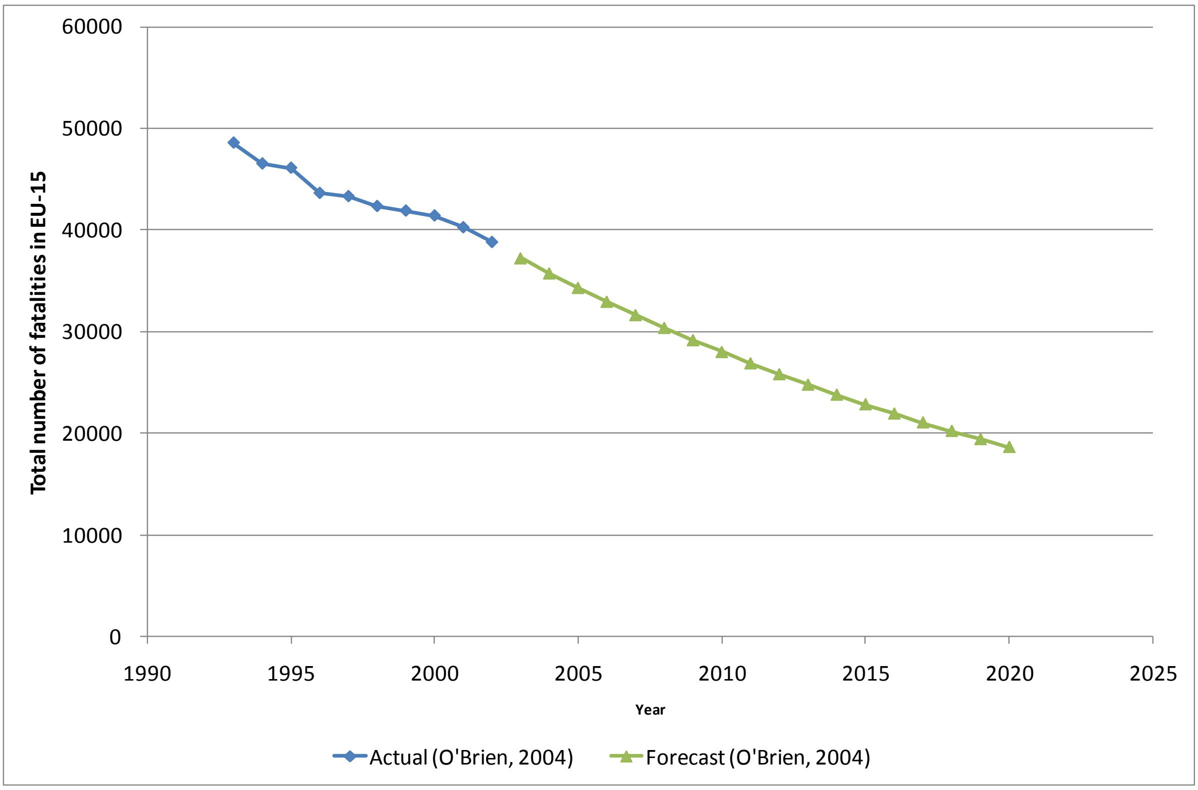


Figure 1: Total fatality numbers actual/forecast based on data and information in (O'Brien 2004)

Tables 4-20 to 4-25 (O'Brien 2004) analysed the data into more detail, considering the number of fatal accidents involving an HGV, LCV or bus/coach in collision with a pedestrian or two wheeled vehicle (pedal cycle, moped and motorcycle). The numbers presented were an average of the last 5 years of data available in each Member State (estimated from comparable country data where actual data not available). Table 1 reproduces an example of the data contained in the Jacobs report (O'Brien 2004).

Table 1: Fatal accidents involving HGVs and two-wheelers or pedestrians in "all areas" (source Table 4-20 (O'Brien 2004), restricted to EU-15)

Country	Abbreviation	Motorcycle & Moped			Pedal cycle			Pedestrian		
		Total	Frontal	Lateral	Total	Frontal	Lateral	Total	Frontal	Lateral
Austria	AT	12	2	1	1	1	0	17	0	0
Belgium	BE	18	6	8	29	3	21	17	0	0
Denmark	DK	9	2	3	20	2	9	10	0	0
Finland	FI	4	1	2	9	2	4	10	0	0
France	FR	99	21	41	25	2	18	86	0	1
Germany	DE	102	18	50	43	3	26	97	0	1
Greece	EL	39	6	22	3	0	2	32	0	1
Ireland	IE	5	2	0	1	0	1	15	0	0
Italy	IT	152	27	99	75	5	54	108	0	2
Luxembourg	LU	4	2	3	0	0	0	2	0	0
Netherlands	NL	31	3	22	65	1	62	22	0	1
Portugal	PT	25	9	10	5	1	2	26	0	0
Spain	ES	67	11	35	11	1	7	88	0	1
Sweden	SE	8	2	5	6	1	5	17	0	0
United Kingdom	UK	55	12	23	34	3	25	105	0	1
Total (calc)	EU-15	630	124	324	327	25	236	652	0	8
Total (copied from source)	EU-15	665	123	324	356	25	236	549	2	9
sanity check	Calc minus source	-35	1	0	-29	0	0	103	-2	-1

The first point to note is that the numbers for each Member State within the EU-15 do not always add to the total provided in the source table purported to represent EU-15. The reason for this is not known, but may be a function of averaging the individual EU-15 totals for 5 years rather than summing the total of the 5 year averages for each individual Member State. The second apparent anomaly is most readily identifiable for fatal accidents involving an HGV and a pedestrian. It can be seen that of 549 fatal accidents in total only 2 were reported to be frontal and only 9 lateral. This implies that the remaining 538 were all involving the rear of the HGV, which seems implausible. The European Commission stated that the impact point on the vehicle was a field in the database used that was not always completed and thus only a proportion of the remaining 538 would be impacts to the rear with the majority likely to have been unknown.

(O'Brien 2004, P88) states that the total number of fatalities was assumed to continue to decline at a rate of 4% per year as described above and that future fatality forecasts by vehicle type and casualty type, were obtained by applying the relevant percentages from the [then] current data. It should be noted that this inherently assumes no change in the distribution of accident types into the future but does allow for a larger sample size in forecasting compared to the alternative of forecasting the detailed trend forward. Based on the data contained in Figure 1 and Table 1, the percentages of all fatalities that arise from accidents involving HGVs and vulnerable road users can be calculated.

Table 2: Proportion of all fatalities (EU-15) that arise from accidents involving HGVs and vulnerable road users based on estimating methods and data from (O'Brien 2004)

Country	Abbreviation	Motorcycle & Moped			Pedal cycle			Pedestrian		
		Total	Frontal	Lateral	Total	Frontal	Lateral	Total	Frontal	Lateral
Total	EU-15	1.62%	0.30%	0.79%	0.87%	0.06%	0.58%	1.34%	0.00%	0.02%

This results in the predicted trend of fatalities from accidents involving HGVs and vulnerable road users in a 'business as usual' scenario where blind spot mirrors were not implemented, as shown in Table 3, below.

Table 3: Predicted trend in fatalities from accidents involving HGVs and vulnerable road users in a business as usual scenario where blind spot mirrors were not implemented based on TRLs interpretation of data and statements presented by (O'Brien 2004).

		Proportion of All fatalities	Year																	
			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Motorcycle & Moped	Total	1.62%	605	581	558	535	514	493	474	455	437	419	402	386	371	356	342	328	315	302
	Frontal	0.3%	112	107	103	99	95	91	88	84	81	78	74	71	69	66	63	61	58	56
	Lateral	0.8%	295	283	272	261	250	240	231	222	213	204	196	188	181	173	166	160	153	147
Pedal cycle	Total	0.9%	324	311	299	287	275	264	254	243	234	224	215	207	199	191	183	176	169	162
	Frontal	0.1%	23	22	21	20	19	19	18	17	16	16	15	15	14	13	13	12	12	11
	Lateral	0.6%	215	206	198	190	182	175	168	161	155	149	143	137	132	126	121	116	112	107
Pedestrian	Total	1.3%	500	480	460	442	424	407	391	375	360	346	332	319	306	294	282	271	260	250
	Frontal	0.0%	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
	Lateral	0.0%	8	8	8	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4

(O'Brien 2004, P88) states that in order to estimate the number of fatalities saved by Class IV/V side view mirrors, it was assumed that only accidents involving two-wheelers, including motorcycles and mopeds, were affected and that there was no effect on pedestrians accidents.. It was also stated that it was necessary to identify the proportion of accidents where the HGV was turning right (left in the UK) at the time of the collision. An estimate of this proportion was single sourced from an analysis of blind spot accidents undertaken in the Netherlands, reproduced as Figure 3-3 of the Jacobs report (O'Brien 2004). This estimate was that 56% of fatal accidents involving an HGV and a two-wheeler involved the HGV turning right (or left in the UK). This results in the estimated "target population" of possibly preventable accidents shown in Table 4, below. Note, it was not explicitly stated whether this proportion should be applied to just the "lateral" accidents identified in Table 3, above or to the "total" numbers, so both possibilities were included at this stage.

Table 4: Target population of fatal accidents involving an HGV and a two wheeler, where the HGV was estimated (O'Brien 2004) to be turning right (left in the UK).

		Year																	
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Motorcycle & Moped	Total	339	325	312	300	288	276	265	255	244	235	225	216	208	199	191	184	176	169
	Lateral	165	159	152	146	140	135	129	124	119	114	110	105	101	97	93	90	86	82
Pedal cycle	Total	181	174	167	161	154	148	142	136	131	126	121	116	111	107	102	98	94	91
	Lateral	120	115	111	106	102	98	94	90	87	83	80	77	74	71	68	65	63	60

The next major consideration is the question of how many of these collisions would have been prevented by fitting class IV and V mirrors. (O'Brien 2004) used an estimate of 40% based on an analysis by SWOV in the NL. However, this did not consider the results of a Danish study of the actual effects of their national scheme, which was also cited as showing only a modest decrease in fatalities and stating that a 50% prediction was overly optimistic. Based on the 40% estimate, and the assumption that no vehicles in the business as usual scenario were equipped with blind spot mirrors, produces the following estimate of the total possible fatality saving from blind spot mirrors.

Table 5: Predicted fatality savings each year of going from 0% class IV/V mirror fitment to 100% (i.e. combined effect of 2003/97/EC and 2007/38/EC).

		Year																	
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Motorcycle & Moped	Total	136	130	125	120	115	111	106	102	98	94	90	87	83	80	77	73	71	68
	Lateral	66	63	61	58	56	54	52	50	48	46	44	42	40	39	37	36	34	33
Pedal cycle	Total	73	70	67	64	62	59	57	55	52	50	48	46	44	43	41	39	38	36
	Lateral	48	46	44	43	41	39	38	36	35	33	32	31	29	28	27	26	25	24

(O'Brien 2004) based their analysis on the assumption that a retro fit would be implemented in 2006. Table 5 suggests that between 2006 and 2020 a total of 2,108 fatalities could have been preventable by fitting blind spot mirrors, but this includes the effects of those fitted as a result of Directive 2003/97/EC on new vehicles and the effects of the [then] proposed retrofit as part of Directive 2007/38/EC. It is, therefore, necessary to estimate the number of vehicles in the fleet each year and the proportion of those that would have been equipped with blind spot mirrors by virtue of first registration in 2007 or later.

The forecasts for numbers of vehicles was not presented by (O'Brien 2004) so the following data has been estimated by TRL based on the 2001 figures that were presented by (O'Brien 2004), the data on forecast GDP growth presented by (O'Brien 2004) and O'Brien's assumption that new registrations would increase in line with GDP each year and that the total fleet would increase in line with GDP+0.5%, thus resulting in a slowly ageing fleet. The results are shown in Table 6, below.

Table 6: Forecast new HGV registrations (thousands) based on (O'Brien 2004)

Country	Abbreviation	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	AT	8.2	8.4	8.6	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	11.0	11.2	11.4	11.6	11.9	12.1
Belgium	BE	12.7	13.1	13.5	13.9	14.2	14.5	14.8	15.2	15.5	15.8	16.1	16.4	16.7	17.0	17.3	17.6	17.9	18.2	18.5
Denmark	DK	4.7	4.8	4.9	5.0	5.2	5.3	5.4	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.4	6.5	6.6	6.7	6.8
Finland	FI	3.3	3.4	3.5	3.7	3.7	3.8	3.9	4.0	4.2	4.2	4.3	4.4	4.4	4.5	4.6	4.7	4.7	4.8	4.9
France	FR	59.5	61.2	63.0	64.9	66.4	67.9	69.5	71.1	72.7	74.4	76.1	77.9	79.7	81.5	83.3	85.1	87.0	88.9	90.9
Germany	DE	98.6	101.3	104.2	107.2	109.6	112.0	114.4	117.0	119.5	122.0	124.6	127.2	129.9	132.6	135.4	138.3	141.2	144.1	147.1
Greece	EL	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.6	3.7	3.8	3.9
Ireland	IE	5.2	5.5	5.9	6.2	6.5	6.7	6.9	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4
Italy	IT	39.1	40.2	41.4	42.5	43.6	44.6	45.7	46.8	47.9	49.0	50.1	51.3	52.5	53.7	54.9	56.1	57.3	58.6	59.8
Luxembourg	LU	1.4	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.7
Netherlands	NL	17.7	18.1	18.6	19.2	19.6	20.1	20.6	21.1	21.6	22.1	22.6	23.1	23.6	24.2	24.7	25.3	25.9	26.5	27.1
Portugal	PT	6.8	7.0	7.2	7.4	7.7	8.0	8.3	8.6	8.9	9.3	9.6	10.0	10.3	10.7	11.1	11.5	11.9	12.4	12.8
Spain	ES	36.5	37.7	39.0	40.3	41.5	42.8	44.0	45.4	46.7	48.1	49.5	50.9	52.4	53.9	55.4	57.0	58.6	60.2	61.9
Sweden	SE	5.7	5.8	6.0	6.1	6.3	6.4	6.6	6.7	6.9	7.0	7.2	7.3	7.5	7.7	7.8	8.0	8.2	8.3	8.5
United Kingdom	UK	56.4	58.1	59.7	61.3	62.9	64.5	66.2	67.9	69.7	71.5	73.2	75.1	77.0	78.9	80.8	82.9	84.9	87.1	89.2
Total (calc)	**EU-15**	**358.0**	**368.3**	**379.3**	**390.7**	**400.4**	**410.3**	**420.4**	**430.8**	**441.5**	**451.9**	**462.5**	**473.4**	**484.6**	**496.0**	**507.4**	**519.0**	**531.0**	**543.2**	**555.7**

Table 7: Assumed proportions of new registrations in compliance with Directive 2003/97/EC, based on (O'Brien 2004) (numerical data in thousands)

Compliance	Year																		
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Proportion of new registrations (Ex BE/NL) in compliance with 2003/97	0%	0%	0%	0%	30%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Number of new registrations (EX BE/NL) in compliance with 2003/97 EU-15	0.0	0.0	0.0	0.0	110.0	375.7	385.0	394.6	404.4	414.0	423.8	433.9	444.2	454.8	465.3	476.1	487.2	498.5	510.1
Cumulative number of vehicles in compliance with 2003/97 EU-15	0.0	0.0	0.0	0.0	110.0	485.6	870.6	1,265.2	1,669.6	2,083.7	2,507.5	2,941.4	3,385.7	3,840.4	4,305.8	4,781.9	5,269.1	5,767.6	6,277.6

Table 8: Forecast total HGV fleet (thousands), based on (O'Brien 2004)

Country	Abbreviation	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	AT	68	70	72	73	75	77	78	80	82	84	85	87	89	91	93	95	96	98	100
Belgium	BE	81	83	85	88	90	92	94	96	98	100	102	104	106	108	109	111	113	115	117
Denmark	DK	61	62	64	65	67	68	70	72	73	75	76	78	79	80	82	83	85	86	88
Finland	FI	64	66	69	71	73	75	77	79	81	82	84	85	86	88	89	91	92	94	95
France	FR	901	926	954	982	1,005	1,028	1,052	1,076	1,101	1,126	1,152	1,178	1,205	1,233	1,260	1,288	1,316	1,345	1,375
Germany	DE	539	553	569	586	599	612	625	639	653	667	681	695	710	725	740	755	771	787	804
Greece	EL	164	171	180	189	196	203	210	217	225	232	240	248	256	264	273	282	291	300	309
Ireland	IE	58	61	65	69	71	74	77	80	82	84	87	89	91	93	95	97	99	102	104
Italy	IT	692	711	732	753	771	790	809	828	848	867	887	908	929	950	971	992	1,014	1,036	1,059
Luxembourg	LU	3	3	4	4	4	4	4	4	5	5	5	5	5	5	6	6	6	6	6
Netherlands	NL	152	156	160	165	169	173	177	181	185	190	194	198	203	208	212	217	222	227	233
Portugal	PT	267	273	281	290	301	312	324	336	349	362	375	389	403	418	433	449	465	482	499
Spain	ES	818	844	873	903	930	958	986	1,016	1,047	1,077	1,108	1,140	1,173	1,207	1,241	1,276	1,312	1,348	1,386
Sweden	SE	82	84	86	88	90	92	95	97	99	101	104	106	108	111	113	115	118	120	123
United Kingdom	UK	437	450	462	474	487	499	512	526	539	553	567	581	595	610	626	641	657	674	691
Total (calc)	EU-15	4,386	4,514	4,655	4,800	4,926	5,056	5,189	5,326	5,467	5,604	5,746	5,891	6,039	6,192	6,344	6,499	6,659	6,822	6,990

Table 9: Estimate of number (thousands) of HGVs available for retrofit, based on (O'Brien 2004)

Available for retrofit in EU-15	Year																		
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number	4,386	4,514	4,409	4,548	4,558	4,306	4,048	3,784	3,514	3,231	2,943	2,647	2,345	2,036	1,716	1,389	1,054	712	362
Proportion of fleet	100%	100%	95%	95%	93%	85%	78%	71%	64%	58%	51%	45%	39%	33%	27%	21%	16%	10%	5%

If it is assumed that the casualty reduction benefit attributable to the retrofit will be in direct proportion to the percentage of the vehicle fleet that are subject to the retrofit (i.e. assuming that the risk of a blind spot accident is not affected by vehicle age), then the fatalities prevented by Directive 2007/98/EC can be estimated from the data presented above. The results are shown in Table 10, below.

Table 10: Estimated fatality reduction potential of a retrofit of class IV/V mirrors, TRL estimate based on data and description from (O'Brien 2004)

	Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Proportion of fleet available for retrofit	100%	95%	95%	93%	85%	78%	71%	64%	58%	51%	45%	39%	33%	27%	21%	16%	10%	5%
Motorcycle & Moped	Total	136	123	118	111	98	86	75	65	56	48	40	34	27	22	16	12	7	4
	Lateral	66	60	58	54	48	42	37	32	27	23	20	16	13	11	8	6	4	2
Pedal cycle	Total	73	66	63	59	52	46	40	35	30	26	22	18	15	12	9	6	4	2
	Lateral	48	44	42	39	35	31	27	23	20	17	14	12	10	8	6	4	3	1

It can be seen that if the retrofit had been implemented at the start of 2006, as assumed in the Jacobs report, the cumulative benefit predicted by 2020 (based on using the figures for all two wheelers, not just those in lateral collisions) would be a reduction in fatalities of 1,078. (O'Brien 2004) produced a figure for EU15 of 1,012, the difference likely to be a result of small differences in the numbers actually used, but not presented, by Jacobs and those assumed by TRL in relation to the description in the Jacobs report.

The analysis above strongly suggests that the estimates for class IV/V mirrors were based on the "total" numbers of two wheelers as reported earlier in Table 1. These estimates would not, therefore, be influenced by the fact that the impact point would be unknown in a proportion of cases. However, the estimate of the effects of Class VI mirrors was stated by (O'Brien 2004) to be based on the figures for "frontal" accidents. Thus, the benefits to pedestrians in particular are likely to be substantially under-estimated as a result of the fact that a very large proportion of impact points appear to be unknown for pedestrians.

The same methods were applied by (O'Brien 2004) to accidents involving LCVs and buses and to the fatalities prevented by requiring class VI mirrors. A summary of the results for EU-15 is reproduced in Table 11, below.

Table 11: Summary of the benefits estimated by (O'Brien 2004)

Vehicle type	Mirror class	Total fatalities prevented 2006-2020	Benefit:Cost Ratio
HGV	IV/V	1,012	3.6
LCV	IV/V	477	0.3
Bus/Coach	IV/V	19	0.5
HGV	VI	145	0.5
LCV	VI	101	0.1
Bus/Coach	VI	11	0.3

4 Assessing the validity of assumptions in light of new evidence

The preceding section found that the following items were of key importance in producing the prediction of benefits reported by (O'Brien 2004) and which informed the decisions with respect to implementation of Directive 2007/38/EC:

- The trend in the overall number of fatalities from road accidents in the EU;
- The proportion of commercial vehicle to vulnerable road user accidents that involve the "critical manoeuvre";
- The effectiveness of mirrors at preventing the relevant accidents, and
- The size of the vehicle fleet and the proportion of that fleet that would be subject to retrofit.

This section considers changes that have occurred and new evidence that has been developed between the time that the previous report (O'Brien 2004) was written and the final implementation of the Directive. To highlight the likely effects that this information might have had if it had been available to (O'Brien 2004) the section has been structured according to the key steps variables outlined above.

4.1 Fatality trends

The EC's Statistical Pocketbook (European Commission 2011) contains data on road fatalities for the EU, covering the historical data reported by (O'Brien 2004) right up to 2009, the year the Directive was implemented. Figure 2, shows the actual observed trend in the total number of fatalities from road accidents in the EU-15 and the predictions made by (O'Brien 2004) and one based on the same principles but actual data to 2009.

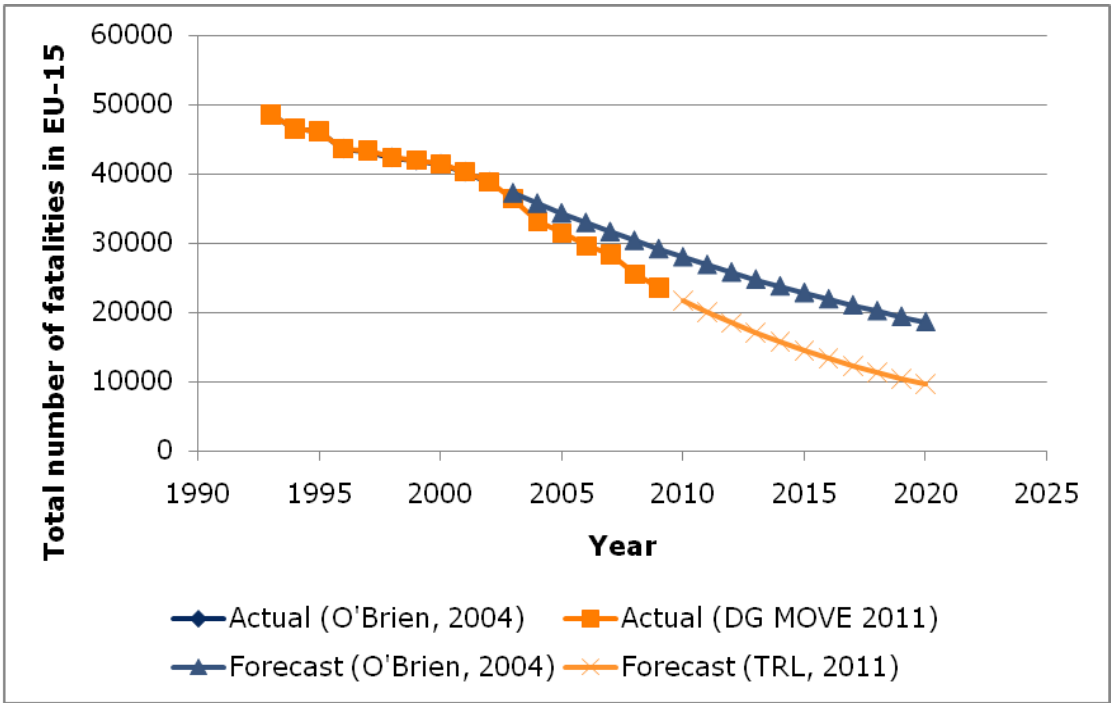


Figure 2: Actual and predicted numbers of fatalities from road accidents in EU-15, based on data from (European Commission 2011)

It can be seen that the prediction in 2004 followed the past trend well. However, after 2004, the pace of fatality reduction increased notably such that the actual number of fatalities recorded was substantially less than predicted. This trend relates to all accident types and cannot be attributed to the decision to fit blind spot mirrors because it pre-dates their introduction. The corollary of this is that the trend in blind spot accidents could be quite different to this. However, because blind spot accidents were assumed to be a fixed proportion of total fatalities in the previous report, then the same analysis repeated on the latest data would have predicted a lower fatality reduction potential than that reported by (O'Brien 2004).

4.2 The critical manoeuvre

4.2.1 Class IV/V mirrors

For class IV and V mirrors the "critical manoeuvre" was identified (O'Brien 2004) as accidents where an HGV, LCV or bus/coach was turning right (left in the UK) and a pedal cyclist or motorcyclist was involved. (O'Brien 2004) estimated that 56% of all fatal accidents involving an HGV and pedal cyclist or motorcyclist fatality did involve an HGV making a right turn (left in UK). This was based on information from the Netherlands.

The European Commission sponsored an in-depth study of truck accidents, the European Truck Accident Causation study (ETAC 2007). The resulting database contained information on 624 truck accidents, 18% of which involved a pedestrian, pedal cyclist or motorcyclist. Blind spots were cited as the main cause of 14 of the 30 (46.7%) of these accidents that occurred close to a junction. In almost 75% of these blind sport cases the HGV was turning left or right at the time. Assuming that no other blind spot accidents occurred when not close to a junction suggests that the critical proportion of HGV/vulnerable road user accidents is 10 of 112 (9%). However, this is 9% of accidents involving all vulnerable road users including pedestrians and including all accident severities.

(Knowles, et al. 2009) studied the causes of pedal cycle accidents. They found that in Great Britain (GB) 430 pedal cyclists were killed between 2005 and 2007, 78 (18%) were in collision with an HGV, of which 48 occurred at an urban junction and 11 at a rural junction, in combination 59 (76%) of all cyclists killed in collision with an HGV. This is greater than assumed by (O'Brien 2004) but again the definition of the sample also differs. Approximately three quarters of the fatal accidents at urban junctions had a blind spot coded as a contributory factor, though it should be noted that this could include blind spots covered by class IV/V mirrors, those covered by class VI mirrors and those caused in direct vision by the A-pillars and mirror clusters themselves. If the same proportions applied to rural junction accidents then this would imply that 57% of fatal accidents involving a pedal cyclist were blind spot related, almost the same as that estimated by (O'Brien 2004) to apply to both pedal cyclists and motorcyclists.

(Robinson and Chislett 2010) analysed the GB Heavy Vehicle Crash Injury Study (HVCIS) database to help assess the relative priorities for commercial vehicle safety. This database contains more than 3,600 records of fatal accidents that occurred between 1995 and 2008 and involved commercial vehicles. It is compiled by TRL analysts that code accidents based on information contained within police reports into fatal accidents, which include expert reconstructions, post mortem data, photographs etc. These analysts code a prediction on a case by case basis of what countermeasures might have prevented the accident or mitigated the injury. The database records 2,078 fatal accidents where at least one HGV was involved, resulting in 2,289 fatalities. Of these, 165 (7.2%) involved pedal cycles killed in collision with an HGV, 381 (16.6%) pedestrians and 228 (10%) motorcycle/moped riders. The distribution of these fatalities by the manoeuvre of the HGV prior to impact is shown in Table 12

Table 12: Distribution of VRUs killed in collision with an HGV by HGV manoeuvre at the time of impact (source: GB HVCIS fatal database)

HGV Manoeuvre	Pedal cycle fatalities		Motorcycle fatalities		Pedestrian fatalities	
	Number	%	Number	%	Number	%
Reversing	1	1%	3	1%	11	3%
Parked	1	1%	6	3%	25	7%
Held-up	1	1%	1	0%	6	2%
Stopping	0	0%	1	0%	1	0%
Starting	15	9%	2	1%	96	25%
U-turn	0	0%	4	2%	1	0%
Turning left	64	39%	4	2%	30	8%
Waiting to turn left	0	0%	1	0%	0	0%
Turning right	9	5%	44	21%	8	2%
Waiting to turn right	0	0%	1	0%	0	0%
Changing lane to left	1	1%	1	0%	1	0%
Changing lane to right	0	0%	3	1%	1	0%
Overtaking moving vehicle	16	10%	4	2%	1	0%
Overtaking stationary vehicle	0	0%	4	2%	6	2%
Undertaking	0	0%	0	0%	0	0%
Going ahead left hand bend	2	1%	6	3%	12	3%
Going ahead right hand bend	0	0%	37	18%	9	2%
Going ahead other	54	33%	89	42%	171	45%
Total	164	100%	211	100%	379	100%
Unknown	1		17		2	

Turning left is expected to be the critical manoeuvre in the UK for class IV/V mirrors (turning right in the rest of the EU). It can be seen that 39% of pedal cyclist fatalities, 8% of pedestrian fatalities and just 2% of motorcycle fatalities were killed when the HGV was making this manoeuvre. If the UK was representative of the EU, which is not known, then this would imply that the estimate of 56% used by (O'Brien 2004) was a substantial over-estimate.

(Cookson and Knight 2010) studied accidents involving pedal cyclists from the point of view of evaluating the effectiveness of sideguards on trucks. However, the work contained data that would be equally applicable to the blind spot scenario and this is reproduced Table 13and Table 14, below.

Table 13. Summary of pedal cyclist casualties in collision with HGVs (Source:(Cookson and Knight 2010))

Severity	1980-1982	1990-1992	2006-2008	% change (80/82 to 06/08) in proportion of casualties of each severity
Fatal	165	127	81	
	7%	7%	9%	22%
Serious	661	465	216	
	28%	24%	23%	-19%
Slight	1533	1322	651	
	65%	69%	69%	6%
Total	2359	1914	948	
	100%	100%	100%	

Table 14: Injury distribution for accidents where the HGV was "turning left" and was impacted on its nearside by a pedal cycle (Source:(Cookson and Knight 2010))

Severity	1980-1982 Total	2006-2008 Total	% change in proportion of casualties of each severity
Fatal	26	22	
	12.9%	15.4%	18.9%
Serious	64	39	
	31.8%	27.3%	-14.3%
Slight	111	82	
	55.2%	57.3%	3.8%
Total	201	143	
	100%	100%	

This data can be used to define the “critical manoeuvre” in the same way as (O'Brien 2004) but for pedal cyclists only i.e. the proportion of all pedal cyclists killed in collision with an HGV (81 GB fatalities in the period 2006-2008) where the HGV was turning left (22 GB fatalities in the period 2006-2008). This implies a proportion of 27% compared with the estimate (O'Brien 2004) of 56% applied to pedal cyclists and motorcyclists.

In summary, no published literature has been identified that allows a rigorous quantification of the proportion of HGV to two wheeler accidents that involve the manoeuvres critical to class IV and V blind spot mirrors that is representative of the EU. However, there is considerable evidence to suggest that the estimate of 56% made in the 2004 study (O'Brien 2004) may have been an over-estimate, particularly with respect to motorcycles.

4.2.2 Class VI mirrors

(O'Brien 2004) found very little evidence with which to quantify the number of casualties in the manoeuvre critical to class VI mirrors, i.e. the vehicle moving away from rest when a vulnerable road user is present in the blind spot immediately in front of the vehicle. O'Brien estimated that for all commercial vehicle types, 25% of those pedestrians, pedal cyclists and motorcyclists killed in collision with the front of a commercial vehicle would involve the critical manoeuvre.

(Knight 2000) found that 12% of all pedestrians killed in collision with an HGV were attributable to the frontal blind spot. However, the proportion of all pedestrian fatalities that involved the front of the HGV was not reported so it is not possible to calculate a figure directly comparable to the 25% used by (O'Brien 2004). It is also worthy of note that this paper did not identify any similar accidents involving a pedal cycle or a motorcycle. Logically, this is because the typical mechanism involved the HGV being stationary at a crossing or junction and the pedestrian, usually elderly and relatively slow moving, crossing the road in front of them. It is relatively unusual for a pedal cycle and certainly a motorcycle to cross the road in front of a stationary vehicle in the same way.

For class VI mirrors the critical manoeuvre is expected to be starting from rest. Table 12, showed that 25% of all pedestrians killed in collision with an HGV, 9% of pedal cyclists and 1% of motorcyclists involved the HGV starting from rest. If this was representative of the whole EU, which is unknown, then it would imply that (O'Brien 2004) had considerably under-estimated the effect on pedestrians (25% of those killed in frontal collisions which was only 2 because impact point was unknown in most cases) but potentially over-estimated the effect on pedal cyclists and motorcyclists.

As stated in the preceding section (ETAC 2007) contained information on 624 truck accidents, 18% of which involved a pedestrian, pedal cyclist or motorcyclist. Blind spots were cited as the main cause of 14 of the 30 (46.7%) accidents that occurred close to a junction. In just over 20% of these cases the HGV was travelling straight on at the time of the accident and thus the blind spot referred to could have been that covered by a class VI mirror. This is equivalent to 3 out of 112, or 3% of all pedestrian, pedal and motorcyclists in collision with an HGV. However, this is based on all casualty severities and not just fatalities.

(Robinson and Chislett 2010) found that 63% of pedestrians killed in collision with a bus, collided with the front of a bus. They also found that for 12% of all pedestrian fatalities killed in collision with a bus, the bus manoeuvre was "starting" from rest. Assuming that all of these relate to the frontal blind spot suggests that 19% of bus frontal collisions with fatally injured pedestrians might be relevant to the class VI mirror.

(Smith and Knight 2005) studied accidents involving LCVs and found that 9% of all fatalities from accidents involving LCVs were pedestrians. It further identified that 76% of those were in collision with the front of the LCV. The manoeuvre of the vehicle was not identified in the report but the impact speed was and is shown in Figure 3, below.

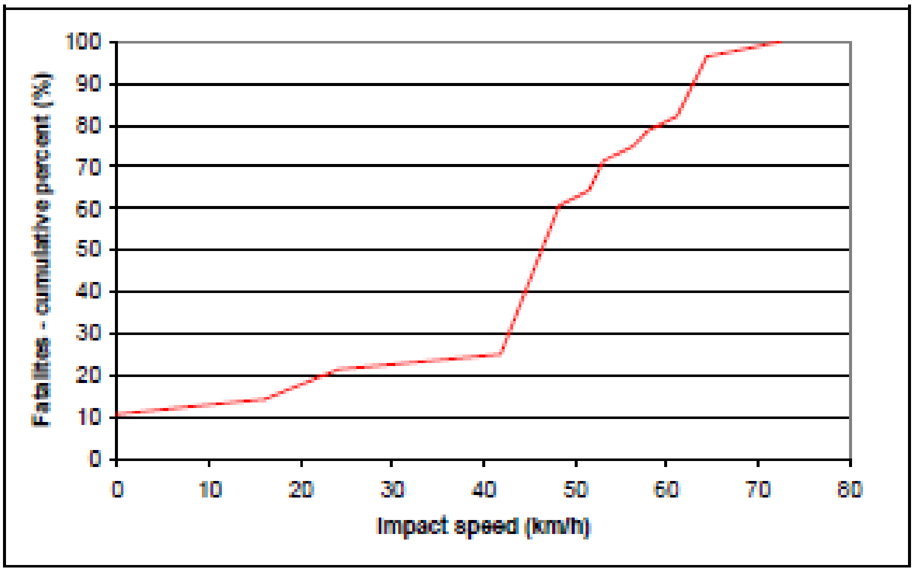


Figure 3: Cumulative speed distribution for fatal accidents between the front of an LCV and a pedestrian, source: (Smith and Knight 2005)

The blind spot in front of a vehicle only extends a very short distance so it will only be relevant to the cause of a collision when the vehicle is stationary or moving very slowly. Analysis the impact speed distribution above suggest that approximately 10%-12% of the fatalities occurred at speeds that might have meant any blind spot was relevant.

In their response to the Commissions questionnaire on the implementation of Directive 2007/38/EC, Ireland stated that:

In the twelve year period between 1996 and 2008, some twenty-one deaths and fourteen serious injuries in Ireland were attributed to the inability of a HGV driver to see his/her victim as they passed through the blind spot in front of their vehicle when they were moving off from a stationary position.

However, no data was provided on the total number of accidents involving HGVs and vulnerable road users, so the proportion making this "critical manoeuvre" could not be evaluated.

4.3 The effectiveness of blind spot mirrors

(O'Brien 2004) estimated that blind spot mirrors (class IV, V, VI) would be effective in preventing;

- 40% of the accidents involving HGVs making the "critical manoeuvre";
- 30% of the accidents involving LCVs making the "critical manoeuvre", and
- 10% of the accidents involving buses and coaches making the "critical manoeuvre".

The 40% effectiveness for HGVs was based on research by SWOV in the Netherlands but no reason was given for the reduced effectiveness for LCVs and buses. Whether or not a mirror will be effective at preventing any given blind spot accident will depend on a range of factors such as:

- Whether the view provided is sufficient to enable the other road user to be seen;
- Whether the mirrors was adjusted correctly to provide that field of view;

- Whether the driver was alert, attentive and correctly surveying the direct field of view and all 6 mirrors;
- The driver workload;
- Whether the driver looked at the right mirror at the exact time that the other road user was visible in that mirror;
- The quality of view provided by the mirror (i.e. clear true images more likely to be recognised correctly than distorted or vibrating views), and
- Whether the driver recognised the image as a hazard and takes appropriate avoiding action.

The physical field of view provided by the mirrors in terms of both area and quality is in theory the same for HGVs, LCVs and buses. The remaining factors mainly relate to driver behaviour and there is no obvious reasons why a bus driver should be less diligent than an HGV driver in terms of adjusting mirrors correctly, paying attention and looking. Although the direct field of view from the different vehicles classes will vary, as will their exposure to risk in terms of frequency of turning in areas where vulnerable road users are present, these should be accounted for in the estimates of the "critical manoeuvre". There appears to be very little evidence to support the differentiation of different vehicle classes in terms of the proportion of those accidents involving "critical manoeuvres" that blind spot mirrors would prevent.

(Fenn, et al. 2005) studied the UKs Heavy Vehicle Crash Injury Study (HVCIS) database. Analysis of the information in this field suggested that improving the side view had the potential to prevent the deaths of 55% of cyclists and pedestrians killed in GB when an HGV turned left (right in the rest of EU).

(Schoon 2009) found that despite a dip during the years of implementation, the number of blind spot accidents in the Netherlands had returned close to the levels seen before blind spot mirrors were implemented. So, the initial 43% reduction observed by SWOV and used as the basis of the effectiveness estimate by (O'Brien 2004) had largely disappeared by 2004. (Schoon 2009) also observed that in Denmark the number had stayed relatively constant despite the fitment of blind spot mirrors.

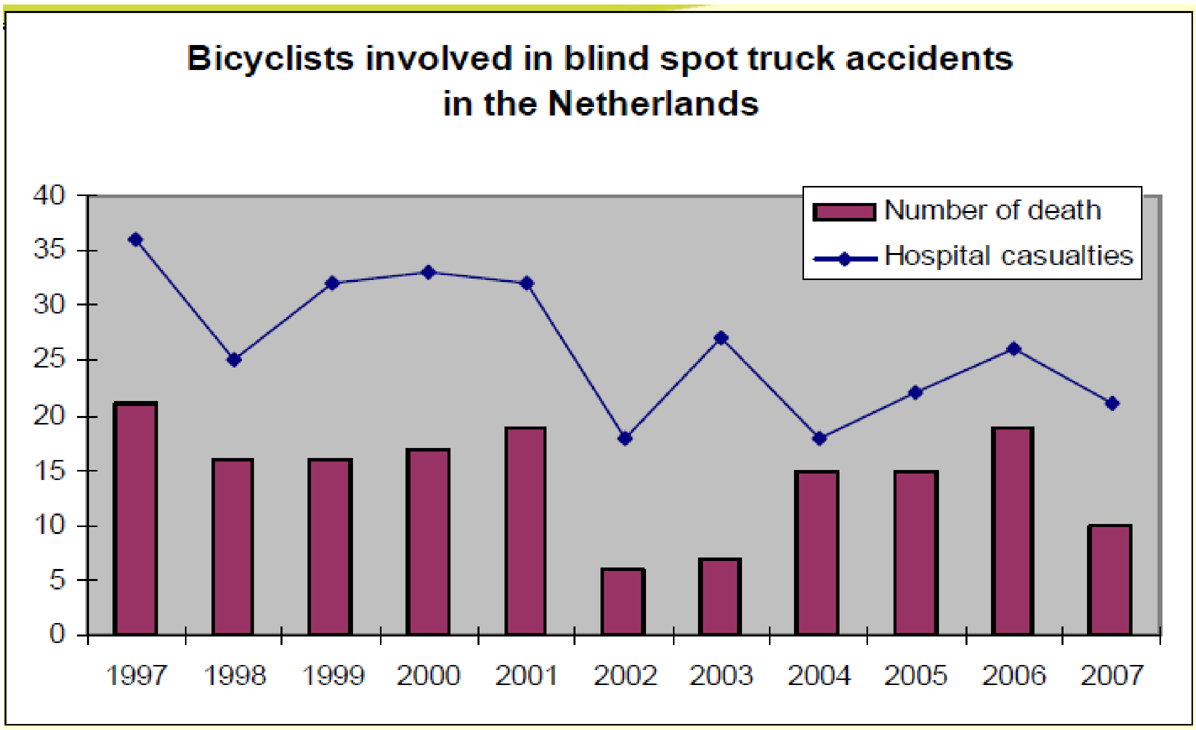


Figure 4: The trend in pedal cyclists injured in truck blind spot accidents in the Netherlands (source (Schoon 2009))

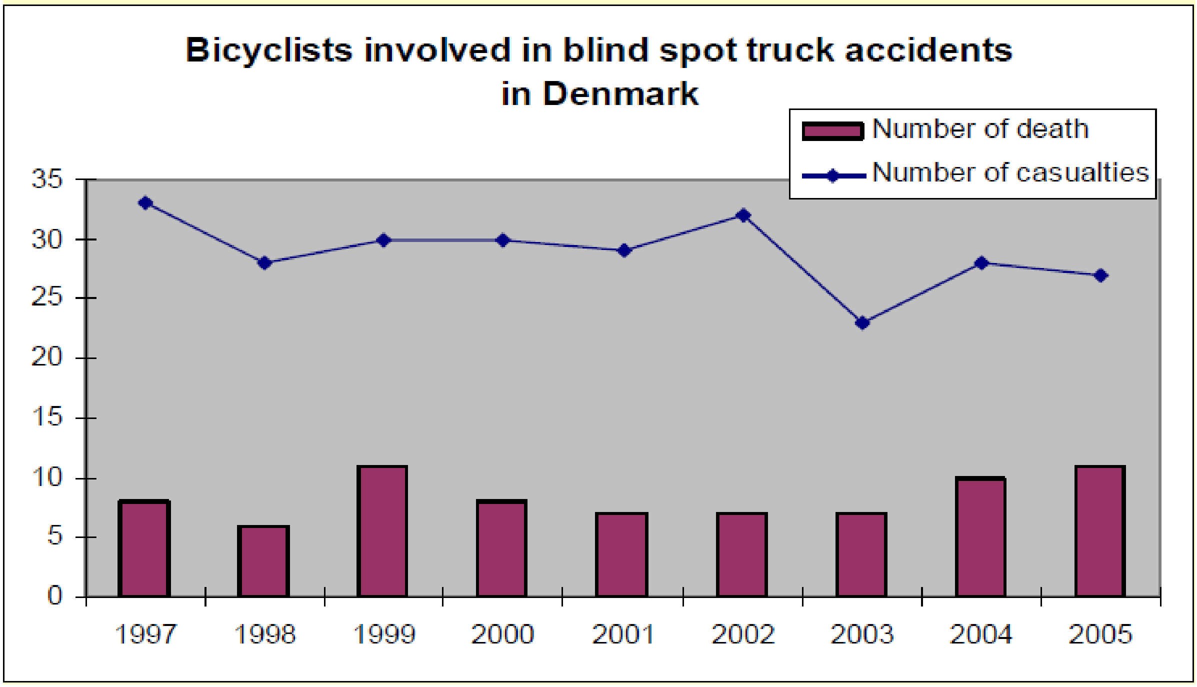


Figure 5: The trend in pedal cyclists injured in truck blind spot accidents in Denmark (source (Schoon 2009))

In a study of 53 in-depth police reports (Schoon 2009) relating to this accident type there were 19 cases where mirror adjustment was checked. For seven (37%) of those checked, the mirrors were poorly adjusted.

4.4 The vehicle fleet

The predictions (O'Brien 2004) of the number of vehicles in the fleet and the proportion that would be equipped with blind spot mirrors as a result of fitment to new vehicles under Directive 2003/97/EC, were based on assumptions that GDP would continue to grow. However, the financial crisis and ensuing recession had a substantial effect on the automotive industry.

The European Commission (European Commission 2011) publishes information relating to the number of new HGVs registered each year and the actual figures recorded are compared to the predictions made by O'Brien (2004) in Figure 6, below.

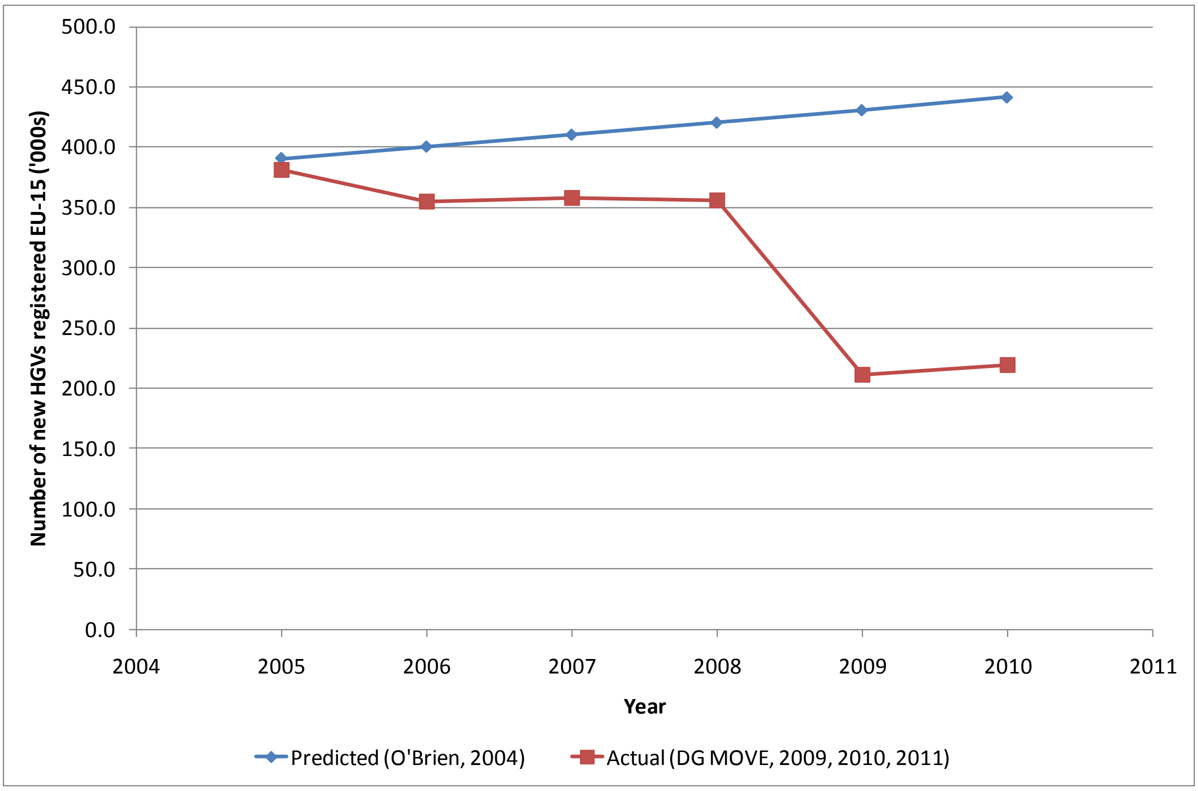


Figure 6: Actual and predicted trends in new truck registrations in EU-15 (source: DG MOVE statistical pocket book 2009, 2010, 2011, and O'Brien, 2004)

The Commission data does not separate figures for goods vehicle stock by GVW so it is not possible to separate LCVs from HGVs to provide a direct comparison of the number of vehicles available for retro-fit when it was actually implemented in 2009 and the estimate made (O'Brien 2004) for a proposed implementation in 2006. However, the data behind Figure 6 shows that the number of newly registered HGVs dropped by approximately 45% between 2005 and 2009. (European Commission 2011) shows that the total freight task (national and international tonne kms in EU15) dropped by just 12% in the same period. This strongly suggests that the average age of the fleet would have increased significantly during this time, making it very likely that the number of vehicles requiring retrofit in 2009 was greater than estimated would be the case, if the proposal had been implemented in 2006. This will have increased the costs of the retrofit compared to the initial estimate but would also be expected to increase the proportion of the total benefit of reducing blind spot accidents that could be attributed to the retro-fit Directive rather than the type approval requirements applied to new vehicles. It would not, therefore, be expected to have much effect on benefit-to-cost ratios.

5 How was the Directive implemented in each Member State?

The results in this section are strongly based on the 13 responses to the questionnaire sent by the European Commission to each Member States prior to the commencement of this study. These responses and TRLs analysis of them are provided in full in Appendix A and a summary of the findings is included here.

The respondents all indicated that the Directive had been transposed into national law, relating to construction of vehicles and/or roadworthiness inspection. Dates of transposition were included for 8 of the 13 responses. These ranged from December 2007 to January 2009 with 4 of the remaining 6 transposing the requirements between April and July 2008.

It is assumed that the dates provided by respondents were the dates on which the legislation entered into force. What will be important to the analysis of the effects on casualties is the dates by which all vehicles in the fleet had to be equipped by and when the voluntary build up of equipment began ahead of the deadline for all vehicles. No information was provided about these dates by the respondents. It seems likely that each Member State would have written into their national implementation the same deadline for all vehicles to be equipped as for Directive 2007/38/EC, that all vehicles shall be equipped not later than 31st March 2009. The extent of voluntary fitment before that date cannot be identified from the questionnaire data.

For 11 of the 13 respondents, national requirements to fit N2 and N3 vehicles with wide angle, close proximity or other blind spot mirrors did not exist before implementation of Directive 2003/97/EC for new vehicles and 2007/38/EC for existing vehicles. Denmark had required all N2 and N3 vehicles to be equipped from 2004. The Netherlands had the same requirement but the date of implementation was not specified. (SWOV 2009) states that a blind spot mirror was required from 2003 but highlights that this did not show as quite as much area as the new class IV and V mirrors in combination.

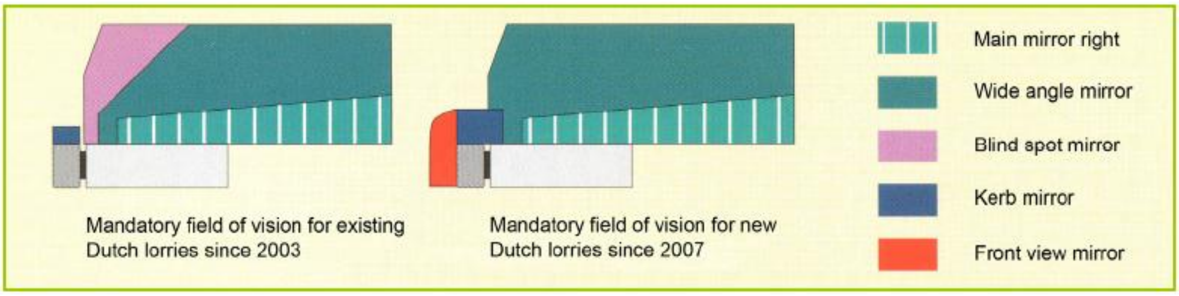


Figure 7: Field of view requirements in the Netherlands. Source: (SWOV 2009)

Respondents were asked to supply details of alternative solutions to standard class IV and V mirrors (e.g. supplementary blind spot mirrors, cameras etc) that were nationally required for vehicles that were out of scope of the Directive (i.e. those registered before the 1st January 2000 and those of < 7.5 tonnes GVW). However, it appears as if some respondents have replied in relation to vehicles that were in scope of the directive but where it was uneconomical to retro-fit the standard mirrors and some as if the supplementary mirrors would be in addition to class IV and V mirrors. For this reason, TRL has attempted to categorise the answers as shown in Table 15, below. It should be noted that it is possible this summary may accidentally misrepresent what the respondent meant but, within the scope of this study, there was insufficient time to contact each respondent and confirm the interpretation.

Table 15: TRL interpretation of responses on the use of alternative mirrors/cameras

	Vehicle categories		
	All in scope of Article 2	**Registered pre 2000**	**N2 ≤7.5t GVW**
Alternatives permitted but no defined list of technical solutions	DK, ES	DK	DK
Alternatives permitted, list of technical solutions provided	NL	NL	NL
Alternatives permitted only where approved Class IV and V uneconomic to retrofit – no list	FR, IE		
Compliance not required		FI, FR, DE, IT, LV, PL, RO, SK, ES	FI, FR, DE, IT, LV, PL, RO, SK, ES
Alternatives not permitted	DE, IT		
Unknown	FI, LV, LU, PL, RO, SK	IE, LU	IE, LU

It can be seen that it is only the two Member States where national schemes were implemented ahead of the implementation of Directive 2007/38/EC that are known to require compliance for vehicles registered before 2000 and for vehicles not exceeding 7.5tonnes GVW. Of these only the Netherlands has specified a list of technical solutions deemed to comply. Most other respondents did not reply in relation to vehicles within scope of the Directive (the question did not strictly ask for a reply). However, France and Ireland made it clear that they would permit supplementary measures where it was uneconomic to retrofit the standard class IV and V mirrors but that this was only the case for a very small number of vehicles. Germany and Italy made it clear that they did not support fitting additional devices over and above the 6 mirrors already required for "most" vehicles, because of the implications for driver workload. This was taken to mean that alternatives were not permitted. However, the replies do not make it entirely clear if they would be supported where they were an alternative to older designs of wide angle and close proximity mirrors fitted to the minority of older vehicles, such that the total number of devices for indirect field of view did not exceed 6.

Respondents were asked how compliance with the Directive was demonstrated and the answers are listed below:

- Mirror test area with markers required at PTI; DK
- Certificate of compliance: FI, FR, IT, LU, PO, ES
- List of approved devices: NL
- Other: DE, IE, RO, SK

It can be seen that most Member States that responded preferred to use a certificate of compliance issued by the installer as a means to demonstrate compliance with the requirements. Only Denmark requires a full test of the field of view at its periodic technical inspection (PTI) and only the Netherlands supply a list of approved devices. Four other respondents used “other” approaches. Germany used a measurement of the radius of curvature to approximate a measure of compliance and the remaining three used some combination of two or more of the four identified methods.

It is worth noting that (VOSA 2008) shows that the UK also implemented the Directive but that its certificate of compliance was permitted to be by means of self certification by the operator of the vehicle. At PTI the certificate would be checked but not that the field of view was in actual fact achieved. The effectiveness thus relied heavily on the integrity of the industry in fitting the appropriate devices.

Most respondents stated that it was not possible to provide information on how many vehicles failed to comply specifically with 2007/38/EC because their periodic technical inspection statistics did not separate non-compliance with this Directive from other mirror failures such as cracked lenses or insecure mountings. Several of these commented that they believed that there were few problems. A few provided data on general mirror failures showing relatively small numbers of failures but did not provide data on the number of vehicles tested so the proportion of failures could not be calculated. The estimates for Luxembourg and the Slovak Republic suggested levels of non-compliance with the Directive of between 0.3% and 2.5%.

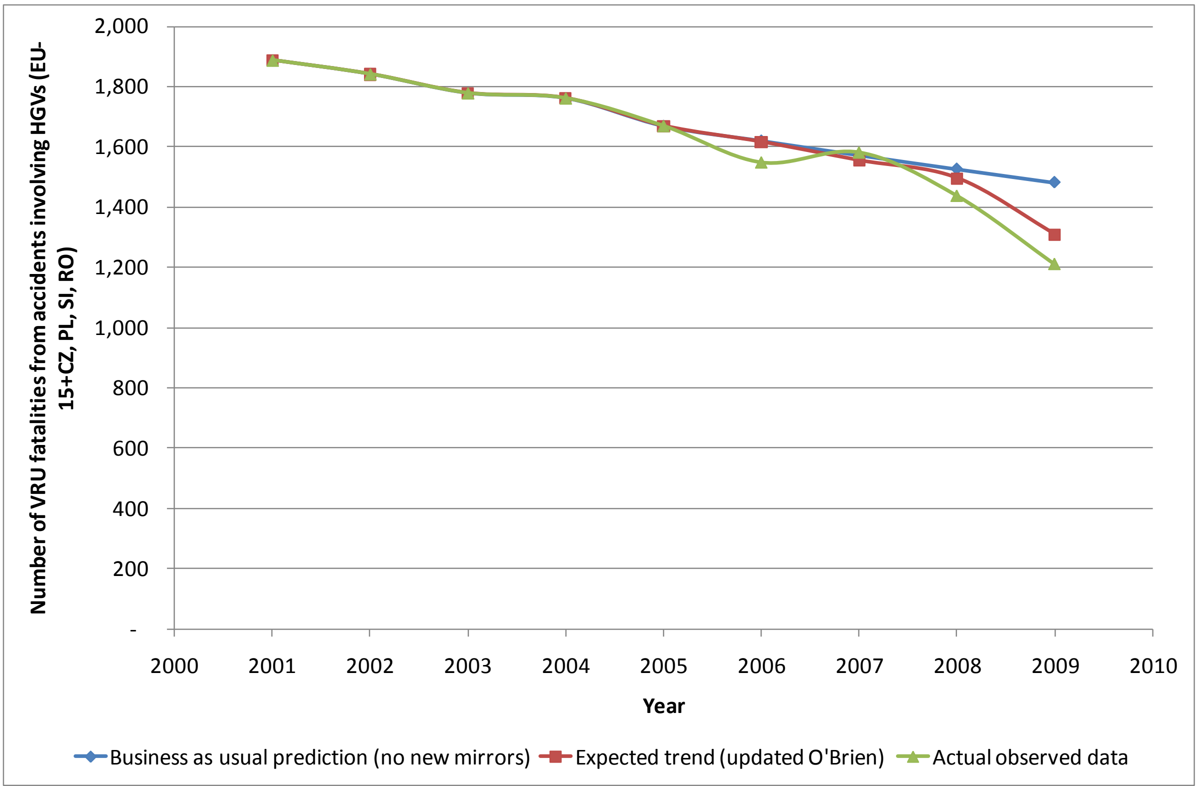
6 Expected and observed casualty trends

The data underlying the figures presented graphically in this section are reproduced in tabular form in Appendix B.

6.1 Accidents involving HGVs

Data was provided to TRL by the European Commission[3] that covered the total number of accidents and fatalities from all accidents, accidents involving HGVs and accidents involving HGVs and vulnerable road users. The data covered the EU-15 countries plus the Czech Republic, Poland, Slovenia and Romania[4] for the time period 2001 to 2009.

Using actual data from 2001 to 2005, inclusive, the methods used by (O'Brien 2004) were employed to produce updated predictions of the 'business as usual' scenario, where no new blind spot mirrors would be fitted to vehicles, and the scenario that was actually implemented where blind spot mirrors were fitted to all new vehicles in 2007 (30% voluntary compliance in 2006) and retro-fitted to existing vehicles in 2009. In other words these were the predictions that (O'Brien 2004) would have made if they had known the actual number of casualties for all years up to 2005, the year before blind spot mirrors would first have become common on new vehicles. These predictions were compared with the actual data recorded, as shown in Figure 8, below.



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[3] The source of the data was the Community database on Accidents on the Road in Europe (CARE).

[4] These four "new" Member States were added to the EU-15 because they were the only new Member States for which data was available as far back as 2001.

Figure 8: Expected and observed trends in the number of vulnerable road user fatalities from accidents involving HGVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

It can be seen that in the absence of fitting new mirrors, the number of VRU fatalities from accidents involving HGVs was expected to continue to decline at the same rate as in the preceding five years. The updated prediction of the effect of blind spot mirrors was that there would be a small additional reduction in the numbers in 2006 and 2007 associated with the fitment of mirrors to new vehicles and then a sharp additional reduction in 2009 when the remainder of the fleet was retrofitted with class IV/V mirrors.

It can be seen that the shape of the actual trend in vulnerable road user fatalities closely follows the prediction but actually shows a lower overall number of fatalities than predicted. This suggests that blind spot mirrors may have worked and, in fact, may have exceeded expectations. However, a very large range of factors can affect the number of fatalities, for example the volume of HGV traffic, the volume of vulnerable road user traffic, the extent to which the two traffic types co-exist on the same roads, and the influence of other trends or safety interventions such as, improved education and training, increasing separation of cyclists in their own cycle lanes, better pedestrian facilities, etc.

The information presented in section 4 suggested that the accident characteristics were different when motorcycles, pedal cycles and pedestrians were involved. In addition to this, only side mirrors were implemented in the retrofit and these were not considered likely to affect pedestrians. The data above has therefore been separated into accidents involving the three different vulnerable road user types, as shown in Figure 9 to Figure 11, below.

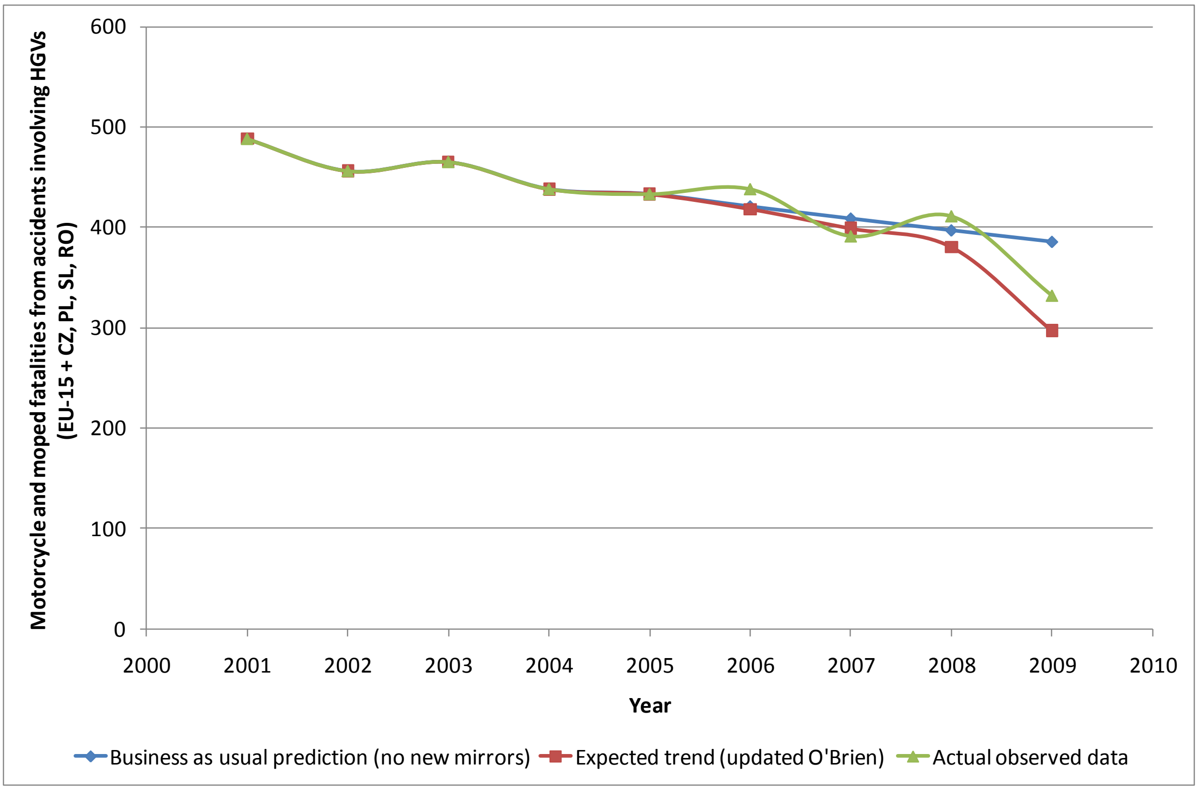

Figure 9: Expected and observed trends in the number of motorcycle/moped rider fatalities from accidents involving HGVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

It can be seen in Figure 9 that the change between 2008 and 2009 also follows fairly closely, the predicted change. However, when only riders of powered two-wheelers are considered the reduction is not quite as great as predicted. In addition to this, the observed trend is more variable from year to year and it can be seen that drawing a linear trend through the years 2005 to 2009 would also provide relatively good correlation with the actual data and would not show the sharp reduction in 2009 expected. It is, therefore, difficult to be sure without data from later years whether the drop seen in 2009 represents a departure from trend as a result of the fitment of blind spot mirrors or is merely part of ongoing random variation around a more slowly declining mean.

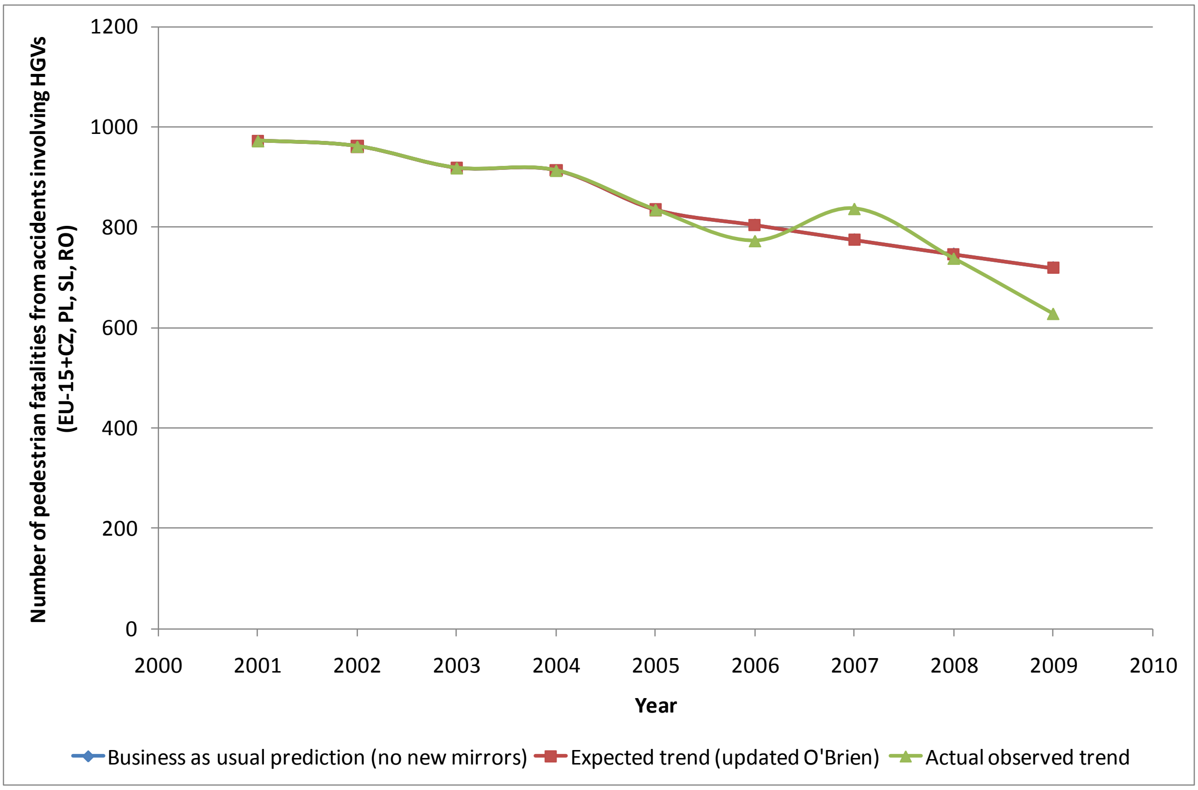

Figure 10: Expected and observed trends in the number pedestrian fatalities from accidents involving HGVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

For pedestrians the 'business as usual' and expected trends are almost the same (Figure 10). This is because pedestrians were only expected to be affected by class VI mirrors and because the predicted effect was small as a result of the small number of cases explicitly identified by (O'Brien 2004) as being frontal (likely because of a large number of unknowns). Class VI mirrors have been fitted to new vehicles since 2007 but they were not part of the retro-fit programme in 2009, so the proportion of the total fleet that are equipped remains small.

Again, there is more fluctuation in the observed data for this smaller group and it is likely that this represents random variation around the predicted means, but it may also be that there is a faster rate of reduction from around the time of introduction of blind spot mirrors. Data for more years after implementation would be required to give more confidence in the conclusion.

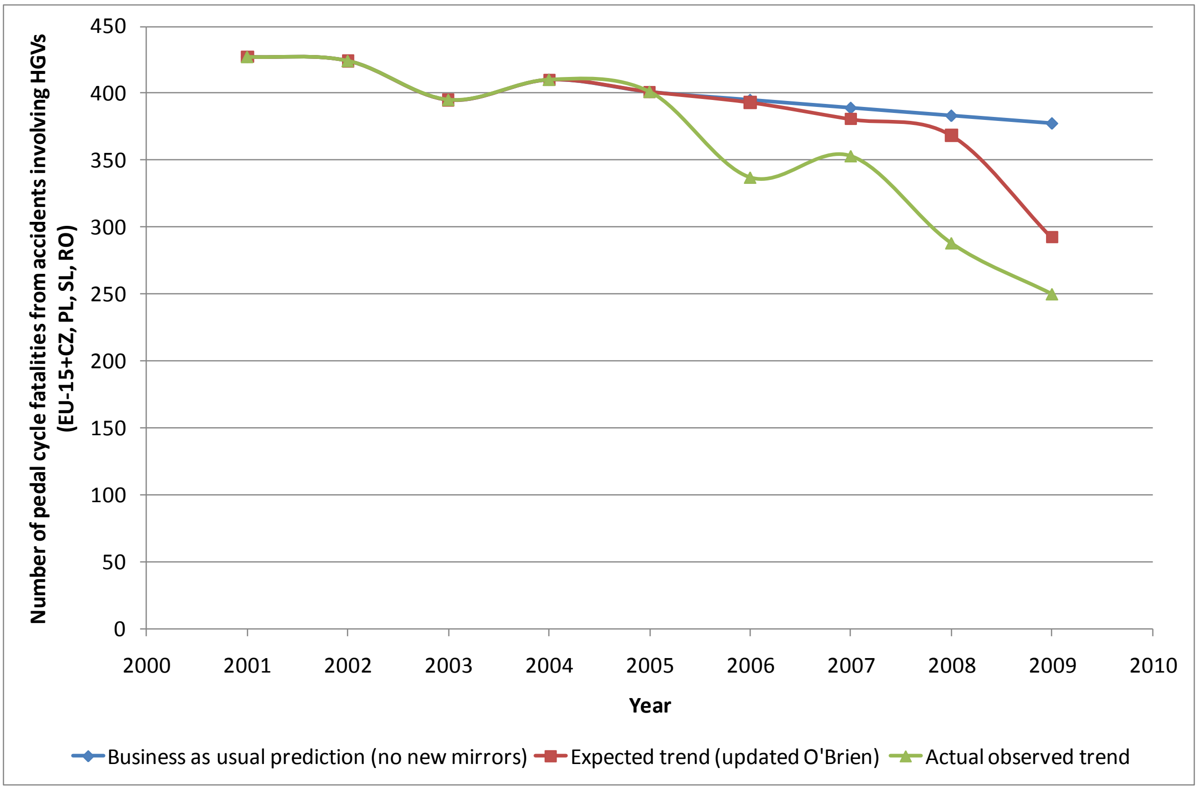

Figure 11: Expected and observed trends in the number of pedal cyclist fatalities from accidents involving HGVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

Much of the evidence presented in section 4.2 suggested that it would be pedal cyclists that gained most from blind spot mirrors, particularly in accidents where they collided with an HGV that was turning right (left in the UK). The data in Figure 11 shows, by some margin, the most noticeable change in trend with a substantial increase in the rate of fatality reduction. However, this change in trend comes after 2005, substantially before the time when blind spot mirrors were mandatory, even on new vehicles. None of the responses from the Commissions survey (see section 5) suggested that voluntary fitment began as early as 2005. Although Denmark and the Netherlands reported mandatory fitment of blind spot mirrors from around 2003, later research also suggests it did not have a large effect on reducing the number of cyclist fatalities. It is, therefore, quite difficult to attribute the casualty reduction identified to the implementation of either blind spot mirror Directives without further evidence and analysis.

The duration (1 month) of this study precluded in-depth studies to try to account for confounding factors and identify what, if any, part of these trends could be scientifically linked to the implementation of the blind spot Directives. However, limited additional analyses were undertaken in an attempt to provide further understanding.

Firstly, it is likely that most existing vehicles only became compliant with Directive 2007/38/EC in late 2008 or the early part of 2009. The most recent accident data available from the European Commission related to 2009 and so there is only one year of data available where the measure would have been close to fully implemented and no data where it is possible to be completely sure that it is fully implemented. This is insufficient to identify post-implementation trends accurately.

In reality, it is likely that at least three years of post implementation data would be required to begin to confidently identify any post implementation trend. This is not currently possible but the national accident database in Great Britain (GB) does additionally have data available for 2010. It also allows the manoeuvre before impact to be identified as well as the type of HGV. A trend was, therefore, produced for pedal cycle fatalities in GB where an HGV was involved and turning left (equivalent to right in the rest of the EU) at the time of the collision. This is shown in Figure 12, below.

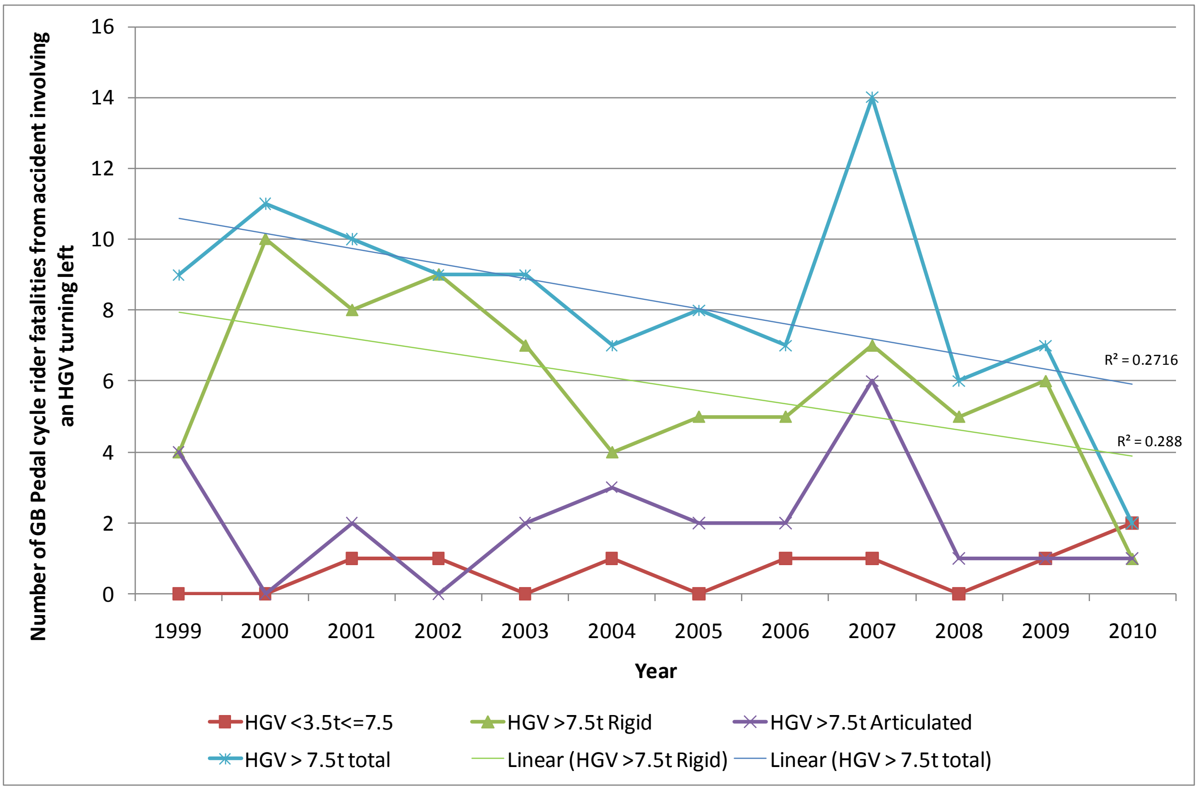

Figure 12: The number of GB pedal cycle rider fatalities from accidents involving HGVs turning left by GVW and rigid/articulated (source: Stats 19, the GB national accident database)

It can be seen that this accident type is dominated by rigid vehicles in excess of 7.5 tonnes GVW, which is perhaps expected because of their greater numbers and increased likelihood of operating in urban areas where conflict with cyclists is more likely to occur. The data does show a substantial reduction in the numbers in 2010 but there is considerable year to year variation in the low overall numbers that means it remains very difficult to establish with any confidence whether there has been a departure from the trend at a time that coincides with the introduction of blind spot mirrors. For example, the numbers actually went up between 2008 and 2009 when the retrofit Directive was implemented.

The HGV manoeuvre is known in the CARE database for Belgium, Denmark, Spain, France, Portugal and the UK. For these countries a breakdown of vulnerable road user fatalities (two-wheelers and pedestrians) is shown by HGV manoeuvre only.

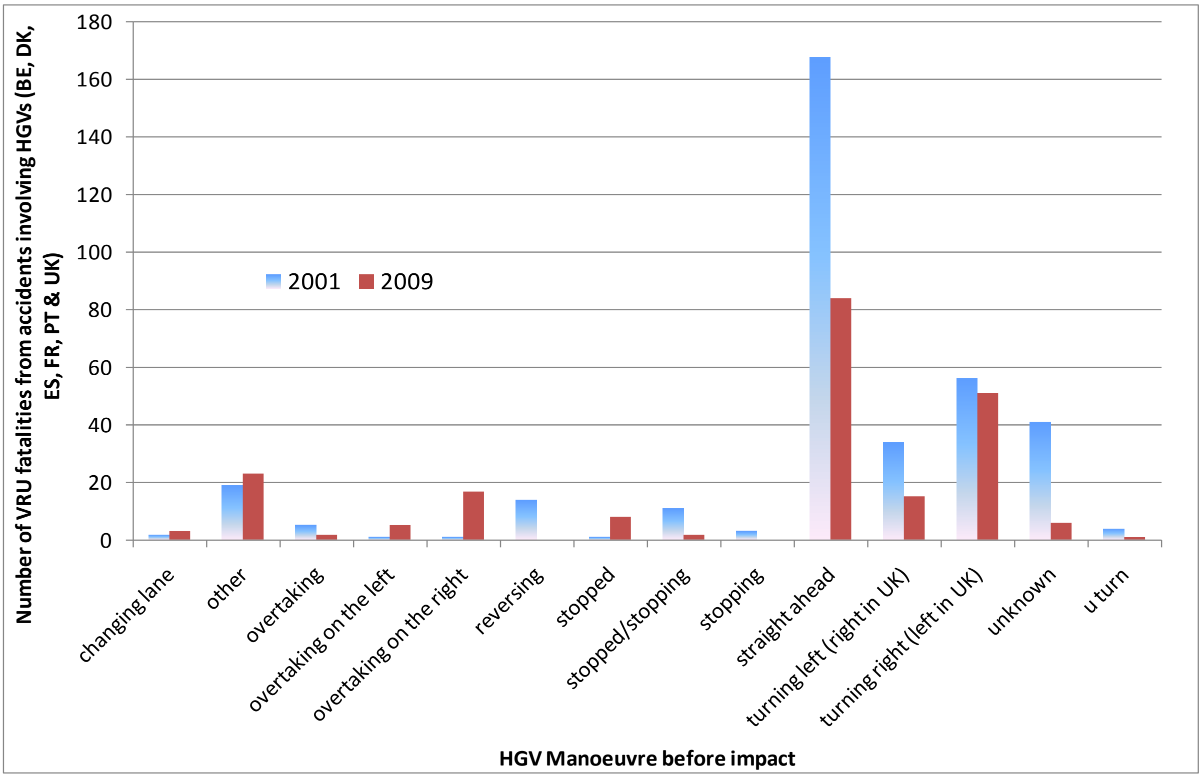

Figure 13: Distribution of VRU fatalities by HGV manoeuvre, 2001 and 2009 (Source: CARE BE, DK, ES, FR, PT, UK)

It was expected that the main manoeuvres to be influenced by blind spot mirrors would be turning right (left in the UK) and starting from rest. However, the casualty numbers are dominated by accidents where the HGV was going straight ahead at the time of impact and this category has reduced to approximately half its 2001 level. This category would include, for example, head on collisions with motorcyclists, those where a two wheeler turned across the path of the HGV, collisions where pedestrians crossed in front of an HGV moving at traffic speed etc. These types of collision are unlikely to be influenced by blind spots. By contrast accidents involving the HGV turning right (left in the UK) have reduced by only a small amount from 56 in 2001 to 51 in 2009. As a percentage of all VRU fatalities from accidents involving HGVs they have increased from 16% to 24%.

Combined with the timing of reductions shown in Figure 11, this data casts substantial doubts as to whether the observed reductions in vulnerable road user fatalities caused in collision with an HGV can be attributed to the measures taken in Directives 2003/97/EC and 2007/38/EC.

6.2 Accidents involving LCVs

The same approach was applied to data from accidents involving LCVs. In this case the predictions that would have been made based on data up to 2005 are shown but it would be expected that the actual data would follow the ‘business as usual’ prediction because no action was taken to retrofit mirrors to LCVs.

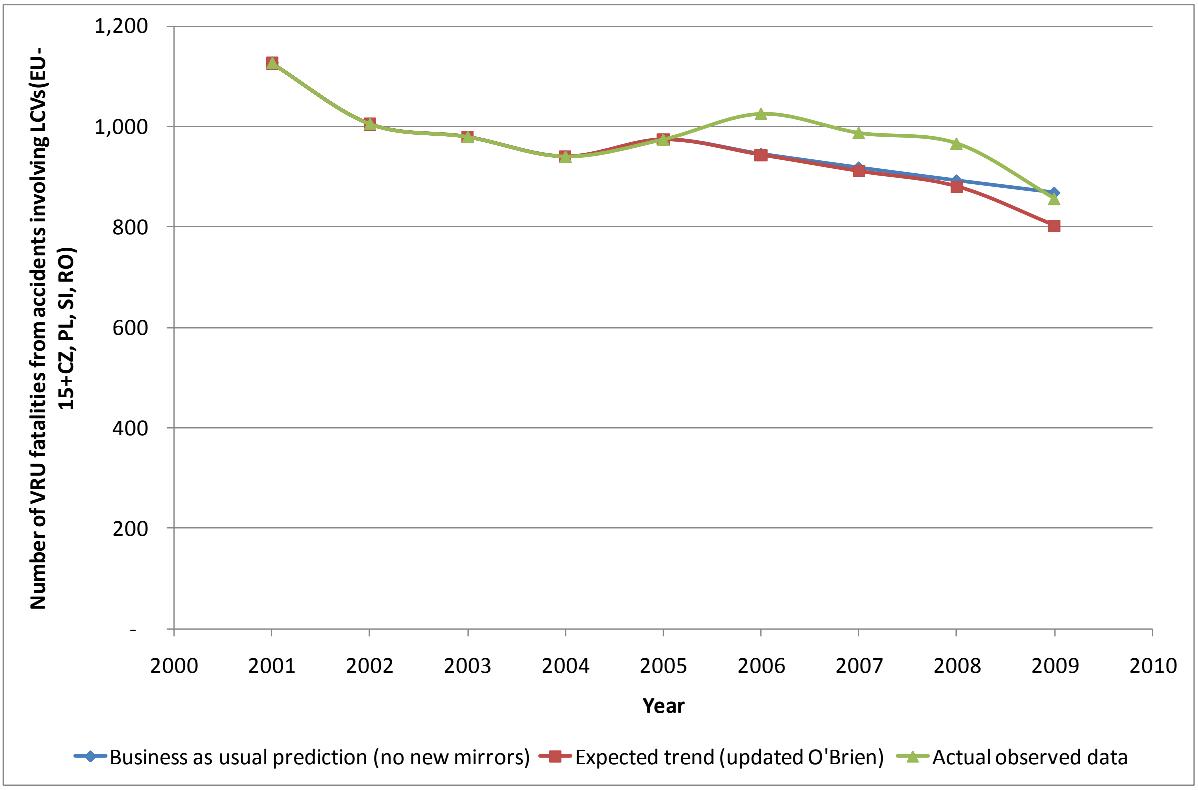

Figure 14: Expected and observed trends in the number of vulnerable road user fatalities from accidents involving LCVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

Figure 14 shows that the actual the number of vulnerable road user fatalities from accidents involving LCVs exceeded that which would have been expected based on data from 2001-2005, except for 2009 when a sudden decline brought the number back into line with expectations. These figures can also be divided into motorcycle/moped, pedal cyclist and pedestrian fatalities, as shown in **Figure 19** to **Figure 21** below.

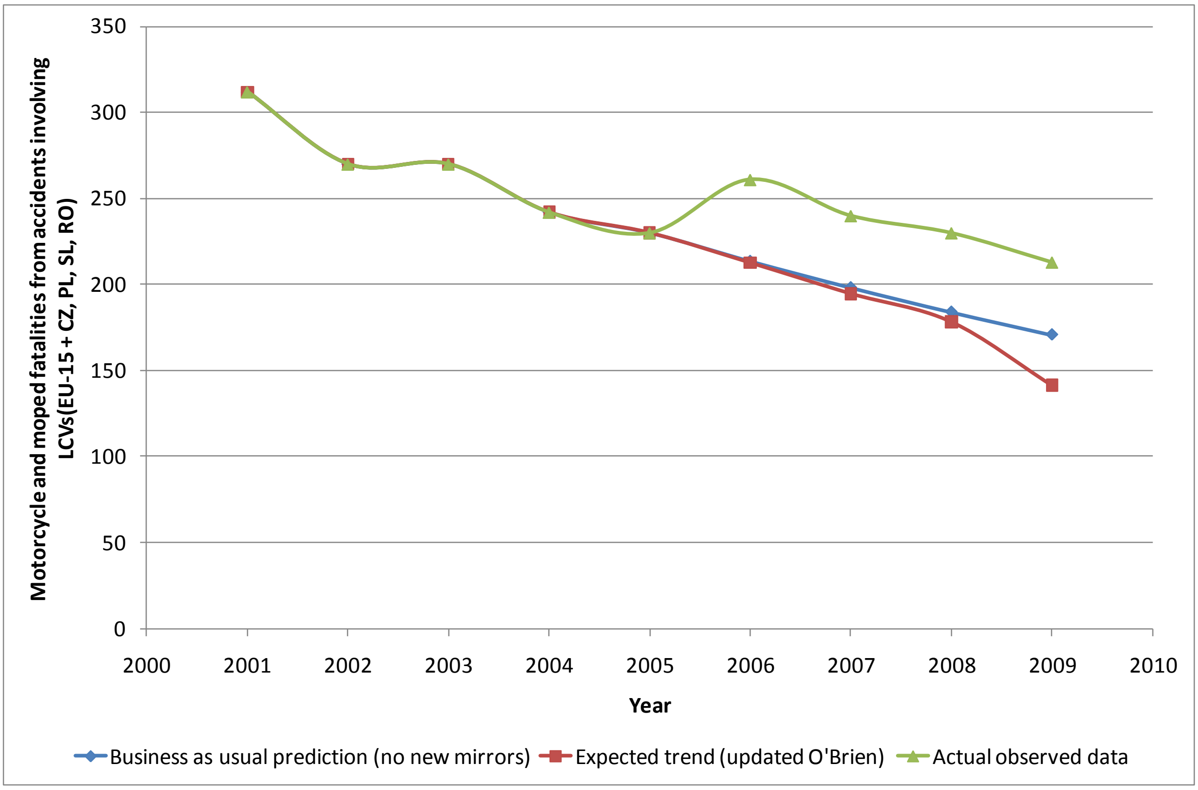

Figure 15: Expected and observed trends in the number of motorcycle/moped fatalities from accidents involving Buses LCVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

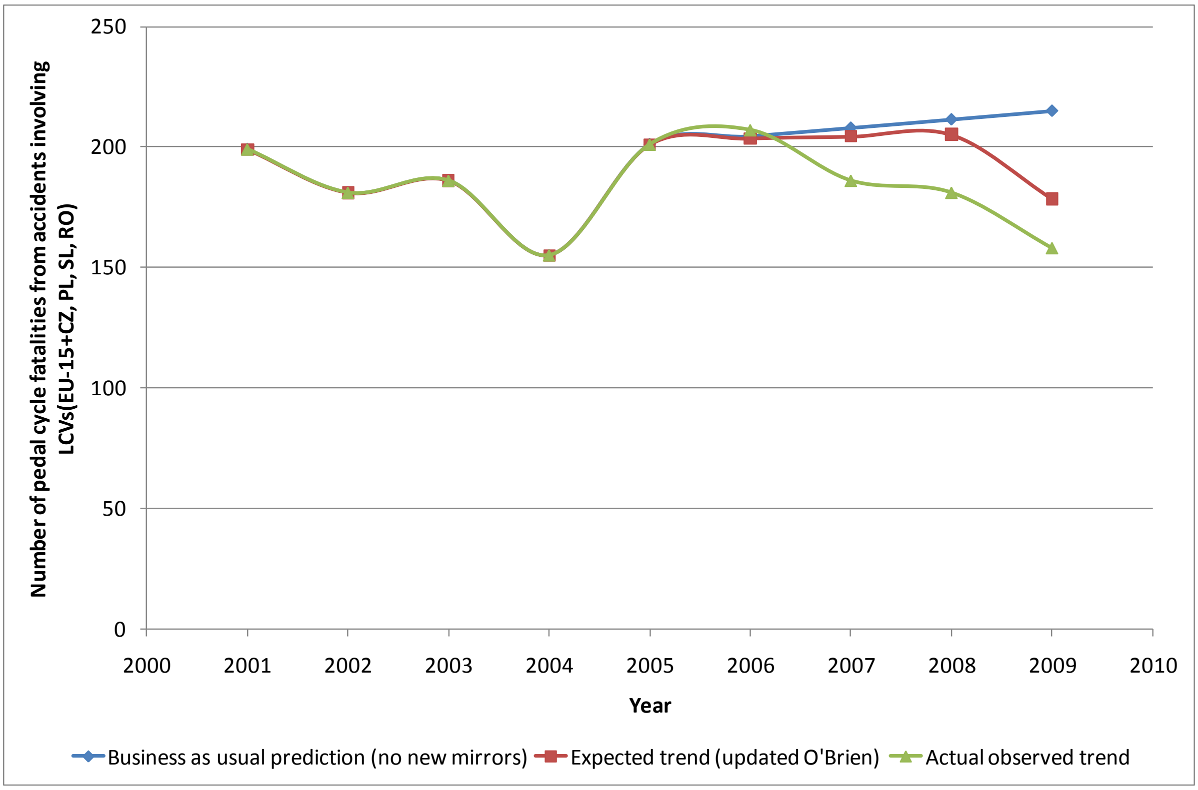

Figure 16: Expected and observed trends in the number of pedal cyclist fatalities from accidents involving LCVs (Source data: CARE EU-15 + CZ, PL, SL, RO)

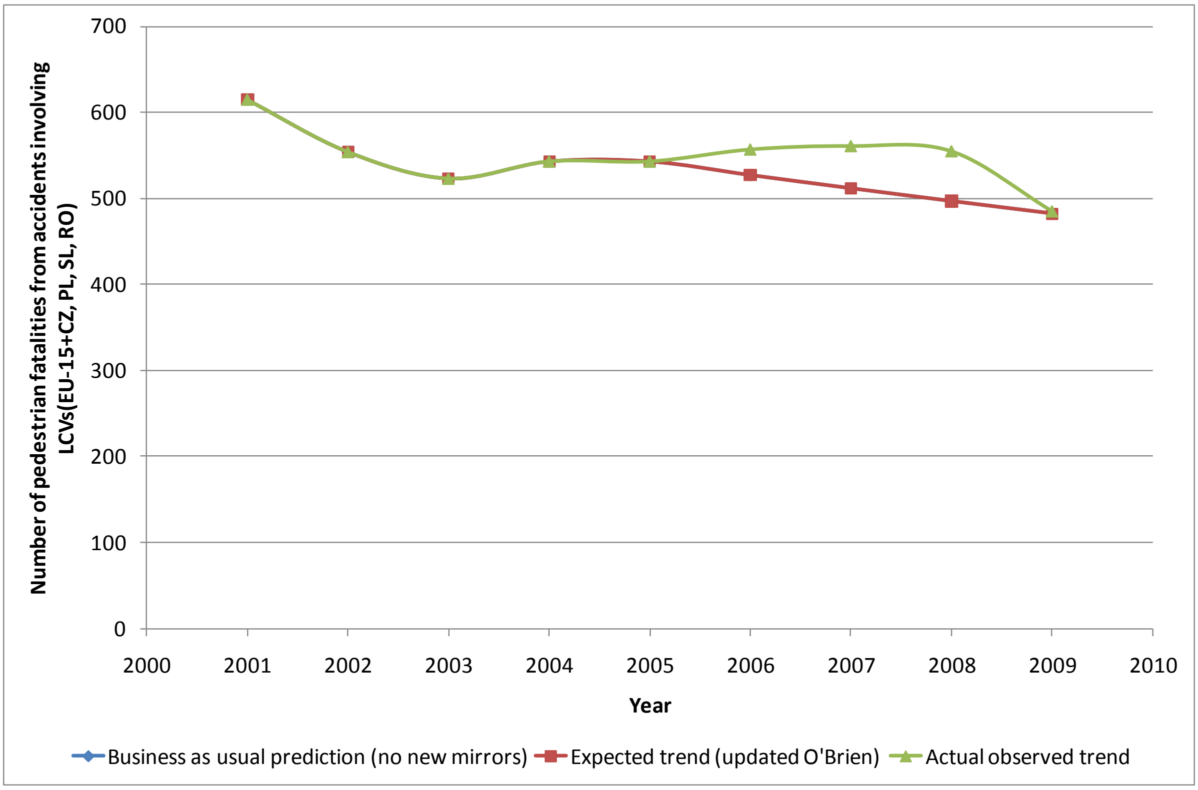

Figure 17: Expected and observed trends in the number of pedestrian fatalities from accidents involving LCVs (Source data: CARE EU-15 + CZ, PL, SL, RO)[5]

From the above graphs it can be seen that the motorcycle/moped and pedestrian fatality trends exceed the values that would have been predicted based on 2001-2005 data. For pedal cyclist fatalities, the actual figures are substantially less than the predictions would have suggested but this result is substantially affected by variation in the annual totals as a result of small numbers.

6.3 Accidents involving buses and coaches

The same approach was applied to data from accidents involving buses and coaches. In this case the predictions that would have been made based on data up to 2005 are shown but it would be expected that the actual data would follow the business as usual prediction because no action was taken to retrofit mirrors to buses, even though they were subject to the requirements for new vehicles.

[5] Note that for pedestrians the business as usual trend is indistinguishable from the expected trend because the expectation was that new mirrors would only be fitted to new vehicles, and that effectiveness was low because it was based on the proportion of pedestrian fatalities resulting from contact with the front of the vehicle.

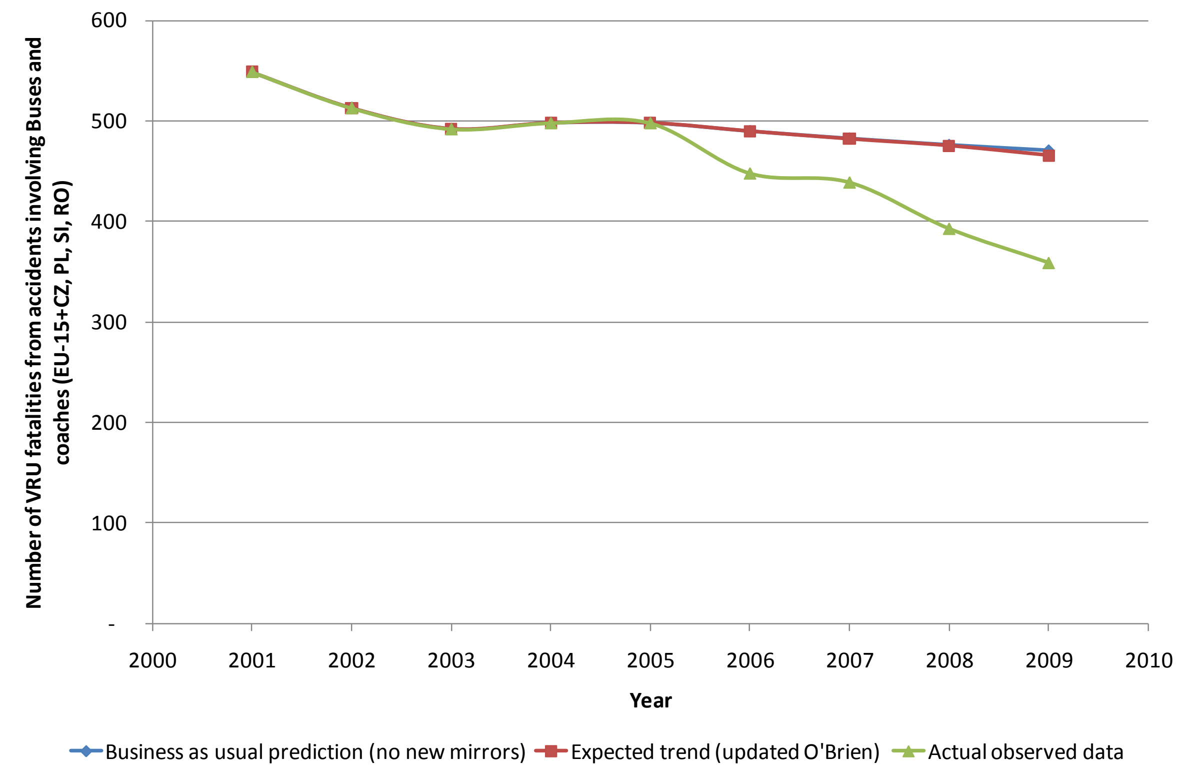

Figure 18: Expected and observed trends in the number of vulnerable road user fatalities from accidents involving Buses and coaches (Source data: CARE EU-15 + CZ, PL, SL, RO)

The total numbers of vulnerable road user fatalities from accidents involving buses is smaller than for HGVs (approx 350 in 2009 compared with approximately 1,200 for HGVs) and so there tends to be greater annual variation. However, it is apparent that there was a noticeable change in trend after 2005 with the pace of casualty reduction increasing such that the actual numbers were considerably less than what would have been predicted based on data to 2005. These figures can also be divided into motorcycle/moped, pedal cyclist and pedestrian fatalities, as shown in **Figure 19** to **Figure 21** below.

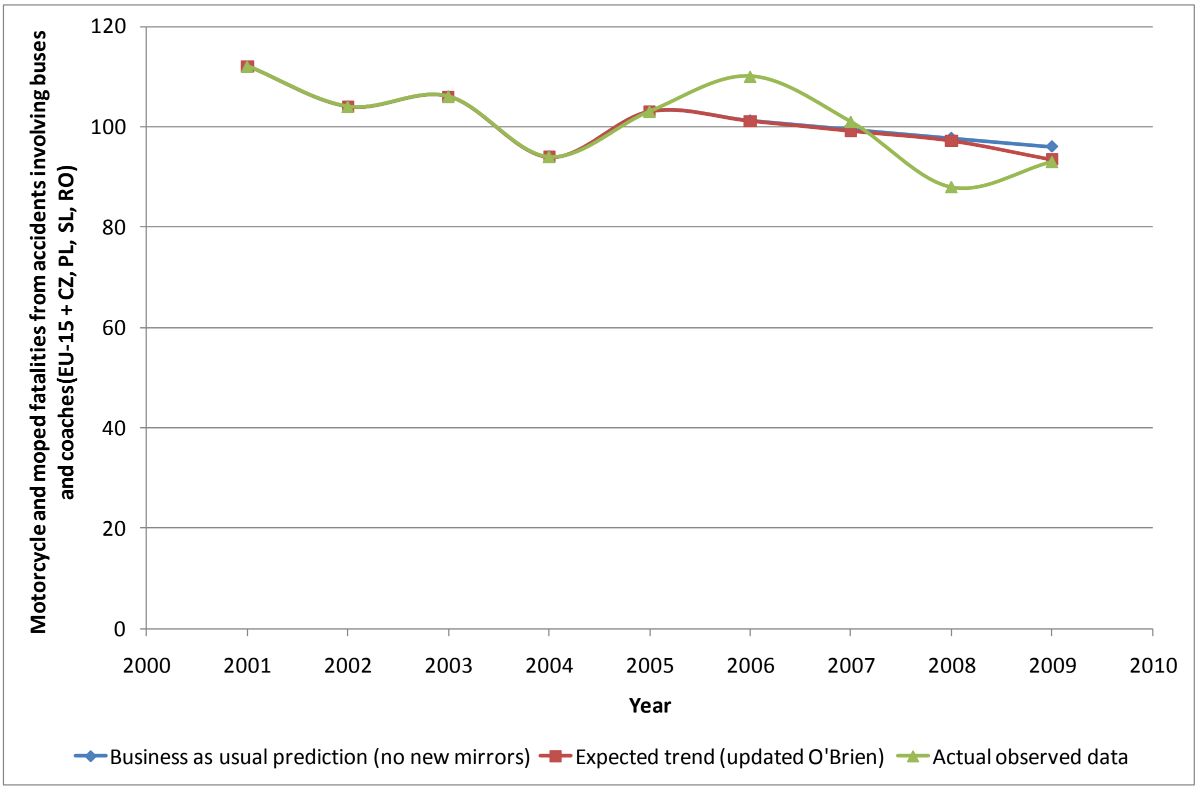

Figure 19: Expected and observed trends in the number of motorcycle/moped fatalities from accidents involving Buses and coaches (Source data: CARE EU-15 + CZ, PL, SL, RO)

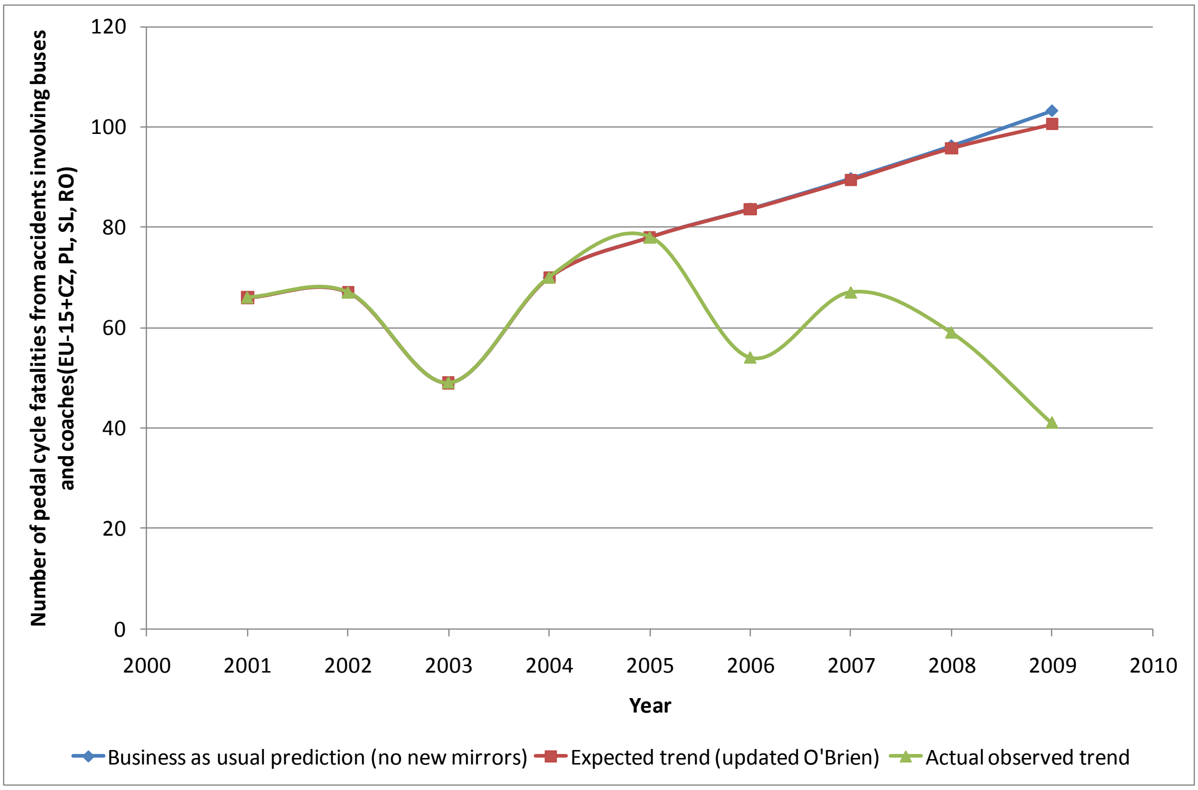

Figure 20: Expected and observed trends in the number of pedal cyclist fatalities from accidents involving Buses and coaches (Source data: CARE EU-15 + CZ, PL, SL, RO)

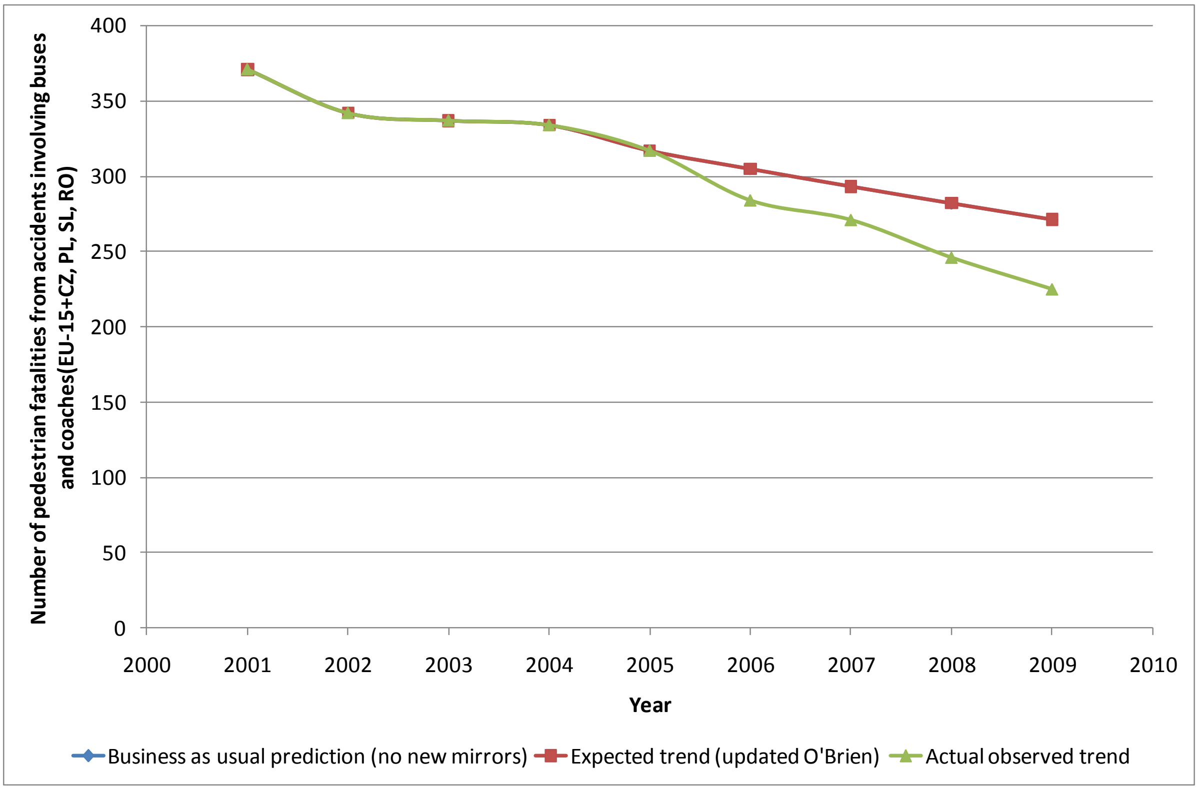

Figure 21: Expected and observed trends in the number of pedestrian fatalities from accidents involving Buses and coaches (Source data: CARE EU-15 + CZ, PL, SL, RO)[6]

It can be seen that despite much more annual variation, the motorcycle fatality trend approximates the predicted business as usual trend, as might be expected. For pedal cyclist fatalities, the actual figures are substantially less than the predictions would have suggested but this result is substantially affected by variation in the annual totals as a result of small numbers (variation of approximately ±33% on a mean for the time period considered of 61). The majority of the vulnerable road users killed in collision with buses and coaches were pedestrians, so this trend is less affected by low numbers but the actual figures are also considerably less than would have been predicted based on data from 2001 to 2005.

[6] Note that for pedestrians the business as usual trend is indistinguishable from the expected trend because the expectation was that new mirrors would only be fitted to new vehicles, and that effectiveness was low because it was based on the proportion of pedestrian fatalities resulting from contact with the front of the vehicle.

7 Cost benefit analysis

A cost benefit analysis requires an estimate of the benefits of the Directive, in this case an estimate of the casualties prevented by the retro-fit of blind spot mirrors and the monetary prevention value associated with them. As explained above, the data is inadequate to produce such an estimate with any confidence and, as such, it is not possible to produce a meaningful comparison of the benefit to cost ratios estimated before and after the implementation of the Directive.

A brief review of costs has been undertaken. (O'Brien 2004) estimated the component costs as follows:

- Side view mirror €150
- Front view mirror €150
- Camera €1,000

It was assumed that tax revenue would cancel out the fitting cost and that there would be 1 hour vehicle down time with no "opportunity" cost as a result. The lack of a cost associated with the vehicle downtime may represent an underestimate but may also be justifiable if the action was taken alongside routine servicing or preparation for annual inspection.

Little published literature has been identified that provided more detail on the actual costs sustained by the industry during the implementation phase. However, a number of product adverts and news articles from the time provide broad support for the costs used in the estimate and perhaps indicate that they might be a slight over-estimate. For example, one magazine article[7] suggested that the recommended fleet price for an unheated Dobli mirror kit is £110 (approximately €125) and heated mirror kits are £125 (c.€145). Prices for a camera monitor system kit started from £370 (c.€425) based on a basic five-inch monitor).

The original benefit to cost ratio estimated (O'Brien 2004) was 4.1. The generally accepted threshold of acceptability for benefit to cost ratios is one. This combined with the possibility that costs may have been slightly less than predicted suggests that the effectiveness of the mirrors could be substantially less than predicted and still result in benefits exceeding costs.

[7] http://www.roadtransport.com/static-pages/standard/blindspot-testing/

8 The scope for future casualty reduction

(Dodd 2009) showed that even the new mirrors required by Directive 2003/97/EC do not eliminate all blind spots for all drivers in all vehicles. In addition to this, many authors have highlighted a potential problem with drivers not correctly adjusting the mirrors provided. Although the analysis of the effectiveness of blind spot mirrors has so far been inconclusive it is clear that despite important reductions in the numbers of vulnerable road users killed by heavy vehicles, a significant number are still occurring with 1,200 VRU fatalities from accidents involving HGVs in 2009 and a further 350 or so involving buses and coaches. The evidence suggests a significant proportion of these do involve low speed manoeuvring and potentially blind spots. A brief review of scientific literature was undertaken to provide an initial view of the range of possible new measures that could be considered and the characteristics and state of the art for each of them.

8.1 Improved indirect field of view

The field of view available from a fairly typical articulated truck is shown in Figure 22, below.

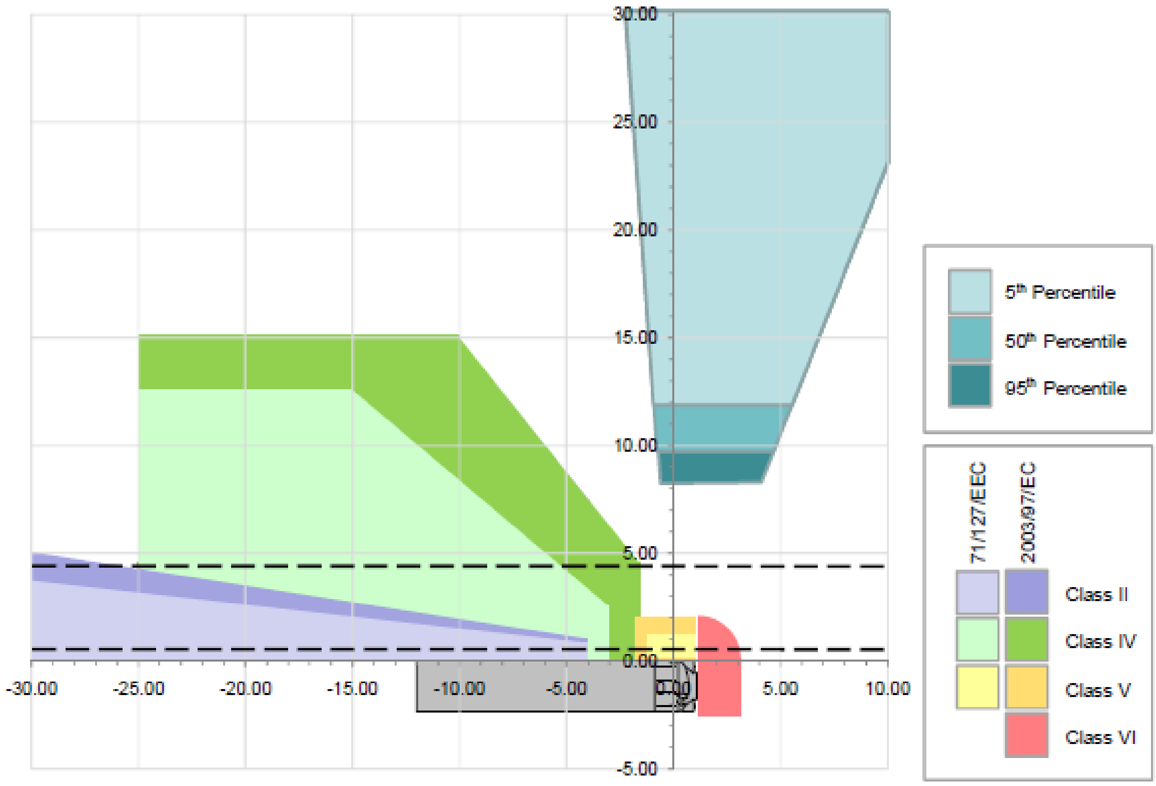

Figure 22: Field of view from a Renault Magnum from mandatory mirrors and directly through side window, source: (Dodd 2009)

The areas marked are on the ground plane, so if a pedal cycle was positioned at the far edge of the yellow area for the class V mirror, all that would be visible of that pedal cycle in the mirror would be the bottom of the wheels. Unless the pedal cyclist was unusually tall the top of their head would not be visible in the direct view through the side window.

Thus the potential for blind spots remains even after the introduction of Directive 2003/97/EC and 2007/38/EC.

A number of possible solutions exist to allow these areas to be seen through additional vision devices. (Dodd 2009) investigated two supplementary mirror devices and a fresnal lens. A selection of the results is reproduced in below to illustrate the overall findings.

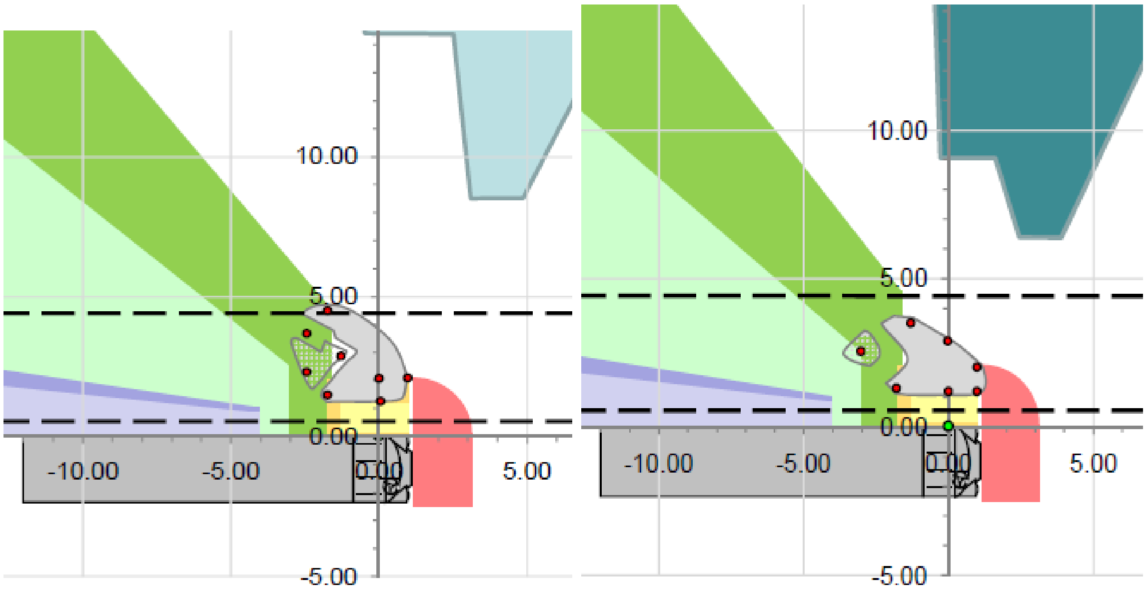

Figure 23: Field of view from Dobli mirror fitted to an Iveco HGV for 5th (left) and 95th (right) percentile drivers, source (Dodd 2009)

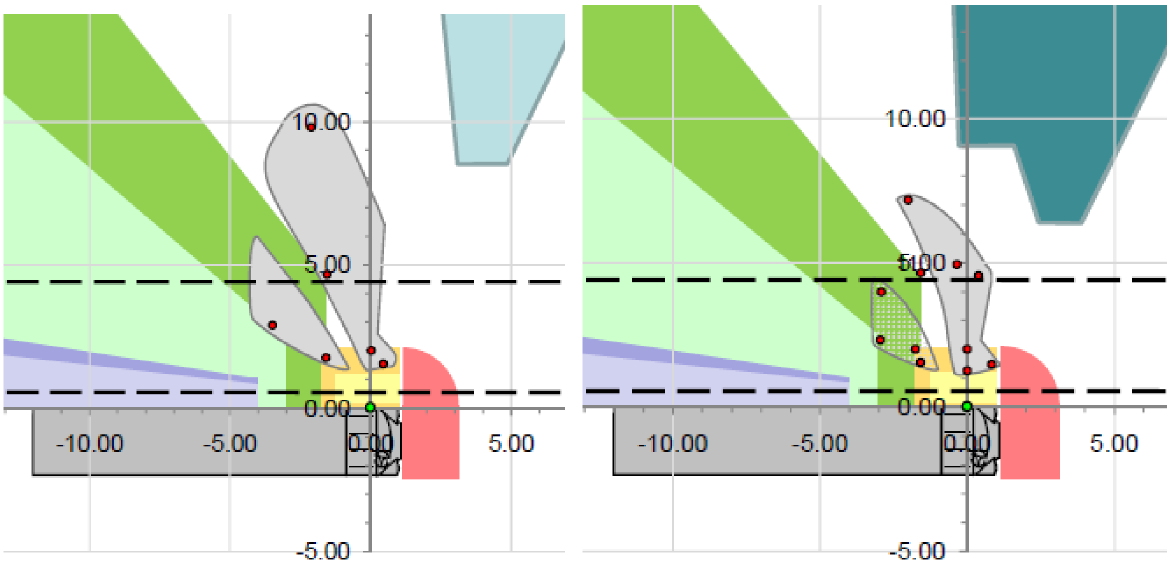

Figure 24: Field of view from BDS mirror fitted to an Iveco HGV for 5th (left) and 95th (right) percentile drivers, source (Dodd 2009)

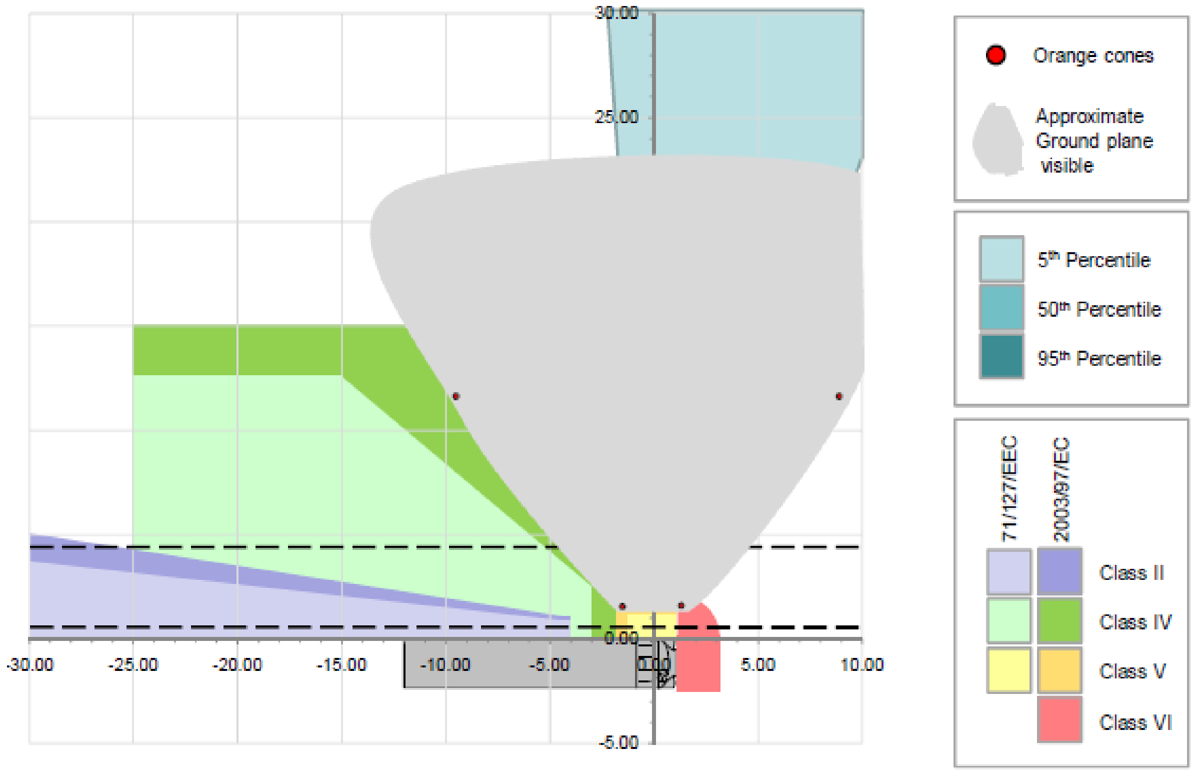

Figure 25: Field of view from Fresnal lense fitted to a Renault Magnum for 5th percentile drivers, source (Dodd 2009)

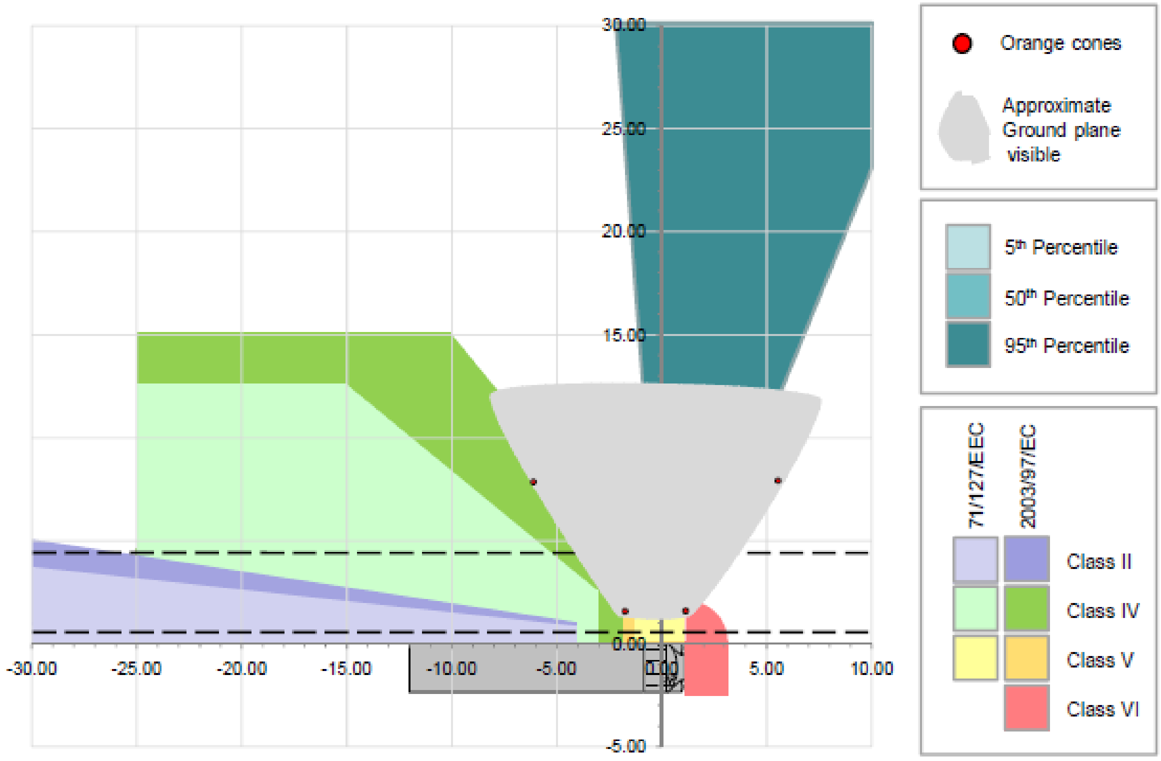

Figure 26: Field of view from Fresnal lense fitted to a Renault Magnum for 95th percentile drivers, source (Dodd 2009)

It can be seen that each of these devices removes at least some of the potential for blind spots, with the Fresnal lens adding most to the visible ground plane. However, all of these evaluations are completely objective and do not account for the influence of the driver in terms of their workload and ability to be looking in the right place at the right time, and their ability to recognise a hazard based on a partial or distorted image of another road user.

Figure 27: Vehicle equipped with mandatory mirrors and three supplementary field of view devices, source (Dodd 2009)

Figure 27 is an extreme example because it would not be expected that three additional devices would be necessary. However, it illustrates the point with respect to driver workload and the potential for confusion resulting from a range of different images and different points of view (e.g. front looking back, top looking down etc). When it is considered that, in a typical turn manoeuvre, the driver will also need to check the front view (class VI mirror, not shown) before moving off, check the driver's side mirror (for risks from tail swing) before beginning the turn and scan the forward field of view throughout the manoeuvre then it can be appreciated that the time that he can be looking at any one view is limited.

The Dobli mirror costs around €166 including VAT[8], the BDS mirror approximately £50+VAT[9], and the Fresnal lens around £15+VAT[10].

[8] http://www.allsicht.de/

[9] www.blindspotmirrors.co.uk

[10] http://www.transportsupport.co.uk/index.php?page=shop.product_details&product_id=72&flypage=flypage.tpl&pop=0&vmcchk=1&option=com_virtuemart&Itemid=4

(Dodd 2009) considered a range of passing vehicle types, three HGVs and three driver sizes and identified where the blind spots were in terms of the longitudinal position relative to the drivers eyes. The results are reproduced in Figure 28, below.

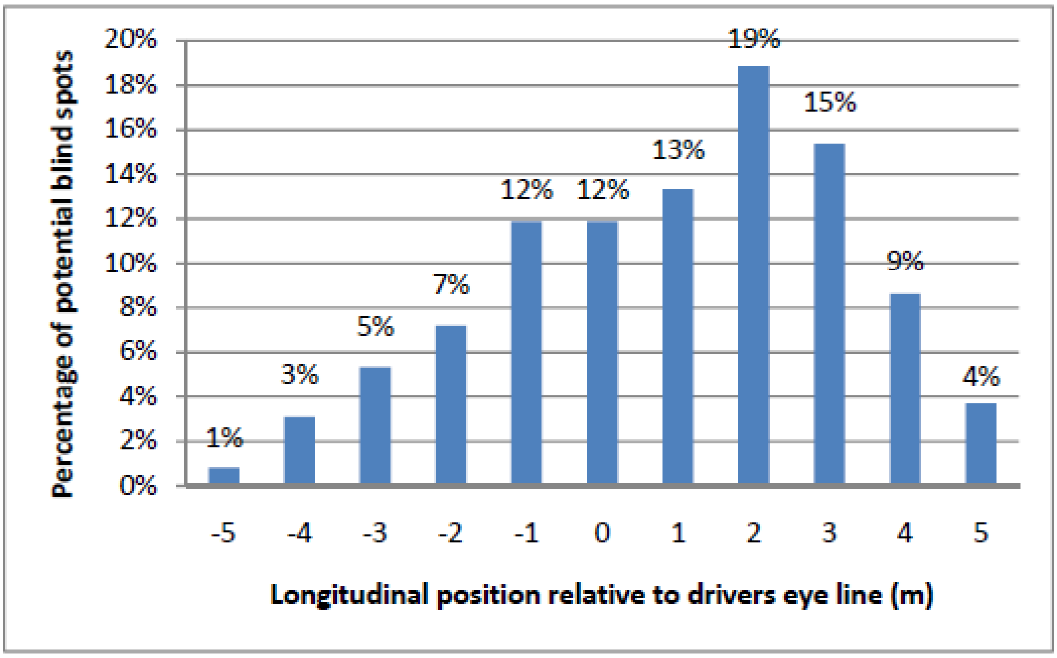

Figure 28: Longitudinal distribution of passenger side blind spots relative to driver eye point, source (Dodd 2009)

It can be seen that the most common location of the blind spot was to the passenger side of the vehicle, two meters in front of the drivers eyes that is a little in front of the front of the vehicle. This is a common position for pedal cyclists to take at junctions, encouraged in some locations by the presence of cycle lanes and advanced stop lines for vehicles, and would be expected to be strongly related to the type of turning accident that class V mirrors were intended to help prevent. (Dodd 2009) found that in this sort of position a pedal cyclist positioned at the edge of an adjacent lane could be entirely hidden in a blind spot despite the presence of all mandatory side mirrors plus the two supplementary mirrors and the fresnal lens, as shown in Figure 29, below, where it has to be taken on faith that there was actually a cyclist present.

Figure 29: View from a Renault Magnum equipped with mandatory class II, IV and V mirrors plus Dobli and BDS mirrors and a fresnal lens where a cyclist was positioned two metres ahead of driver's eyes at the edge of an adjacent lane.

In this case, the vehicle was not equipped with a class VI mirror but the cyclist would have been visible in such a mirror. This provides evidence that a class VI mirror, principally intended to protect pedestrians injured when a vehicle pulls away from rest, could also be of benefit to cyclists and other vulnerable road users injured when a vehicle turns right (left in UK). (Schoon 2009) suggests that retro-fitting of the class VI mirror could present a short term measure to help the blind spot problem. In addition to this, in the Irish response to the Commission's questionnaire on the implementation of Directive 2007/38/EC, the question of retro-fitment of class VI mirrors was also raised as shown in the direct quote below.

"In the twelve year period between 1996 and 2008, some twenty-one deaths and fourteen serious injuries in Ireland were attributed to the inability of a HGV driver to see his/her victim as they passed through the blind spot in front of their vehicle when they were moving off from a stationary position.

We therefore formally requested that the Commission reconsider the retro fitment of Class VI mirrors throughout Europe in an effort to reduce the number of injury and death incidents involving HGV's and pedestrians or cyclists. They indicated that there are no immediate plans to mandate their fitment on older vehicles throughout Europe but that we were free to introduce Class VI mirrors on all vehicles on a national basis.

Hence in March 2011 we launched a public consultation seeking the views of interested parties on proposals to introduce the mandatory fitment of front blind spot (Class VI) mirrors to all HGV's with DGVW exceeding 7.5 tonnes.

This proposals (including draft regulations) have been reviewed and approved by our Minister for Transport and it is expected that regulations requiring Class VI mirrors to all HGV's with a DGVW exceeding 7.5 tonnes, irrespective of the year of first registration, will shortly be signed into law here. A positive check to ensure compliance with the field *of vision requirement for Class VI mirrors will also be introduced at the annual roadworthiness test."*

Camera systems have been developed that offer several potential advantages over mirrors. Firstly, a single camera and display can offer a greater view area than a mirror, an example of which is shown in Figure 30, below.

Figure 30: Example of field of view from a side view camera, source www.orlaco.com

In addition to this, the location where the image is displayed is not limited in the same way as for a mirror, where the position of the display is critical to the image than can be seen in that display. Thus, the camera can be positioned in a way intended to reduce the workload of the driver. However, this freedom also means that the display can be positioned in places that increase the workload. Two example positions are shown in Figure 31, below.

Figure 31: Examples of display positioning for camera systems, source www.orlaco.com

Where multiple camera views are available (e.g. to cover class V and VI blind spot requirements) there may also be the option for rationalising the images onto one display but then the manner in which this is achieved may influence the effectiveness in terms of the ability of the driver to recognise and appropriately respond to hazards.

In addition to this, some manufacturers are integrating blind spot camera systems into wider accident cameras, data recorders and warning systems that may provide other benefits. However, there are significant additional costs to blind spot camera systems and integrated systems based on them, with one example[11] costing approximately £640 (c.€740)+VAT.

8.2 Improved direct field of view

Direct field of view is the area that can be seen directly through the windows of the vehicle. While the indirect view is regulated, the direct view is not regulated and thus there is no minimum standard relating what must be visible. A typical perception is that taller vehicles will have more blind spots but the reality is more complex. The direct view will depend on the relative positions of the drivers eye point (and therefore, occupant size and seating position), the edges of the windows, the size and position of obstructions such as mirror clusters, dashboard equipment and the ground plane.

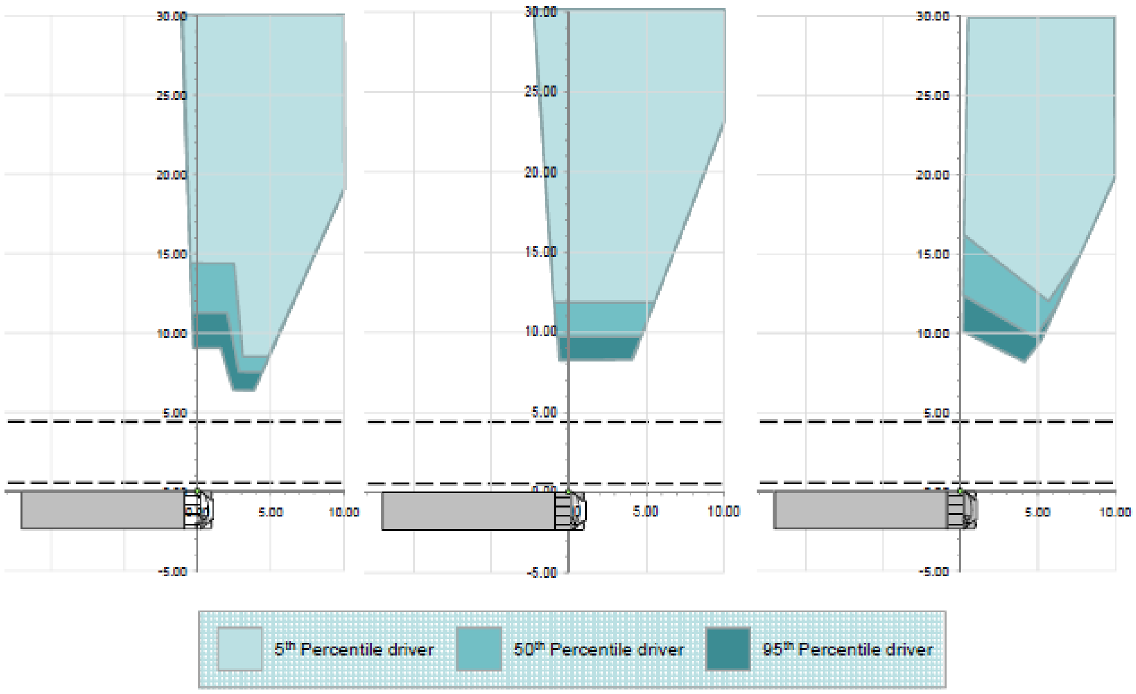

Figure 32: Direct field of view through the side window for different drivers in different vehicles, source (Dodd 2009)

In this analysis, the middle vehicle was a Renault Magnum, which was by some margin the tallest vehicle of the three assessed. However, it was found that the shorter vehicle in the right hand chart had less view close to the vehicle, particularly for small drivers. This variation suggests that it may be possible to at least encourage the vehicles with the most restricted view to improve to the level of the vehicles with the least restricted view without imposing excessive limitations on fundamental design characteristics such as height and layout.

Examples of designs that improve direct view to the side can be seen in Figure 33, below, which is from a production vehicle first registered in 1998.

[11] http://www.y3k.com/product/142/smart_witness_commercial_vehicle_blindspot_system

Figure 33: Example of side door designed to offer improved direct field of view, source (Dodd 2009)

(Robinson, Knight, et al. 2011) also examined the potential for increased length of trucks to be reserved for improvements to the safety and environmental performance of vehicles. One aspect of this was to improve the forward field of view, thus reducing the need to rely on the class VI mirror. It was shown that by shaping the front of the vehicle such that at bumper height the structure was substantially further forward than the lower edge of the windscreen, the field of view could be improved considerably. The same shape also had the potential to reduce aerodynamic drag and fuel consumption and improve the kinematics of pedestrian collisions as well as increasing the potential for energy absorption in car collision.

The advantage of improved direct view is that it is likely to be more intuitive for the driver because everything seen is in its correct orientation and not magnified or distorted. This should, in theory, enable drivers to more easily recognise hazards. The disadvantage is that it can require substantial re-engineering of the cab layout and can present conflicts with other design or regulatory requirements. In the case of small additional windows (as opposed to increasing the view through existing windows) is that it can create an additional place for the driver to look in, thus having a similar effect on driver workload to an additional mirror.

8.3 Roadside mirrors

At least one company has begun marketing convex mirrors for fitment to existing fixed infrastructure (such as signs or traffic lights) at junctions where there is a risk that vulnerable road users could come into conflict with heavy vehicles. The aim is that these mirrors would allow heavy vehicle drivers to see vulnerable road users in their frontal and side blind spots, more effectively than is possible from existing on-board mirrors. A study in Germany (Technical University of Kaiserslautern 2011) recommended the nationwide introduction of these mirrors in conjunction with driver training courses. This was based on the results from the study in Freiburg that reported positive acceptance of the roadside mirrors by 83% of professional drivers and a reduction in right-turning accidents at the junctions where such mirrors were installed, although it is unclear whether the mirrors were directly responsible for this.

Accidents involving vulnerable road users and turning HGVs can be regional in nature, for example, approximately 40% of all GB fatalities from accidents involving cyclists killed in collision with a truck turning left actually occur in London (Cookson and Knight 2010). Uneven geographic distributions like this can substantially affect the benefit to cost ratios of regionally targeted infrastructure based solutions in comparison to on-board solutions.

8.4 Improved underrun protection

(Cookson and Knight 2010) found that there is little evidence to suggest that sideguards are effective at mitigating fatal injuries in accidents where a turning truck collides with a pedal cyclist. This was thought to be because the sideguards were intended to prevent cyclists or pedestrians falling between the wheels of an HGV. This is a common accident mechanism when, for example, an HGV overtakes a cyclist while travelling in a straight line and the resulting wind effects cause the cyclist to wobble and fall towards the side of the HGV. Few fatalities now occur in these circumstances, where sideguards are fitted. It was considered that in many turning cases, the cyclist was in collision with the front of the HGV and was knocked to the ground such that the sideguard passed over the top of the prone cyclist as the rear of the vehicle "cut-in" to the corner.

The report (Cookson and Knight 2010) acknowledged that it was possible that reducing the ground clearance of sideguards might have some benefit in turning accidents by pushing the prone cyclist away from the wheels rather than passing over the top of them. However, it was also acknowledged that a great deal of technical uncertainty existed as to whether this would be effective. Such uncertainty is partly the result of a lack of specific research in this area but also a result of limitations in the usual test tools. A low sideguard may push a crash test dummy out of the way but such devices are not very bio-fidelic when used in circumstances for which they were not designed and it is questionable whether this would accurately represent the behaviour of a real human in such a situation (i.e. there is a possibility the human could be crushed in circumstances where the dummy was simply slid out of the way when pushed by the sideguard).

8.5 Sensors and warnings

When considering all of the field of view improvements discussed above, the main limitation is that they all rely on an attentive driver looking in the right place, at the right time and for the driver to recognise the hazard and take the appropriate action. These measures would not be expected to be effective where the driver is either attentive but not looking in the right place at the right time, or not attentive at all.

The principle of using sensing and warning systems is that they will continuously look in the right place at all times, independent of what the driver is doing. If a potential conflict is identified they can then attract the attention of the driver to that conflict.

Blind spot sensors are now relatively common for new cars with systems being produced by major tier one suppliers and OEMS. However, these systems are generally intended to detect cars passing in adjacent lanes, not vulnerable road users, which are more technically difficult[12].

Systems are available in the aftermarket. For example, Transport for London[13] highlight several suppliers of aftermarket sensor systems at costs that can be as low as around €150. They state that a 4 week trial of the technologies was undertaken and cite strong support from the operators involved but do not provide objective quantification of effectiveness. One of the systems mentioned is an ultrasonic sensor from Brigade electronics[14] that will detect a cyclist within a range of 1.5m of the side of the truck whenever the relevant direction indicator is activated and issue a warning to both driver and vulnerable road user. Step Protect is a similar system that uses a traffic light visual warning for the driver with an optional audible warning when the VRU gets to the closest detectable distance.

Both of these systems appear to be simple proximity warnings, that is, they will activate every time an object is within range. If this was to result in a lot of warnings being issued by the system in situations that the driver did not consider imminently dangerous, it could erode their responsiveness to the system. This is a typical concern of vehicle OEMs, who do not yet market such systems. The European PREVENT project aimed to develop a camera based system[15] and Volvo has developed a system in the Intersafe 2 project[16] that is based on the fusion of data from ultrasonic sensors and laser scanners. This system distinguishes between the close proximity of a pedestrian or a cyclist, when the system provides the driver with a visual warning only, and when a collision with the pedestrian or cyclist is imminent, when the driver is alerted with flashing lights and sound. Even after this project, Volvo state that the development will not lead directly to a production version because more work is required to separate the detection of vulnerable road users from other traffic in the urban environment.

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[12] See for example Conti system intended only for vehicles http://www.conti-online.com/generator/www/de/en/continental/automotive/themes/commercial_vehicles/safety/adas/bsd/bsd_en.html

[13] http://www.tfl.gov.uk/microsites/freight/documents/publications/hgv-cycle-safety-procurement-guide.pdf

[14] http://www.brigade-electronics.com/product-focus/ultrasonic-obstacle-detection

[15] http://www.prevent-ip.org/en/prevent_subprojects/vulnerable_road_users_collision_mitigation/usercams/

[16] http://www.intersafe-2.eu/public/

8.6 Advanced rear steering control

Most current goods vehicles have fixed rear axles without steering but a wide range of rear steering systems are available. These can be broadly categorised as follows:

- Self steer
- Command steer
- Pivotal bogie
- Active steer

The basic principle governing the use of steered rear axles is that they reduce the effective wheelbase, thus reducing the "cut in" or swept path of the vehicle. This means that for a given length and wheelbase of vehicle, incorporating rear steering will mean that the rear cuts into the corner less. In a typical accident where a vulnerable road user is knocked to the ground by the front of a turning HGV these systems have the potential to reduce the likelihood of the person being run over by the rear wheels. However, for the main types of system currently in production, i.e. those that steer in direct proportion to tyre side forces, steering wheel input, or tractor trailer articulation angle, there is a trade off such that reduced cut in results in increased tail swing. So in a right turn the rear of the vehicle would initially swing out to the left by more than a vehicle without rear steering would, but would then cut in to the corner by less. Thus, reducing the hazard to vulnerable road users on the inside of the turn might increase the risk to other road users on the outside of the turn. The exact effects of any individual implementation will depend on the position of the steered bogies and axles and the relationship between steer angle at the front axle and steer angles at the trailer axles.

A small number of researchers (e.g. Hata *et* al., 1989, Notsu *et al.*, 1991, Cheng & Cebon, 2007, Kharrazzi *et al.,* 2008) have been investigating the potential of active steering systems to offer further improvements in cut-in, without adverse effects on out swing, while also improving high speed stability. In this context, active steering means a command steer system where the linear relationship between articulation angle and semi-trailer steer angle, typically provided mechanically or hydraulically, is replaced by a more sophisticated non-linear control function provided electronically.

All of the research agrees that adopting such an approach can provide substantial improvements in low speed manoeuvrability (cut-in and out swing) while also improving stability at higher speed. Jujnovich & Cebon (2008) describe the development of control algorithms for active steering systems for articulated vehicles and found that systems could be developed that allowed the rear of the vehicle to track the path of the front of the vehicle at any speed and on any path. Thus these systems could improve the cut-in, reducing risks to vulnerable road users on the inside of the vehicle, while simultaneously reducing tailswing and the risks to other road users on the outside of the turning vehicle.

Jujnovich *et al.* (2008) describe implementing the active steering system on a prototype articulated vehicle. The basic principle of the system is illustrated below, where it can be seen that all three trailer axles are individually steered to different degrees in order to achieve perfect path following.

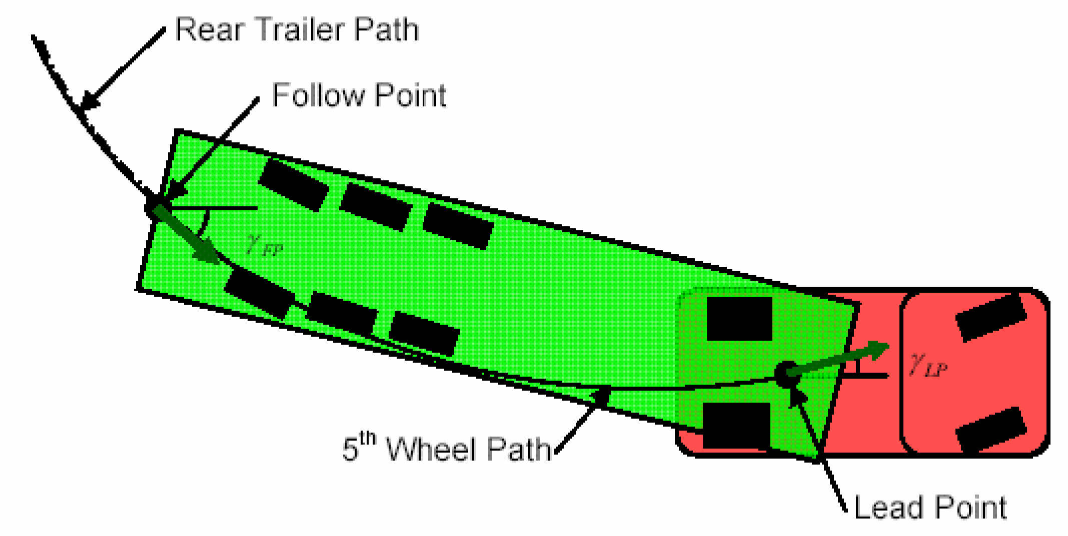

Figure 34. Active steering system (Jujnovich et al, 2008)

The active steering is achieved by electronically controlling separate electro-hydraulic actuators that act on each individual axle. It is understood that work is in progress to develop this concept into production systems, which could take somewhere in the region of two years, depending on the extent of predicted demand. In particular, trade-offs between performance and the number of actively controlled axles are being examined to investigate whether the cost and mass of the system can be reduced.

One potential barrier to implementation of this technology is that it appears that it could not gain the necessary approval to European steering regulations (UNECE R79), which states that the regulation does not apply to "*the electrical control of full power steering systems fitted to trailers*". It is possible that type approval could still be gained by using clauses in the framework Directive (2007/46/EC) intended to allow the approval of new technology where it can be demonstrated to offer at least equivalent levels of safety. If such technology were to be permitted or required, further investigation and possibly amendment of the regulations would be required.

9 Discussion

The main objective of this review was to assess the extent to which Directive 2007/38/EC was successful in its objective of reducing the number of vulnerable road users killed in collisions with turning trucks. The data provided on the number of vulnerable road users killed in collisions involving heavy goods vehicles shows that in fact the numbers closely follow the predictions that would have been made if the previous study (O'Brien 2004) had been undertaken immediately prior to implementation. The reduction in such fatalities is undoubtedly a positive indicator but it is also important to assess the extent to which this reduction can be attributed directly to the measures taken in Directive 2007/38/EC.

First, the validity of the predictions made (O'Brien 2004) have been assessed. It was found that some actual events have differed from a number of the input assumptions, for example a much greater reduction in fatalities and accidents of all types has occurred than could have been predicted in 2004 and the recent financial crisis has had an effect on the age of the fleet as well as traffic and accident volumes. In addition to this, more recent analyses suggest that some of the input assumptions with respect to the number and type of accidents potentially affected by blind spot mirrors and the effectiveness of the mirrors themselves may not have been borne out. Some of these would tend to produce an under-estimate of effects and others an over-estimate. The net effect is uncertain but there is some evidence to suggest the magnitude of effects predicted for side view mirrors could be over-estimated and the benefit of front view mirrors under-estimated. One thing that was reasonably clear was that it would be expected that the greatest effect would be expected on pedal cyclists killed in collision with a turning HGV.

Reviewing how Member States implemented the Directive suggested that all had complied with the requirements, there were not any major difficulties with doing so, and that good levels of compliance were achieved. In some cases, however, the means for demonstrating compliance did allow the possibility that the requirements would not be precisely met and problems with mirror adjustment may remain.

When the data on vulnerable road users killed in collision with HGVs (all manoeuvres) was separated into motorcyclists, pedal cyclists and pedestrians, it was apparent that there has been a substantial reduction in the pedal cyclist numbers. However, this reduction was evident from 2006, substantially before implementation of the retro-fit directive. The manoeuvre of the HGV at the time of the collision was only available for six Member States but in these six it could be seen that the number of vulnerable road users killed in collision with HGVs that were turning right (left in the UK) was almost the same in 2009 as it had been in 2001, thus representing a larger proportion of all HGV-VRU fatalities in 2009 than it had in 2001. Both of these findings are contrary to the expected effect of implementing the directive.

However, the most recent accident data available from CARE is for the year 2009 and the requirements of the Directive were such that the national authorities were obliged to fail vehicles at annual inspection if they were not equipped with the relevant mirrors by the end of March 2009. Thus, in theory, if a vehicle was presented for annual inspection on the 30th March 2009 it may not have been checked for compliance with the directive and, therefore, may not actually have been required to fit the mirrors until 30th March

2010. It is, therefore, possible that the full effect of the mirrors would not be seen until 2010 accident data is available. This theory was assessed based on a brief analysis of GB national statistics, where data for 2010 and for vehicle manoeuvre were available. These data did show a substantial drop in the number of pedal cyclists killed by a truck turning left (equivalent to a right turn in the rest of the EU) in 2010 compared with 2009. However, the overall number of fatalities was found to be low and quite variable from year to year so data for future years would be required to assess whether this was a low point in a trend showing wide variations around a slowly decreasing mean or whether it does in fact represent a step change that could possibly be associated with the requirement to retro-fit blind spot mirrors.

If the requirement to retro-fit blind spot mirrors was effective, it would be expected that the number of vulnerable road users killed in collision with an HGV would decline by substantially more than the number killed in collision with a bus or coach which has similar blind spots but for which there was no requirement to retro-fit blind spot mirrors. This might also be expected to be true in comparison to light commercial vehicles (<3.5 tonnes), although to a lesser extent because the blind spots associated with LCVs are likely to be smaller than for HGVs and buses. The analysis showed that to be true for LCVs but in the more relevant comparison with buses and coaches it was in fact found that the proportional reduction was almost the same for accidents involving buses and coaches as for HGVs (approximately 35%).

The overall conclusion of this work, therefore, has to be that although there has been a substantial reduction in the number of vulnerable road users killed, slightly in excess of the reduction predicted to be associated with Directive 2007/38/EC, the data is not sufficient to be able to positively identify whether or not the reduction was linked to the Directive. Some evidence is consistent with expectations, thus suggesting that the Directive was a substantial influence, other evidence is contrary to expectations and suggests that the Directive was not the main influence. The absence of a quantification of the effectiveness of the Directive precludes a meaningful analysis of costs and benefits.

Regardless of the actual effectiveness of the measures taken to-date, in 2009 there was still a significant number of vulnerable road users killed in collision with a truck and a substantial proportion of these involved a turning truck. A wide range of measures are available, or in development, that have the potential to reduce this number in future. These include, further extensions to the indirect field of view either using on-board mirrors or alternatives such as Fresnel lenses and/or cameras, roadside mirrors, improvements in the direct field of view, the fitment of proximity sensors and/or collision warning systems, increasing the use of rear steering and improving under-run protection, as well as continuing to improve education and training for both road user groups. However, each possible solution will have strengths and weaknesses and while each may affect slightly different accident types there will be a core group of accidents where the effect of different measures would overlap. Thus, implementing all of them would be unlikely to be cost efficient because the benefits of each system would not be additive. At the same time, no research was identified that aimed to objectively compare and quantify the effects of the systems individually and collectively such that the most cost effective solution, or group of solutions could be identified.

10 Conclusions

1. The number of vulnerable road users killed in collision with an HGV has fallen substantially such that in 2009 the number was less than the prediction of the effects of retro-fitting blind spot mirrors suggested it would be.
2. This would suggest that retro-fitting blind spots had been successful. However, the overall number of fatalities fell more sharply in the same time period and the specific data available are limited. It is not, therefore, possible to quantify the extent to which the overall fall in HGV-VRU fatalities was associated with the fitment of the mirrors.
3. One of the limitations of this study is that the "after implementation" period is very short because EU data was only available up to 2009, the year in which it became obligatory for vehicles to be failed at annual inspection if they were not equipped with the new mirrors. Thus, the emergence of new data for 2010 and beyond may provide additional insight, although other limitations may still prevent firm conclusions.
4. A wide range of additional technical measures have been identified that have the potential to further reduce the number of vulnerable road users killed in collision with heavy vehicles. These include measures relating to direct field of view, on-board mirrors/lenses/cameras, roadside mirrors, sensors and warnings and rear steering. However, each will have advantages and disadvantages, the benefits will not be additive and no research has been found that objectively quantifies the relative costs and benefits to identify the most cost effective solution, or group of solutions.

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Appendix A Commission Questionnaire on the implementation of Directive 2007/38/EC of the European Parliament and of the Council of 11 July 2007 on the retrofitting of mirrors to heavy goods vehicles registered in the Community

A.1 Introduction

This Appendix will reproduce in full without amendment the response of each Member State to each question asked in the Commissions questionnaire. Under separate heading, it will then add TRLs interpretation and analysis of those answers.

A.2 Description of the implementation process

A.2.1 Denmark

As one of the "parent states" Denmark required retrofitting of mirrors to comply with upcoming EU-demands to field of view.

A.2.2 Finland

Directive 2007/38/EC implemented in the national degree of the Construction and Equipment of Motor Vehicles and Trailers (1211/2007, given on 11th December 2007) by Ministry of Transport and Communications. No difficulties occurred.

A.2.3 France

The application of the directive 2007/38/EC in French national right was made on the basis of a ministerial decree of April 10th, 2008 amended on January 30th, 2009. National requirements have been strictly those imposed by the Directive for the categories of vehicles and their registration dates. The process for regulatory compliance of the vehicles was:

- Definition of a harmonized model for attestation of compliance by type of vehicles:
    - With the article 3-1 of the Directive 2007/38/EC;
    - Otherwise, by dispensation on justification, with the article 3-2 of the directive 2007/38/EC;
    - Otherwise, due to the lack of economically viable technical solutions and on justification, with the article 3-3 of the directive 2007/38/EC.
- For the types of vehicles, the manufacturer of the vehicle or the manufacturer of the device establishes this attestation justifying the technical solution for the type of vehicle and, if necessary, describes the special requirements of assembly. The choice of compliance with article 3-2 must be accompanied by the inability to comply with article 3-1. The choice of compliance with article 3-3 must be accompanied by the inability to comply with article 3-2.
- On the basis of the type attestation, the installer certify complete the installation as specified by the manufacturer of the vehicle or the manufacturer of devices and returns the attestation to the owner of the vehicle.
- At the first vehicle inspection after installation, the controller asks the attestation evidencing regulatory compliance. In default of compliance, the vehicle must be represented after alignment. This inspection was carried out during one year after the deadline, until March 31, 2010, to control the entire vehicle fleet concerned.

Difficulty: Certain manufacturers of additional devices wanted a systematic application of their device for all the types of vehicles within the framework of the article 3-3 of the directive 2007/38/EC.

The French authorities refused this systematic solution as far as the application of the article 3-3 concerns only the very rare situations due to the lack of economically viable technical solutions for regulatory compliance with the Article 3-1 or 3-2.

On the occasion of the complaints made by these manufacturers to the Commission, we constantly reminded that the reporter of the text at the European Parliament (Mr. Paolo Costa) aims in his presentation report, for the purpose of the article 3-3, in a restrictive way trucks for which compliance would require a significant change in the structure of the cab or doors.

The cases of application of the Article 3-3 were thus to be very rare and, in the practice, we did not thus make use of the Article 3-3 so that the whole park is correctly equipped according to articles 3-1 or 3-2.

A.2.4 Germany

The Directive 2007/38/EC was transposed into national German law by the 31st regulation of 26 May 2008 (BGBl. I S. 916) to amend the Straßenverkehrs-Zulassungs-Ordnung (StVZO). Detailed information on the national implementation and inspection of the requirements have been explained and published by announcement in the Verkehrsblatt (VkBl. 2008 S. 441, see attached document).

The main difficulty during the implementation was to ensure the installation of a simple process within the periodic technical inspection of vehicles to check the compliance of the retrofitted mirror with the requirements given in Directive 2007/38/EC. Germany has decided to use a tool checking the radius of curvature of the installed mirror. The differences in the radius of curvature of the old and the new mirror are clearly visible for the inspectors by using the curvature tool.

Due to the fact that mirror manufacturers have installed the mirror production lines in preparation for the changes implemented by the Directive 2007/38/EC no problems during the implementation were seen.

A.2.5 Ireland

The Regulations transposing Directive 2007/38/EC in Irish law providing for the fitment of additional mirrors to reduce the lateral blind spots on the passenger side of certain heavy goods vehicles registered since 1 January 2000 were signed by our Minister for Transport on 1st August 2008 and became effective from 1st Jan 2009. Therefore a period of five months was allowed to prepare our roadworthiness test centres and ensure that they were capable of testing the affected vehicles for compliance with 2007/38/EC.

Difficulties arose in deciding the method of testing for compliance with the field of vision requirements stipulated in Directive 2003/97/EC, as the UK opted for a certificate of compliance rather than a positive check that the mirrors were adequate. We felt that the introduction of a positive check for affected vehicles at their annual roadworthiness test would ensure greater compliance amongst Irish hauliers with the retrofitting requirements. Also the wording used in Article 2 of Directive 2007/38/EC is ambiguous, which led to some confusion surrounding which vehicles were in scope etc and hence needed to have wide-angle and close-proximity mirrors retrofitted. This was especially the case with respect to the requirements for category N_2 vehicles with a DGVW exceeding 3.5 tonnes and not exceeding 7.5 tonnes, resulting in two clarification circulars being issued to our Vehicle Testing Network.

A.2.6 Italy

The Directive 2007/38/EC was transposed into national Italian law by the Decree of Ministry of infrastructure and transport of 11 January 2008 (Official Journal n. 76 of 31/03/2008). Detailed information on the national implementation and inspection of the requirements have been explained and published by Decree of Head of Department of 11/11/2008 (Official Journal n. 278 of 27.11.2008).

The main difficulty during the implementation was to ensure the installation of a simple process within the periodic technical inspection of vehicles to check the compliance of the retrofitted mirror with the requirements given in Directive 2007/38/EC.

A.2.7 Latvia

Requirements concerning the installation of the mirrors transposed into national legislation for PTI. No significant difficulties encountered.

A.2.8 Luxembourg

The mandatory fitting of suitable mirrors on the relevant vehicles was realized by implementing the above mentioned directive in national law and by adapting legislation on periodical technical inspections accordingly.

A.2.9 The Netherlands

In The Netherlands, vehicles of categories N2 and N3 are subject to national measures which entered into force before the dates for transposition of Directive 2003/97/EC and require fitment, on the passenger side, of other means of indirect vision covering not less than 95 % of the total field of vision at ground level of class IV and class V mirrors under that Directive. Hence The Netherlands comply with the Article 2, under 2(c) No difficulties were hence encountered during the implementation.

A.2.10 Poland

Directive 2007/38/EC was implemented to Polish Law by regulation of the Ministry of Infrastructure on the technical requirements of the vehicle and its necessary equipment.

A.2.11 Romania

The European Directive 2007/38/EC was transposed in national legislation by the Minister of Transport Order number 1002/2008. We detailed the provisions of the European Directive in Annex 3 of the Roadworthiness Regulations, which are Annex of the Order mentioned above. For periodical technical inspection centers, the main difficulty consist in arrangement of mirror test areas with markers. We do not encountered difficulties during this process.

A.2.12 The Slovak Republic

Directive 2007/38/EC was implemented by government regulation No. 113/2008 Coll. which entered into force 1.4.2008. Problems were regarding financial costs of transport companies. Subsequently we decided to allow possibility of exchanging only mirror area with rounded with a radius of 300 mm, and also checking the radius of curvature of the installed mirror.

A.2.13 Spain

Directive 2007/38/EC was transposed into national laws by updating the annexes of Royal Decree 2028/1986 by Order ITC/1620/2008. For the implementation of the directive it was issued Resolution of July 3, 2008, of Directorate General of Industry laying down the procedures for determining the adequacy of systems for retrofitting of mirrors to heavy goods vehicles goods registered in the Community. Additionally, it was modified paragraph 2.9 (Mirrors) of the Procedures Manual for Roadworthiness Inspection Stations, including the mandatory retrofitting of mirrors to N2 and N3 vehicles registered between 01/01/2000 and 07/27/2008, submitted to inspection from March 31, 2009 and not approved by Directive 2003/97/EC.

A.2.14 TRL interpretation and analysis

The Respondents all indicated that the Directive had been transposed into national law, relating to construction of vehicles and/or roadworthiness inspection. Dates of transposition were included for 8 of the 13 responses. These ranged from December 2007 to January 2009 with 4 of the remaining 6 transposing the requirements between April and July 2008.

It is assumed that the dates provided by respondents were the dates on which the legislation entered into force. What will be important to the analysis of the effects on casualties is the dates by which all vehicles in the fleet had to be equipped by and when the voluntary build up of equipment began ahead of the deadline for all vehicles. No information was provided about these dates by the respondents. It seems likely that each Member State would have written into their national implementation the same deadline for all vehicles to be equipped as for Directive 2007/38/EC, that all vehicles shall be equipped not later than 31st March 2009. The extent of voluntary fitment before that date cannot be identified from the questionnaire data.

A.3 National measures on retrofitting of mirrors to heavy goods vehicles (art 2.2, (c))

Respondents were asked *"Did your country apply any national measure which entered into force before 6 August 2008 requiring the fitment, on the passenger side, of other means of indirect vision covering not less than 95 % of the total field of vision at ground level of class IV and class V mirrors?"*

A.3.1 Denmark

From 1st October 2004 DK required mirrors retrofitted to all N2 and N3 vehicles giving the field of view in Directive 2003/97.

A.3.2 Finland

No any national measure applied in Finland before that day.

A.3.3 France

France is not a State having anticipated the measure and is not thus concerned by the Article 2-2-c the Directive 2007/38/EC.

A.3.4 Germany

Germany did not introduce any additional mandatory requirements to reduce the blind spot on heavy trucks. But the German truck manufacturers did install the improved mirrors on new trucks already since the end of year 2004 on a voluntary basis.

A.3.5 Ireland

Ireland did not introduce any national measures requiring goods vehicles to be fitted with wide angle or close proximity mirrors on the passenger side of the vehicle before 6th August 2008, other than those necessary for vehicles subject to the type –approval obligations set out in Directive 2003/97/EC. The requirement to retrofit wide angle and close proximity mirrors to vehicles of categories N_2 and N_3 which were registered before 1st Jan 2000 was introduced by the Road Traffic (Driving Mirrors - Additional Requirements for Heavy Goods Vehicles) Regulations 2008. (S.I. No 312 of 2008). These Regulations came into operation on 1st January 2009.

A.3.6 Italy

Referring to directive 2007/38/CEE, Italy did not introduce any additional mandatory requirements.

A.3.7 Latvia

None

A.3.8 Luxembourg

The above mentioned implementations took place in May 2009 with a slight delay. Before that date, no other national measures are known

A.3.9 The Netherlands

Yes, see answer above (section A.2.9).

A.3.10 Poland

No

A.3.11 Romania

No

A.3.12 The Slovak Republic

Slovak republic did not introduce any additional mandatory requirements which are not covered by Directive EU or regulations of ECE.

A.3.13 Spain

No national measures had been implemented.

A.3.14 TRL interpretation and analysis

For 11 of the 13 respondents, no national requirements to fit N2 and N3 vehicles with wide angle, close proximity or other blind spot mirrors existed before implementation of Directive 2003/97/EC for new vehicles and 2007/38/EC for existing vehicles. Denmark had required all N2 and N3 vehicles to be equipped from 2004. The Netherlands had the same requirement but the date of implementation was not specified. (SWOV 2009) states that a blind spot mirror was required from 2003 but shows that this did not show as quite as much area as the new class IV and V mirrors in combination.

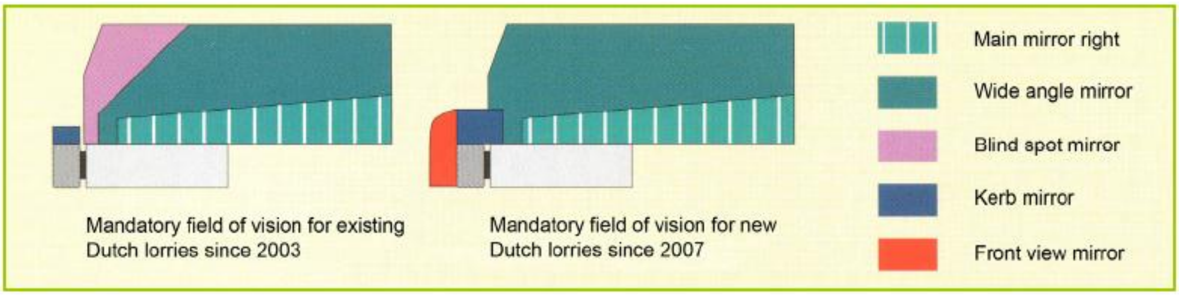

Figure 35: Field of view requirements in the Netherlands. Source: (SWOV 2009)

A.4 Art. 3.2, 3.3, 3.4 and 2.2 (a) and (b)

Respondents were asked to *"communicate to the Commission the list of the technical solutions related to:*

- *the supplementary mirrors and*
- *the equipment, other than mirrors, regulated under Directive 2003/97/EC*

which could have been retrofitted on

- *the vehicles registered before 1 January 2000 and*
- *on the vehicles not exceeding 7,5 tons."*

A.4.1 Denmark

"Blind-spot-mirror" or camera is allowed in addition to old style mirrors to fulfill new requirements for field of view.

A.4.2 Finland

We have no any specific technical solutions for vehicles (and GVW < 7,5t) registered before 1 January 2000.

A.4.3 France

The vehicle fleet affected by Article 2 of the Directive was brought into compliance essentially with 100% of the field of visibility within the framework of the article 3-1. A small part was brought into compliance with the article 3-2. An economically viable technical solution was always found and thus we had very little use of the article 3-3.

The Directive excludes from its field of application the vehicles mentioned in Article 2-2 for technical reasons explained in the discussion of the draft text. We respected this exclusion.

A.4.4 Germany

Germany does not support the idea to have supplementary mirrors installed in addition to the six mirrors that are required currently for the majority of vehicles of categories N2 and N3 as this would clearly overload the driver to check the different mirrors. The example in the Netherlands on the installation of a supplementary mirror clearly showed that no benefit with regard to road safety was achieved. To increase safety of heavy trucks, Germany is in favor of supporting activities to get driver assistance systems (e.g. blind-spot detection, turning-assist) installed which will warn and inform the driver in case of dangerous situations.

For vehicles registered before 01 January 2000 Germany does not see the necessity to have retrofitting solutions for mirrors as the registration figure of these vehicles is already quite low and will further decrease. In the current accident statistics no significance can be seen with regard to the accidents in which these vehicles are involved.

For vehicles of category N2 not exceeding 7,5 tons the advantage of retrofitting new mirrors or installing supplementary is not known. In Germany most accidents of trucks during turning maneuvers involving cyclists are happening with trucks exceeding 7,5 tons.

A.4.5 Ireland

In general it is our experience that the majority of vehicles within the scope of retrofitting requirements of Directive 2007/38/EC were able to fulfill the field of vision requirements stipulated by this directive by having two additional mirrors fitted. However, in a minority of cases camera-monitor type devices have been used, but this is usually as a last resort as these devices are more expensive to retrofit and maintain. Note though that whether a mirror or a camera-monitor system is used to satisfy the wide angle field of vision; proving that such devices satisfy the field of vision requirement for the Class IV mirror outlined in Directive 2003/97/EC is difficult to verify due to the large test area needed. Hence the approach taken to measure the radius of curvature was used when checking this mirror, i.e. wide angle mirrors must have a radius of curvature of 300mm or greater but less than 400mm in order for the vehicle to satisfy this aspect of its roadworthiness test.

A.4.6 Italy

Italy does not support the idea to have supplementary mirrors installed in addition to the six mirrors that are required currently for the majority of vehicles of categories N2 and N3 as this would clearly overload the driver to check the different mirrors. To increase safety of heavy trucks, Italy is in favor of supporting activities to get driver assistance systems (e.g. blind-spot detection, turning-assist) installed which will warn and inform the driver in case of dangerous situations. Referring with prescription of directive 2007/38/EC, Italy does not see the necessity to have additional requirements for vehicles registered before 01 January 2000 and vehicles exceeding 7,5 tons.

A.4.7 Latvia

Re. 2.2.a) and b) – no specific national measures

A.4.8 Luxembourg

Provided no answer to this question

A.4.9 The Netherlands

In The Netherlands a list has been drawn up in 2002 with mirrors complying with the field of vision mentioned in the 2003/97/EC directive. This list can be found (a.o.) here: https://zoek.officielebekendmakingen.nl/stcrt-2002-236-p15-SC37410.html.

A.4.10 Poland

None

A.4.11 Romania

We do not have a list with technical solutions.

A.4.12 The Slovak Republic

Vehicles registered before 1.1.2000 are exempted from retrofiting of mirrors. For these vehicles are apply requirements which are covered by others Directive EU or regulations of ECE. Vehicles N2 up to 7,5 t are exempted from retroffiting of mirrors class IV and V according of requirements of Directive:" Vehicles of category N2 having a maximum total permissible mass not exceeding 7,5 tons, where it is impossible to mount a class V mirror in a way that ensures that the following conditions are fulfilled:(i) no part of the mirror is less than 2 m (a tolerance of + 10 cm may be applied) from the ground, regardless of the adjustment position, when the vehicle is under a load corresponding to its maximum technically permissible weight; and (ii) the mirror is fully visible from the driving position."

A.4.13 Spain

Some procedures were established to prove that each vehicle, as required by Article 2 of Directive 2007/38/EC, fulfilled the requirements of class IV and V of Directive 2003/97/EC as mirrors proposed for the retrofitting of vehicles. These procedures were:

- The manufacturer of one type of vehicle could request verification from the technical service designated by the type approval authority of a Member State. The certificate issued by the technical service would be extended to all the vehicles of the same type.
- The owner of a vehicle could request verification from a technical service designated by the approval authority of a Member State. The certificate issued by the service is only valid for that vehicle.
- A manufacturer might certify that a retrofit system fulfill the requirements of Article 3 of Directive 2007/38 / EC for a type of vehicle, based on available reports of type approval of devices for indirect vision. The reports must be

validated by a technical service approved by the Ministry of Industry, Tourism and Commerce.

- If the type of vehicles or vehicle is exempt from compliance with Directive 2007/38/EC, as provided in paragraphs b) and c) of Article 2.2, or does not need retrofitting of mirrors because it was approved under Directive 2003/97/EC, the manufacturer or a technical service might certify such circumstances.

Once certified the adequacy of a retrofit system for a vehicle a workshop must certify proper installation of the retrofit system.

The first time, after March 31 2009, the vehicle passed periodic technical inspection showing the certificate a), b), c) or d) and the certificate of installation, technical inspector after a visual inspection of the mirrors will consider the compliance with the Directive 2007/38/EC.

A.4.14 TRL interpretation and analysis

It appears that respondents may have found some ambiguity in this question because the responses were not always entirely clear. TRLs interpretation of the question is that it asks respondents to supply details of alternative solutions to standard class IV and V mirrors (e.g. supplementary blind spot mirrors, cameras etc) that were nationally required for vehicles that were out of scope of the Directive (i.e. those registered before the 1st January 2000 and those of < 7.5 tonnes GVW). However, it appears as if some respondents have replied in relation to vehicles that were in scope of the directive but where it was uneconomical to retro-fit the standard mirrors and some as if the supplementary mirrors would be in addition to class IV and v mirrors. For this reason, TRL has attempted to categorise the answers as shown in Table 16, below. It should be noted that it is possible this summary may accidentally misrepresent what the respondent meant but insufficient time was available to contact each respondent and confirm the interpretation.

Table 16: TRL interpretation of responses on the use of alternative mirrors/cameras

	Vehicle categories		
	All in scope of Article 2	Registered pre 2000	N2 ≤7.5t GVW
Alternatives permitted but no defined list of technical solutions	DK, ES	DK	DK
Alternatives permitted, list of technical solutions provided	NL	NL	NL
Alternatives permitted only where approved Class IV and V uneconomic to retrofit – no list	FR, IE		
Compliance not required		FI, FR, DE, IT, LV, PL, RO, SK, ES	FI, FR, DE, IT, LV, PL, RO, SK, ES
Alternatives not permitted	DE, IT		
Unknown	FI, LV, LU,	IE, LU	IE, LU

PL, RO, SK

It can be seen that it is only the two MS where national scehemes were implemented ahead of the implementation of Directive 2007/38/EC that are known to require compliance for vehicles registered before 2000 and for vehicles not exceeding 7.5tonnes GVW. Of these only the Netherlands has specified a list of technical solutions deemed to comply. Most other respondents did not reply in relation to vehicles within scope of the Directive (the question did not strictly ask for a reply). However, France and Ireland made it clear that they would permit supplementary measures where it was uneconomic to retrofit the standard class IV and V mirrors but that this was only the case for a very small number of vehicles. Germany and Italy made it clear that they did not support fitting additional devices over and above the 6 mirrors already required for "most" vehicles, because of the implications for driver workload. This was taken to mean that alternatives were not permitted. However, the replies do not make it entirely clear if they would be supported where they were an alternative to older designs of wide angle and close proximity mirrors fitted to the minority of older vehicles, such that the total number of devices for indirect field of view did not exceed 6.

A.5 Article 4, Part a

According to article 4 *"Compliance with the requirements set out in Article 3(1), (2) and (3) shall be established through proof furnished by a Member State in accordance with Article 3 of Directive 96/96/EC".*

Respondents were asked *"How were the national periodical technical inspection requirements updated to fulfill the above mentioned obligation?"*

A.5.1 Denmark

The inspection sites were obliged to establish mirror test places with markers not later than 1st April 2007 and make test of field of view at every PTI of lorries.

A.5.2 Finland

We have written technical directions to inspection companies including evaluating of compliance for the mirrors and technical solutions.

A.5.3 France

As stated in [section A.2.3] above, evidence of compliance with Articles 3-1 or 3-2 is established by the presentation of the attestation of compliance at the technical inspection.

A.5.4 Ireland

The 'Mirrors Page' of the HGV (Heavy Goods Vehicle) Testers Manual was updated to include a specific section relating to the requirements for N_2 and N_3 vehicles registered after 1st Jan 2000, with a copy of the revised page of the HGV Manual being circulated to each registered roadworthiness testing centre with a cover note. Furthermore the software used by the Test Centres in conducting the tests was updated to enable them to record the test result for this item.

A.5.5 Italy

Updating the registration document made by a sticker after inspection and/or testing.

A.5.6 Latvia

Requirements transposed into the national legislation on PTI by way of amendment.

A.5.7 Luxembourg

A new paragraph has been added to the relevant article of the legislation on periodical technical inspection

A.5.8 Netherlands

None, inspection was already carried out.

A.5.9 Poland

It was updated by amending the regulation of the Ministry of Infrastructure on the technical inspections of vehicles. The regulation amended, according to directive 2007/38/EC one of the positions obligatory checked during the periodical technical inspection.

A.5.10 Romania

In the Annex 2 – Items to be inspected - of the Roadworthiness Regulations, which is the Annex of the Minister of Transport Order number 1002/2008, we imputed requirements to fulfill the provisions of the European Directive 2007/38/EC.

A.5.11 The Slovak Republic

According law we adopted methodology for periodical technical control.

A.5.12 Spain

Any vehicle N2 or N3 registered between 01/01/2000 and 27/08/2008 by the mere fact of having passed an inspection ITV after the March 31, 2009 fulfill Directive 2007/38/EC. Any vehicle registered in Spain after the 27.08.2008 fulfill with Directive 2003/97/EC.

A.5.13 TRL interpretation and analysis

While the methods vary, each Member State has updated their periodic technical inspection regimes to require some demonstration of compliance with Directive 2007/38/EC.

A.6 Article 4, part b

In 2007 the note "Directive 2007/38/EC on the retrofitting of mirrors to heavy goods vehicles" was circulated by the European Commission (Road Safety Unit) to the Technical Adaptation Committee (TAC) under Directive 96/96/EC.

To ensure that the mirrors and other equipment installed are compliant with Directive 2007/38/EC, that note proposed three solutions:

- Mirror test areas with markers,
- Release of a certificate of compliance,
- Drawing up a list of permitted mirrors

Respondents were asked *"Which one has been preferred?"*

A.6.1 Denmark

Mirror test areas with markers.

A.6.2 Finland

We have preferred a certificate of compliance from manufacture or technical service.

A.6.3 France

Certificate of compliance

A.6.4 Germany

Use of a tool to measure radius of curvature at annual inspection. But the Federal Ministry of Transport, Building and Urban Development supports an initiative of Daimler, MAN and DEKRA to install mirror test areas with markers in Germany for heavy goods vehicles, e.g. at parking areas next to the motorway.

A.6.5 Ireland

The field of vision of the close proximity 'Class V' mirror is checked by ensuring that the area outlined in section 5.5 of Directive 2003/97/EC is visible from the driver's seat. This area has been painted on the floor in all test centres at a location adjacent to the test lane. The field of vision of the wide angle 'Class IV' mirror is checked by using an RSA approved mirror checking tool to verify that the mirror has the correct radius of curvature, i.e. wide angle mirrors must have a radius of curvature of 300mm or greater but less than 400mm in order for the vehicle to satisfy this aspect of its roadworthiness test. We sourced these tools from a German supplier and distributed them to each registered tester to use in testing these mirrors for compliance with the area outlined in section 5.4.2 of Directive 2003/97/EC.

A.6.6 Italy

Release of a certificate of compliance.

A.6.7 Latvia

No separate certification/compliance statement – the proof of compliance is the proof of passed PTI.

A.6.8 Luxembourg

The second option [certificate of compliance] has been preferred, however, in absence of a certificate of compliance, additional technical checks on the design (mainly curvatures of the mirror pane) may be performed in order to approve the mirror

A.6.9 The Netherlands

See above [A.4.9].

A.6.10 Poland

Certificate of compliance

A.6.11 Romania

A vehicle is approved at the visibility check regarding the class IV and class V mirrors if:

- the driver can release a certificate of compliance issued according to the Directive 2003/97/EC;
- the mirrors are type approved and marked accordantly;
- Testing the mirrors in test area with markers.

A.6.12 Slovakia

We check approval marks on the mirror and check the radius of curvature of the installed mirror.

A.6.13 Spain

There is no possible in a periodical inspection as regulated in Directive 2009/40/EC to check correctly the fulfilling of requirements of Directive 2003/97/EC concerning fields of vision and installation. Neither is appropriate to provide a list of permitted mirrors. It should be different for each type of vehicle, not ensuring proper installation of the mirror in the vehicle. Therefore we opted for dual certification: 1) adequacy of the system to a particular vehicle for retrofitting, 2) proper installation of retrofit system in the vehicle.

A.6.14 TRL interpretation and analysis

The responses are summarised below:

- Mirror test area with markers required at PTI; DK
- Certificate of compliance: FI, FR, IT, LU, PO, ES
- List of approved devices: NL
- Other: DE, IE, RO, SK

It can be seen that most Member States that responded preferred to use a certificate of compliance issued by the installer as a means to demonstrate compliance with the requirements, with only Denmark requiring a full test of the field of view at PTI and only the Netherlands supplying a list of approved devices. Four other respondents used "other" approaches. Germany used a measurement of the radius of curvature to approximate a measure of compliance and the remaining three used some combination of two or more of the four identified methods.

It is worth noting that (VOSA 2008) shows that the UK also implemented the Directive but that its certificate of compliance was permitted to be by means of self certification by the operator of the vehicle. At PTI the certificate would be checked but not that the field of view was in actual fact achieved. The effectiveness thus relied heavily on the integrity of the industry in fitting the appropriate devices.

A.7 Article 4, part c

Respondents were asked "How many vehicles failed the periodic technical inspection due to the fact that they were not compliant with Directive 2007/38/EC?"

A.7.1 Denmark

Cannot be answered precisely, unfortunately due to no detailed registration of faults in relation to extended field of view. However, due to significant focus on the issue our estimate is, that very few vehicles didn't fulfil requirements after date of implementation. From 01.10.2009 our central database contains results from PTI. For the period 01.10.2009 to 30.05.2011 61.769 lorries N3 were inspected at PTI stations. Of those did 1136 have defective mirror(s) of some kind and 2900 did have maladjusted mirror(s).

A.7.2 Finland

We have no exact information of failed vehicles. Only a few vehicles have refused in the periodic technical inspection.

A.7.3 France

On all technical inspections conducted, there has been no noticeable increase of defects of checkpoint 3.3 of Annex 2 of Directive 96/96/EC. But any non-compliance in inspection was only temporary in that the vehicle had to be represented after alignment.

A.7.4 Germany

Cannot differentiate from other mirror failures.

A.7.5 Ireland

We do not have exact figures as to the number of vehicles that have failed due to not being compliant with the above Directive as the test data currently being returned is not sufficiently detailed. We are currently working on upgrading our Commercial Vehicle Test Centre IT systems which will give us much more detailed test information in the future.

A.7.6 Italy

This information is not applicable, as the periodic technical inspection information does not differentiate if a vehicle failed due to non-compliance with the requirements given in Directive 2007/38/EC or other failures regarding a mirror.

A.7.7 Latvia

Since 2009, goods vehicles failed on grounds of the defects related to mirrors, are as follows:

- Under 12 tons:
  - 2009 - 361
  - 2010 - 405
  - 2011 - 149
- Over 12 tons:
  - 2009 - 592
  - 2010 - 718
  - 2011 – 263

There is no information available for the number of vehicles failed particularly because of the incompliance with the requirements of the Directive in question.

A.7.8 Luxembourg

Between June 2010 and May 2011, approximately 2,5 % of the vehicles in scope failed during PTI because of non-compliancy with that particular provisions.

A.7.9 The Netherlands

Table 17. Number of PTI failures in the Netherlands as a result of non-compliance with the mirror field of view requirements

APK	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
fail	1	13	23	12	5	7	15	8	10	4	3		5	3	1

A.7.10 Poland

Ministry of Infrastructure is not competent for collecting such statistics.

A.7.11 Romania

During the 2009 year, we record the following number of vehicle rejected and different reasons for rejection:

- 19 vehicles was rejected because mirrors are missing;
- 51 vehicles was rejected because the mirrors were not in compliance with the field of visibility;
- 4 vehicles was rejected because the equipment, other than mirrors, are not functioning accordingly;
- 4 vehicles was rejected because the equipment, other than mirrors, are not in compliance with the field of visibility.

During last year, we record the following number of vehicle rejected and different reasons for rejection:

- 6 vehicles was rejected because mirrors are missing;
- 11 vehicles was rejected because the mirrors were not in compliance with the field of visibility;
- 1 vehicle was rejected because the equipment, other than mirrors, is not functioning accordingly;
- 1 vehicle was rejected because the equipment, other than mirrors, is not in compliance with the field of visibility.

A.7.12 The Slovak Republic

This is is result according database. In a lot of cases can be vehicle failed due to non compliance according other failures regarding mirror incorporated by also 2007/38/EC.

Table 18. Mirror failures at PTI in the Slovak Republic 2009/10

category	1.4.2009 up to 31.12.2009			since 1.1.2010 up to 31.12.2010		
	Number of PTI control	Did not pass according 2007/38/EC		Number of PTI control	Did not pass according 2007/38/EC	
N2	6731	28	0,42 %	9926	34	0,34 %
N3	14210	82	0,58 %	21909	74	0,34 %

A.7.13 Spain

There are no specific statistics data but there were no major problems. Transport companies, maintenance workshops and roadworthiness stations were informed in plenty of time of requirements established in Directive 2007/38/EC.

A.7.14 TRL analysis and interpretation

Most respondents stated that it was not possible to provide information on how many vehicles failed to comply specifically with 2007/38/EC because their periodic technical inspection statistics did not separate non-compliance with this Directive from other mirror failures such as cracked lenses or insecure mountings. Several of these commented that they believed that there were few problems. A few provided data on general mirror failures showing relatively small numbers of failures but did not provide data on the number of vehicles tested so that the proportion of failures could not be calculated. The estimates for Luxembourg and the Slovak Republic suggested levels of non-compliance with the Directive of between 0.3% and 2.5%.

Appendix B Tabular data underlying graphs in section 6

B.1 Accidents involving HGVs

Table 19: Number of VRU fatalities from accidents involving HGVs based on a business as usual trend (no new mirror fitment) from the year 2006 (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	488	427	972	1,887
2002	456	424	961	1,841
2003	465	395	918	1,778
2004	438	410	913	1,761
2005	433	401	835	1,669
2006	421	395	804	1,620
2007	408	389	775	1,572
2008	397	383	746	1,526
2009	385	378	719	1,482

Table 20: Number of VRU fatalities from accidents involving HGVs based on predicted effects of mirror fitment (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	488.0	427	972	1,887
2002	456.0	424	961	1,841
2003	465.0	395	918	1,778
2004	438.0	410	913	1,761
2005	433.0	401	835	1,669
2006	418.2	393	804	1,616
2007	398.9	381	775	1,554
2008	380.5	369	746	1,495
2009	297.2	292	719	1,309

Table 21:Actual observed number of VRU fatalities from accidents involving HGVs (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	488	427	972	1,887.00
2002	456	424	961	1,841.00
2003	465	395	918	1,778.00
2004	438	410	913	1,761.00
2005	433	401	835	1,669.00
2006	438	337	773	1,548.00
2007	391	353	837	1,581.00
2008	411	288	738	1,437.00
2009	332	250	628	1,210.00

Table 22: Distribution of VRU fatalities by HGV manoeuvre, 2001 and 2009 (Source: CARE BE, DK, ES, FR, PT, UK)

Manoeuvre	2001	2009
changing lane	2	3
other	19	23
overtaking	5	2
overtaking on the left	1	5
overtaking on the right	1	17
reversing	14	0
stopped	1	8
stopped/stopping	11	2
stopping	3	0
straight ahead	168	84
turning left (right in UK)	34	15
turning right (left in UK)	56	51
unknown	41	6
u turn	4	1
Total	360	217

B.2 Accidents involving LCVs

Table 23: Number of VRU fatalities from accidents involving LCVs based on a business as usual trend (no new mirror fitment) from the year 2006 (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	312	199	615	1,126
2002	270	181	554	1,005
2003	270	186	523	979
2004	242	155	543	940
2005	230	201	543	974
2006	213	204	527	945
2007	198	208	512	918
2008	184	211	497	892
2009	171	215	482	868

Table 24: Number of VRU fatalities from accidents involving LCVs based on predicted effects of mirror fitment (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	312.0	199	615	1,126
2002	270.0	181	554	1,005
2003	270.0	186	523	979
2004	242.0	155	543	940
2005	230.0	201	543	974
2006	212.6	204	527	943
2007	194.6	204	512	911
2008	178.2	205	497	880
2009	141.4	179	482	802

Table 25:Actual observed number of VRU fatalities from accidents involving LCVs (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	312	199	615	1,126.00
2002	270	181	554	1,005.00
2003	270	186	523	979.00
2004	242	155	543	940.00
2005	230	201	543	974.00
2006	261	207	557	1,025.00
2007	240	186	561	987.00
2008	230	181	555	966.00
2009	213	158	485	856.00

B.3 Accidents involving buses and coaches

Table 26: Number of VRU fatalities from accidents involving buses and coaches based on a business as usual trend (no new mirror fitment) from the year 2006 (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	112	66	371	549
2002	104	67	342	513
2003	106	49	337	492
2004	94	70	334	498
2005	103	78	317	498
2006	101	84	305	490
2007	99	90	293	482
2008	98	96	282	476
2009	96	103	271	470

Table 27: Number of VRU fatalities from accidents involving buses and coaches based on predicted effects of mirror fitment (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	112.0	66	371	549
2002	104.0	67	342	513
2003	106.0	49	337	492
2004	94.0	70	334	498
2005	103.0	78	317	498
2006	101.1	84	305	490
2007	99.2	89	293	482
2008	97.2	96	282	475
2009	93.5	101	271	465

Table 28:Actual observed number of VRU fatalities from accidents involving buses and coaches (EU15 +CZ, PL, SI, RU)

Year	Motorcycle/Moped	Pedal cycle	Pedestrian	All VRU
2001	112	66	371	549.00
2002	104	67	342	513.00
2003	106	49	337	492.00
2004	94	70	334	498.00
2005	103	78	317	498.00
2006	110	54	284	448.00
2007	101	67	271	439.00
2008	88	59	246	393.00
2009	93	41	225	359.00