Policy evaluation programme vehicle safety standards: improving car crashworthiness

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Improving Car Crashworthiness
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Table of Contents

Executive Summary .............................................................................................................. 1
1 Introduction ......................................................................................................................... 11
1.1 The Relationship Between DfT and TRL ................................................................. 11
1.2 Context ......................................................................................................................... 12
1.3 Aims and Objectives ................................................................................................. 13
2 Background ....................................................................................................................... 15
2.1 Historical framework for vehicle safety policy development in Europe............. 15
2.2 Research and development in car crash protection ........................................... 17
2.3 Frontal impact Protection ....................................................................................... 19
2.4 Side impact protection ............................................................................................ 23
2.5 The growth of consumer information .................................................................. 25
3 Methodology ................................................................................................................... 30
3.1 Quantitative Data ....................................................................................................... 30
3.2 Qualitative Data .......................................................................................................... 31
4 Quantitative Analysis ....................................................................................................... 33
4.1 National Accident Data Analysis ............................................................................. 33
4.1.1 Car Occupant Casualty Trends ........................................................................... 34
4.1.2 Analysis based on Vehicle Age .......................................................................... 37
4.1.3 Summary of Findings - National Accident Data .............................................. 39
4.2 CCIS Data Analysis ................................................................................................. 44
4.2.1 Summary of CCIS Analysis Results ................................................................. 45
4.3 Discussion .................................................................................................................... 51
4.4 Basic Cost Benefit Analysis (1990-2002). ............................................................. 55
4.4.1 Costs ................................................................................................................... 55
4.4.2 Benefits ............................................................................................................. 58
5 The Qualitative Data ....................................................................................................... 62
5.1 Part 1: Impact ............................................................................................................. 62
5.1.1 The Regulations ............................................................................................... 62
5.1.2 EuroNCAP ........................................................................................................ 79
5.2 Part 2: Process ........................................................................................................... 98
5.2.1 The Regulations ............................................................................................... 98
5.2.2 EuroNCAP ........................................................................................................ 117
5.3 Summary of Qualitative Data ................................................................................. 130
5.3.1 Regulations versus Consumer Testing ......................................................... 130
6 Conclusions ..................................................................................................................... 136
7 References ....................................................................................................................... 144
8 Acknowledgements ....................................................................................................... 148
9 Glossary .......................................................................................................................... 149

Appendix 1 Quantitative Analysis Figures and Charts
Appendix 2 Time Line
Appendix 3 Topic Guides

PPAD 9/033/128, S0221/VF VSRC
Executive Summary

Introduction
This project aims to offer a comprehensive identification, evaluation and understanding of the extent to which the Department for Transport (DfT) has met policy aims for road casualty reduction through its contribution to regulations, in particular the development of the front and side impact Economic Commission for Europe Directives (ECE R94 and ECE R95) and the European New Car Assessment Programme (EuroNCAP).

Methodology

The quantitative analysis has three distinct and complementary elements:

- an analysis of the GB Road Accident Database Statistics (STATS 19);
- an examination of the UK Co-operative Crash Injury Study (CCIS) database;
- a basic cost-benefit analysis.

In the accident data analysis, vehicles were divided into two distinct groups; those pre regulation and those post regulation. Comparisons were made between the two groups considering the impact direction, the impact object and the gender / age of the occupants (older or younger than 50 years).

The cost benefit analysis was based on project and staff costs provided by DfT and casualty trends within the STATS19 data.

The qualitative analysis was based upon responses to in-depth interviews with experts drawn from government, vehicle safety research, the motor manufacturing industry and consumer organisations in the UK and Europe. The analysis had two dimensions: impact and process. The impact dimension presented respondents’ views on what difference the front and side impact regulations and EuroNCAP had made to the levels of protection offered to occupants in a car accident. The process dimension reported on the views and experiences of the processes which had brought the regulations and EuroNCAP into effect.
Quantitative Data Results

**STATS 19 database**

An analysis was made of the STATS19 data base for the years 2001-2003 and car occupant killed or seriously injured (KSI) rates considered. The results indicate:

**Car to car impacts**

- Benefits in post regulation vehicles for all drivers across all directions of impact.
- Benefits in post regulation vehicles for front seat passengers (FSP) across all directions of impact except for female FSPs in frontal impacts and older FSPs in right side impacts who saw disbenefits.
- Disbenefits in post regulation vehicles for all rear seat passengers (RSP) in frontal impacts, for female and older RSPs in rear impacts, for older RSPs in right side impacts and for male and for older RSPs in left side impacts.

**Car to non car impacts**

- Benefits in post regulation vehicles for all drivers across all directions of impact except for female drivers in left side impacts who saw disbenefits.
- Benefits in post regulation vehicles for all FSPs across all directions of impact except for female FSPs in rear impacts who saw disbenefits.
- Benefits in post regulation vehicles for all RSPs across all impact directions except for older RSPs in front, rear and left side impacts who saw disbenefits.

**CCIS database**

Weighted data from the CCIS database were analysed for the period 1995-2005 to gain a better insight into occupant injury outcomes for each body region in frontal, struck and non-struck side crashes. The results show:
Frontal impacts

- Drivers have seen an improvement in head protection in post regulation vehicles for both car to car and car to non-car impacts but this is not the case for front seat passengers.
- Chest injury outcome has improved for all front seat occupants. For pelvic injuries improvements are seen for all drivers in car to non car impacts but disbenefits are apparent for male drivers and older drivers in car to car impacts.
- Post regulation vehicles offer better thigh protection to front occupants in car to car impacts but such benefits are not as apparent, particularly for FSPs, in car to non car impacts.
- Whilst drivers have improved knee protection in car to non car impacts, female drivers and younger drivers show an increased risk of serious injury in the post regulation cars; there is a lack of data to comment on knee injuries for FSPs.
- Lower leg protection has improved all round for drivers but it is not possible to draw conclusions for FSPs.
- With foot and ankle injury, female and younger drivers appear disadvantaged in newer vehicles for car to car impacts but there are improvements for all drivers in car to non-car impacts. Where the data supports the analysis the foot/ankle outcome for FSPs is generally better in the newer cars, the exception being for female drivers in car to non car impacts.
- With respect to facial, neck and abdominal injuries, the data does not support robust conclusions.

Struck-Side Impacts

- Post regulation vehicles offer improved cranium, chest and lower leg protection for all front occupants in car to car impacts. However, only the older occupants see benefits in car to non car impacts (excluding chest injury outcome).
Mixed gains are apparent for neck injury. In car to car impacts there are improvements for female and younger occupants only and there are disbenefits across the board for car to non car impacts.

For abdominal injury outcome, female and older occupants see disbenefits in the post regulation vehicles for car to car impacts whilst in car to non car impacts only the younger occupants appear to be disadvantaged.

General improvements are noted for thigh protection, the exception being female front occupants in car to car impacts.

The data does not support robust conclusions with respect to facial, pelvis, knee or foot/ankle injury outcome.

Non Struck-Side Impacts

Cranium protection has improved in all non struck-side impacts except for females in car to non car impacts, though a result for the older occupants in car to car impacts could not be calculated.

Chest injury outcome has improved for all but the older occupants in car to car impacts but conversely, there appear to be disbenefits for all but the elderly in car to non car impacts though this result needs to be treated with caution.

The sample size and scarcity of injury did not allow for robust conclusions to be drawn for any other body regions.

Cost benefit analysis

The cost benefit analysis showed an average annual reduction of 3.9% in the number of car occupants with KSI outcome between 1999 and 2003. The relative contribution to improved outcomes of research into crashworthiness should increase as recent vehicle models become more widespread across the fleet.

The year-on-year fall of accidents involving serious injury over the past ten years represents considerable savings. For one year alone, 2002-3, the fall in
the number of seriously injured occupants equates to savings of more than £196 million at 2001 prices.

**Qualitative Data Findings**

*Impact*

**Regulations:** A clear majority of respondents said that the front and side impact regulations had enhanced the protection of car occupants in an accident. They believed that the regulations were qualitatively superior to previous testing regimes, singling out the side impact test and the offset barrier test for frontal impact as critical elements.

The regulations were not, however, seen as promoting continuous improvement in crashworthiness; rather, they were said to have produced a step change at a particular moment by setting minimum standards which then became fixed.

Most respondents agreed that without the regulations motor manufacturers would have introduced piecemeal improvements as the necessary technology became available but these would not have created a consistent safety standard across the industry.

Whole vehicle testing was widely regarded as the indispensable basis of an effective safety regime.

While it was agreed that the regulations had led manufacturers to optimise their cars in order to meet test requirements, views differed as to whether this had created significant disbenefits for certain vehicle users. Some expressed concerns that female and older drivers, rear seat passengers and children had been significantly disadvantaged.

Most respondents did not have a firm view as to whether regulation had resulted in additional problems of compatibility. Compatibility between cars and heavier vehicles, particularly lorries, remained an important and largely unresolved issue.
None of the interviewees believed that the regulations had resulted in vehicles that were less pedestrian friendly. But neither did they consider that they had made much positive impact upon pedestrian safety.

Opinion was divided about whether the speed of the regulatory tests should be raised to that used by EuroNCAP. Several argued for maintaining a separation between the requirements of the regulations and EuroNCAP in order to discourage optimisation at a single point.

**EuroNCAP:** There was near unanimity that protection for car occupants had improved since the introduction of EuroNCAP, which had stimulated continuous improvement in crashworthiness performance by diffusing the most advanced levels of protection throughout the industry.

Virtually everyone believed that optimisation of vehicles was an inevitable consequence of EuroNCAP although, as in the discussion of the regulations, there was disagreement about the extent and nature of disbenefits to the non 50th percentile male.

Views about the effect of EuroNCAP on compatibility and pedestrian friendliness were tentative, most believing that it had neither brought improvements nor made things worse.

Most believed that EuroNCAP had influenced consumer attitudes towards purchasing cars, although it was difficult to know how consumers balanced safety against other criteria.

There was near unanimity that EuroNCAP ratings had exercised a powerful positive impact upon investment by the industry in improving car crashworthiness.

Opinion within the group was divided about the value of consumer-oriented publications such as “Choosing Safety”, based upon retrospective analysis of
real world accident data. Some argued that these were more comprehensive and transparent than EuroNCAP, while others questioned the capacity of retrospective ratings to influence current and future design.

While agreeing that EuroNCAP should continue and that its funding should be sustained and improved, the respondents expressed different views about its future role and priorities. Some felt that priority should be given to extending the existing testing regime while others believed that more resources should be diverted into primary safety.

Process

Regulations: Technical research into key aspects of occupant safety was identified as a primary driving force behind the regulations. Whole car crash testing was integral to this research and the UK government was acknowledged as a leader in this field because of the work undertaken in the Transport Research Laboratory (TRL) at the DfT from the early 1980s.

Much effort was devoted to creating a suitable barrier for frontal impact and a dummy for side impact. Some believed that the nature of the barrier for side impact had received too little attention, with the result that the efficacy of this test had been undermined.

The commitment of individuals was said to have been critical to the formulation of the regulations. They were variously to be found in research, consumer and government institutions, both national and European. The TRL was singled out as having provided a particularly sympathetic environment for safety champions and CCIS was said to have injected an urgency into the safety agenda by demonstrating a level of personal and social cost from road accidents that was politically unacceptable.

There was general agreement that co-operative effort across Europe, for example in the European Experimental Vehicle Committee (EEVC) and the European Transport Safety Council (ETSC), had been an indispensable pre-condition for the successful implementation of the regulations. At the later
stages, the decision by the European Parliament to reject the Commission’s weakened draft directives had been critical to the implementation of effective regulations.

National governments were said to have differed markedly in the extent to which they promoted vehicle safety, with the UK and the Netherlands consistently described as the leading advocates.

There was a striking difference of perspective between motor industry representatives and other respondents about the extent to which the industry had opposed the introduction of the front and side impact regulations. The main sticking points in the formulation of the regulations were said to have been technical in nature: crash testing versus computer simulation for side impact collisions, the nature of the barrier for frontal impact crash testing, the height of the side impact barrier, and the speed of the tests.

There was a fair level of agreement that the financial burden to industry of meeting the regulations had been slight, although somewhat greater for side impact than for frontal impact.

**EuroNCAP:** A sense of frustration with the delays and difficulties of the regulatory process was described as a primary driving force behind EuroNCAP. Leading safety champions had begun to look to consumer testing as a potentially more effective route for achieving improvements in crashworthiness. Models for consumer testing had already existed elsewhere, particularly in the United States.

The UK government was widely credited with having initiated EuroNCAP through its support for the United Kingdom New Car Assessment Programme (UKNCAP) programme at the TRL, followed by its political orchestration for cross-national support for an expanded European programme. But it was recognised that the UK could not have launched EuroNCAP without the support of European allies.
Almost all respondents agreed that individual manufacturers and bodies representing the industry had been hostile towards EuroNCAP at the outset but that industry opposition had subsequently evaporated. Good ratings in EuroNCAP had provided manufacturers with a valuable opportunity to distinguish themselves in a crowded marketplace.

Most respondents agreed that EuroNCAP had been more successful than previous consumer testing approaches in exerting pressure on manufacturers to improve safety. Nonetheless, concerns remained amongst some manufacturers about aspects of the programme, including its benefits in terms of real world safety.

Very little information was obtained from the interviews about the costs of designing cars to meet EuroNCAP requirements but it was clear that manufacturers had found them burdensome.

Most respondents believed that both the regulation and EuroNCAP would continue to be important in the future and that the linkage between them, through research and test protocols, should be maintained.

**Conclusions**

The front and side impact regulations and EuroNCAP have exercised a positive and sustained impact upon car occupant safety in the UK. The regulations have provided a basic safety platform that has ensured a minimum standard for all vehicles, and EuroNCAP has harnessed competition between manufacturers to raise safety standards.

Whole vehicle testing has been the indispensable basis of effective predictive tests and much credit can be given to the UK government for providing technical leadership in this field.

At national government level, the UK’s contribution to securing progress in frontal and side impact protection through the regulations and consumer testing was clearly substantial and indeed indispensable in the case of
EuroNCAP. The UK also orchestrated the necessary political support in the European arena.

The DfT’s Transport Technology and Standards Division (TTS) research programme has been highly cost effective and has made a vital and effective contribution to the key policy objective of reducing serious road casualties.

The increased KSI outcome for RSPs in car to car frontal impacts and the uneven distribution of injury mitigation by body region between drivers and passengers across the impact scenarios considered remain matters of concern. These present challenges for the regulations and EuroNCAP to address through improvements to their testing regimes.
1 Introduction

1.1 The Relationship Between DfT and TRL

During the time frame covered by this project, the Department for Transport (DfT) has taken a number of different names. These are as follows:

Pre 1990-May 1997 Department of Transport (DOT)
May 1997-June 2001 Department of the Environment, Transport and Regions (DETR)
June 2001-May 2002 Department for Transport, Local Government and the Regions (DTLR)
May 2002-Present Department for Transport (DfT)

Within the Department for transport, the Transport Technology and Standards (TTS) Division has variously been called:

Vehicle Standards and Engineering (VSE) - 1991
Vehicle Technology and Standards (VTS) - 2004
Transport Technology and Standards (TTS) - 2005

TRL was first established in 1933 as an experimental station of the Ministry of Transport Roads Department and later as the Road Research Laboratory (RRL) in the Department of Scientific and Industrial Research (DSIR). It was funded through the DSIR but the research programme was determined by the Director, with advice from an Advisory Board which included members from the Transport Ministry.

On 1st April 1965, RRL became an integral part of the DfT and was funded direct from the vote. The research programme remained the responsibility of the Director through agreement with Research Committees.
In April 1992, TRRL became a Government Agency and bid for research contracts from the DfT, who now held the research budgets, with provision also for winning work competitively from other public and private bodies, in competition with other research organisations.

On 1\textsuperscript{st} April 1996, TRRL became a fully private limited company known as TRL Limited, wholly owned by the Transport Research Foundation, a non-profit distributing company and a Scientific Research Association. Under its independence of ownership, TRL works throughout the world undertaking independent and impartial research for clients in both the public and private sectors.

Throughout this report the acronyms DfT, TTS and TRL will be used to refer to the Department for Transport, the Transport Technology and Standards Division and the Transport Research Laboratory respectively.

1.2 Context

In order to support the DfT’s aims to ensure that the UK has a modern integrated transport system that is safe, sustainable and minimizes the impact on society, the TTS division has a broad based research programme directed towards minimizing the number of road accidents and resulting casualties as well as towards reducing the impact of vehicles on the environment. Specifically, the Government’s commitment to road safety requires a reduction in the number of KSI road users by 40 percent, with an equivalent figure for children of 50 percent, by 2010 when compared with the average for 1994-1998.

Improvements in car crashworthiness have been shown to be highly effective in reducing the number and severity of occupant injuries. A driving force behind such improvements is the requirement for new vehicles to pass regulatory tests and a desire by the manufacturers to perform well in the consumer tests, namely EuroNCAP. Research directed towards the development of these tests has, over the past 10-15 years, formed a
substantial part of the secondary safety element of the TTS research programme. Much of this research was carried out by TRL. See section 1.1 for the historic relationship between DfT and TRL.

The DfT currently has a requirement to assess the effectiveness of its research programme in meeting the Policy aims and objectives. It is the beneficial contribution that Departmental initiatives have made to regulatory and consumer tests that form the basis for this evaluation.

It is recognized that the current European front and side impact regulations and also EuroNCAP were very much UK government led initiatives. However, over the years, there has been increasing involvement at a European level. For the purposes of this Policy evaluation it is necessary to distinguish the input made by the UK government within the overall development of the test programmes.

1.3 Aims and Objectives

The primary aim of this project was to provide a comprehensive and objective identification, evaluation and understanding of the extent to which Departmental activities have met Policy aims in terms of road casualty reduction by considering how Regulatory testing and EuroNCAP have contributed to advances in car safety.

To this end, the project objectives were to identify, comprehend and assess the different ways in which the Department has contributed to car crashworthiness specifically through its input into the front and side impact Directives (ECE R94 and ECE R95) and the EuroNCAP test programme. Particular consideration was given to addressing the following questions:
• Which particular groups in society have been affected and in what ways?
• What is the general balance to society arising from the Directives and EuroNCAP?
• To what extent have the Department's interventions prompted a process of continuous improvement?
• Would the outcomes have happened without intervention?
• What resources have been put into the programme to deliver the net benefits?
• What is the added value of these interventions in terms of casualty reductions and value for money?
• What mechanisms and processes proved most effective in developing and implementing policy and why?
• Could the programme have been managed and/or delivered differently to improve the return on this investment?
• Are there any lessons Government should learn in terms of policy making and/or programme delivery strategy?

The impact and processes of the Directives and EuroNCAP were evaluated in order to determine which have been most successful in meeting the Policy aims and objectives and recommendations have been made at the end of this report for potential improvements where these were identified.
2 Background

Substantial improvements in vehicle safety design have taken place over the last ten years in Europe leading to a large reduction in fatal and serious injury risk amongst car occupants. These results are due to a combination of the effects of new European legislative standards and the impact of new predictive and retrospective consumer information systems providing objective data on the performance of cars in state of the art crash tests and real crashes.

The outcomes in legislative and consumer information development, contested at the time by the European car industry, came about as a result of leadership from policymakers in the UK in initiating and supporting substantial research and legislative development. This was backed up by European Parliamentarians from the main parties and advocacy from consumer, safety and motoring organisations.

This section of the report traces such developments with reference to the growing scientific knowledge-base and the key role played by UK vehicle safety professionals, whether policymakers, researchers, Parliamentarians or advocates in efforts to secure long overdue, research-based improvements in front and side impact protection in cars.

2.1 Historical framework for vehicle safety policy development in Europe

International harmonisation in standards affecting vehicle construction and use in the UK has taken place since 1958 following the signing of the United Nations (UN) agreement supervised by the Inland Transport Committee’s Working Party on the Construction of Vehicles in Geneva (WP 29). This provided the framework for a voluntary type approval system based on United Nations Economic Commission for Europe (UN ECE) Regulations. The principal objective of such UN ECE harmonisation was the removal of trade barriers. Such harmonisation provided many advantages for trade and
industry and freed them from having to meet a variety of national regulations. However, success in securing a high level of safety and consumer protection harmonisation proved to be elusive given the opposition of the car industry to prescribed design and performance standards and their concern that these might inhibit future freedom in styling.

In the US, interest in unsafe vehicle design was awakened in the late 1960s by a well-publicised design fault in the Chevrolet Corsair, the work of Ralph Nader and debates surrounding the mandatory installation of safety improvements such as seat belts in cars. Following a 1965 report by a Congressional Committee – the Ribicroft Committee, the first Federal Motor Vehicle Safety Standards (FMVSS) were issued in 1967. These rules, on which many European standards were largely based, were described as arbitrary design rules lacking in comprehensive justification by Mackay.

In 1985, the European Regulations Global Approach (ERGA) passive safety group was set up by the European Commission and Member States to study the possibilities for adapting existing European Economic Committee (EEC) Directives to technical progress.

By the late 1980s/early 1990s, concern amongst European vehicle safety professionals about the length of time taken for the legislative process to keep abreast of technical progress in the interest of safety had increased.

In 1992, the TRL produced estimates, which were to be used widely in the legislative debates, that improved crash test procedures could lead to a saving of 65,000 deaths and serious injuries in frontal impacts and some 25,000 fewer deaths and serious injuries in side impacts in European Union (EU) countries annually. A report by the ETSC in 1993 concluded that many European vehicle safety standards were some 20 years behind the needs identified by road crash injury research.

As the European Union developed and more countries joined, a new framework, new impetus and more opportunity for international agreement
and co-operation on vehicle safety initiatives in Europe emerged. The main
developments comprised: EEC Directives permitting EU-wide requirements
for the type approval of vehicles (1970); Single Market requirements for the
provision of a high level of consumer protection in harmonised standards
(1987); EU Whole Vehicle Type Approval for cars (1992 coming into full
effect in 1996); and Maastricht Treaty changes giving the EU shared powers
with Member States for road safety as well as co-decision powers for the
European Parliament with the Council of Ministers in transport and road safety

As this new framework emerged, together with a new political willingness to
take action on road safety at EU level, the 1990s saw unprecedented
opportunity to make progress in vehicle safety. Due to the leadership and
pressure from various Member States (UK, The Netherlands and the Nordic
countries), European Parliamentarians and consumer (Bureau Europeen des
Consommateurs BEUC), safety (ETSC) and motoring organisations;
Federation Internationale de l’Automobile (FIA) and Alliance Internationale de
Tourism (AIT), the EU institutions were encouraged to take research-based
legislative action on front and side impact protection.

At the same time, as a result of the lack of responsiveness of the European
regulatory process to safety needs, a new predictive consumer information
system (the New Car Assessment Programme) emerged. This was initiated
by the UK government, co-sponsored by Sweden, the Netherlands, consumer
and motoring organisations which stimulated the European car industry to
deliver higher levels of front and side impact protection than required by
regulation in a range of models.

2.2 Research and development in car crash protection

In the late 1960s and early 1970s in-depth accident research and analysis at
the Birmingham University Accident Research Unit (founded in 1964) provided
the first insights nationally into the nature and sources of injury sustained by
car occupants in frontal and side impacts. This work highlighted the
importance of maintaining the integrity of the passenger compartment in frontal and side impacts and the huge potential for casualty reduction by improved car crash protection $^{12,13,14}$.

In response to the US Department of Transportation’s initiative for an international programme on the experimental safety of vehicles, European cooperation on research and development on safer vehicles was established in 1970 in the form of the EEVC. Set up by the governments of France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom to focus on crash safety, EEVC working groups comprise governmental representatives and industrial experts who undertake research and development of test methods, tools and requirements $^{15}$. Scientists from TRL representing the UK government played a key role in chairing Working Groups on frontal and side impact protection and in developing the legislative tests, requirements and tools.

The 1970s and 1980s saw much development in knowledge about the biomechanics of injury through in-depth accident research and cadaver testing. Crash dummy development advanced with the introduction of the HYBRID III dummy in 1975 in the US. The biennial Experimental Safety of Vehicles (ESV) conferences provided the international focus for shared information and government status reports on scientific development and adaptation to technical progress.

During the 1980s crash research in the UK intensified with whole car testing for research purposes beginning at TRL in 1980 and with the establishment of the CCIS in 1983 bringing together Birmingham and Loughborough Universities, the TRL, the DfT and various car manufacturers $^{16}$. In 1987, the first UK casualty reduction target was set. In order to achieve it the strategy identified the substantial contribution that could be made by improvements in vehicle crash protection $^{17}$. By 1990, the collection and analysis of real world accident data had increased in importance and support as a policymaking tool in the national programme.
2.3 Frontal impact Protection

The first legislative (48km/h) and consumer information (56km/h) frontal crash tests were introduced in the US using a 100% full width frontal barrier test in 1978. Over the next 15 years, in-depth research in the UK and elsewhere continued to show that the vast majority of car crashes nationally were partial overlap offset frontal crashes. The safety engineering need was to improve the front car structure so it could sustain severe offset impacts with little or no intrusion of other vehicles or objects, so minimizing the risk of serious and fatal injury. The importance of leg injury, in addition to head and chest injury in frontal impacts was also established. Such work highlighted the need for a European frontal crash protection standard which could better reproduce real-world conditions than the 100% full-width frontal barrier test, although the latter is acknowledged to be an appropriate test for occupant restraint system performance.

In 1982, a proposal for an angled barrier test was made by UN ECE in Geneva, but was not adopted for a variety of technical reasons.

During the 1980s consumer testing in Germany and the UK started to awaken public awareness about the inadequacies of current car design in real crashes and pressure for European regulation gradually increased.

In 1984, TRL, with DfT funding, began development of a mobile deformable barrier. Five years later EEVC set up Working Group 11 on Frontal Impact to develop a frontal impact test procedure. Australian research provided further evidence to show that the involvement of the full frontal structure in crashes was the exception to the rule.

In 1992, the earlier UN ECE proposal was revised to try and account for some of the technical criticisms and a 30 degree angled barrier test with anti-slide device was proposed. In the interests of wider harmonisation, the US
presented a frontal impact test option – their full width barrier legislative test. The EEVC proposal for the more realistic offset deformable barrier (ODB) test was also near the final stages of development. Due to a deadlock in discussions because of different opinions on the best way forward, the debate moved to Brussels. 

In view of concern about the absence of evidence-based road safety policymaking in European harmonisation, particularly in matters of vehicle standards, the ETSC was established in early 1993 by the UK Parliamentary Advisory Committee on Transport Safety (PACTS), German, and Dutch safety organisations. The Council launched with the publication of a comprehensive report on vehicle safety (largely the work of Vehicle Safety Consultants (UK) and PACTS), and was distributed to policymakers in EU institutions and nationally. The report concluded that current legislative standards were around 20 years behind the needs identified by crash research. That year, ETSC joined forces with the European consumer organisation, BEUC, to put the case to the EU institutions for improvements in vehicle crash protection standards.

In April 1994, the attention of media and Parliamentarians was focussed on the casualty reduction potential of EU action in a symposium held in the European Parliament by the ETSC. The ETSC’s Vehicle Safety Working Party highlighted the concern of professionals throughout Europe about the need for legislation to better reflect the needs identified by crash injury research. Attention was drawn to how market forces stimulated by consumer information could have a large and dynamic impact on the rate of progress. European Parliamentarians from the two leading parties expressed concern about the slow rate and poor quality of legislative development. During this year, a compromised co-ordinated position of EU Member States concerning the UN ECE proposal was agreed involving a possible first step in 1995 using a modified angled barrier test, followed by the EEVC proposal as soon as it was ready. A month later, the EEVC Working Group 11 reported on the development of an offset deformable barrier test to the fourteenth ESV Conference in Munich. Key findings from other international research in
support of this work were also presented. Several studies confirmed that intrusion was a key factor in the generation of severe injuries \(^{32-34}\); and that a partial overlap of 40% was the most realistic test \(^{32-33,35-37}\). The new test was repeatable - over 50 tests had been carried out using the new barrier \(^{32}\). Information was also presented casting doubt on the efficiency of the anti-slide device of the 30 degree angled barrier test option \(^{32}\).

In December 1994, the European Commission issued a two stage proposal for legislation for frontal impact protection \(^{38}\). Stage 1 comprised a 30 degree rigid barrier test and anti-slide device for new car types (01.10.95) and Stage 2, foreseeing the offset deformable barrier test by 01.10.98, though the detail of Stage 2 was not included in the proposal for a Directive, thus creating an uncertain future goal. The Explanatory Memorandum of the draft Directive acknowledged that it was the Stage 2 test which was likely to have 'significant consequences in terms of vehicle design' and envisaged that if all passenger cars were built to meet Stage 2 requirements then around 65,000 deaths and serious injuries in Europe could be avoided.

Within the European Commission’s Advisory Committee - the European Motor Vehicles Working Group – the European car industry trade association, Association des Construteurs Europeen d’Automobile (ACEA), argued that the Stage 1 test was preferable and that the Stage 2 test was not practicable and would cost too much. However, such arguments lacked credibility since at least one manufacturer had been using offset deformable barrier tests since the 1970s \(^{35}\), the results of offset deformable barrier test (ODB) (40% frontal at 60 km/h) had been used in Australian consumer information since 1993 and the Explanatory Memorandum of the Commission proposal acknowledged that 'the cost to industry will be minimal'.

In 1995, the ODB test (64 km/h) was used for the first time by the US Insurance Institute for Highway Safety in consumer information\(^{39}\).

Non-governmental organisations in Brussels stepped up the campaign. The first edition of ETSC’s ‘CRASH’ newsletter on vehicle crash protection was
compiled by vehicle safety experts from across the EU and was circulated widely. The same year, the European motoring organisation, AIT/FIA, joined the ETSC/BEUC non governmental organisation (NGO) campaign for research-based improvements to the crash test proposals. With the support of FIA/AIT, ETSC developed a video produced by TRL for policymakers ‘Legislating for Safety’ to explain why changes were needed to the Commission’s front and side impact proposals. Featuring an interview with EEVC WG Chairman, the video provided evidence to show that the Stage 1 (UN ECE draft tests) were weak, unscientific, unreliable and the uncertain Stage 2 EEVC tests were realistic, scientific, reliable, and practicable. Concerned that Stage 1 was being introduced to delay Stage 2 indefinitely, experts and MEPs argued for removal of Stage 1 of legislative proposals for both front and side impact protection and the immediate adoption of Stage 2.

A cross party European Parliamentary resolution tabled on 7.2.94 expressed concern that new EC proposal for frontal impact protection did not reflect best practice. Given Parliament’s right of co-decision for Single Market legislation, the Commission’s proposals were discussed formally by European Parliamentary Committees. A seminar in the European Parliament was organised by the lead Committee on this issue - Economic and Monetary Affairs. Amendments setting out the detail of EEVC ODB test procedures and requirements were tabled to the Directive by the UK Member of European Parliament (MEP) (assisted by the UK DfT). In July 1995, after a strong campaign by the European non-governmental organisations, the Stage 1 frontal impact proposal was unanimously rejected by the European Parliament in favour of going straight to Stage 2 in the Strasbourg plenary in July 1995. An amendment was also added to require a review of the Directive, two years after its implementation.

Following continued support from UK, Dutch, Danish and Swedish policymakers and with the full EEVC report, the amended and final front impact Directive was agreed in May 1996, as the EEVC produced its validation report and was published in December 1996.
2.4 Side impact protection

During the 1980s, research and development work in the US and Europe produced two different specifications for a side impact test procedure.

In Europe, a joint Birmingham University and TRL in-depth accident research project (1978-81) provided a representative sample of the characteristics of side-impacts feeding into the research and development work of the EEVC Working Group 9. This EEVC group of experts oversaw the development of the new European side impact test procedure which involved the development of a new generation of European Side Impact Dummies (EuroSID-1) and development of a moving deformable barrier representing the front of a standard vehicle. In 1982, EEVC proposed a standardised test procedure for cars using a movable deformable barrier in a full scale test with the EuroSID dummy.

Extensive research and development by EEVC took place over the next 6 years reported at ESV and elsewhere. With the imminent development of a full-scale crash test, ACEA put forward a proposal in 1989 for a composite test procedure for side impact – a computer modelling plus component testing option as opposed to the EEVC full test procedure. EEVC reviewed this option in 1990 and concluded that the composite test procedure was based on assumptions which had yet to be validated scientifically. That year EEVC Working Group 9 also produced a specification for the EEVC Side Impact Dummy EuroSID-1. The US side impact test procedure was also adopted that year in FMVSS 214 with a different barrier to European barrier.

In 1991 the EEVC Working Group on Side Impacts (WG 9) presented recommendations for side impact test procedures (90 degree impact with moving barrier with ground clearance height of 300mm) to the 13th ESV Conference in Paris. A TRL study estimated that a better side impact test procedure could lead to a saving of 25,000 deaths and serious injuries in EU
countries. Several elements of this specification differed from the Geneva proposal, the most important being the height of the mobile barrier. In 1993 the UN ECE agreed a new side impact regulation compromising on a barrier height of 260mm. The Vehicle Safety Research Centre (VSRC) at the University of Loughborough conducted measurements of front stiff structure heights and demonstrated that the 260m barrier clearance in the Geneva regulation was unrepresentative of real conditions.

At the 14th ESV Conference in Munich in May, 1994, EEVC Working Group 9 issued its final report on the Side Impact Test Procedure. Despite EEVC’s recommendations, the European Commission issued a two stage proposal for legislation for side impact protection based on the UN ECE Regulation later that year. This comprised a Stage 1 test for a 260mm ground clearance height for the mobile barrier for new car types (01.10.95) and a possible Stage 2 test with a barrier height of 300mm from 2001. The Explanatory Memorandum of the draft proposal noted that there was no experimental research to validate the ground clearance height of 260mm. While 300mm "did have a basis in research, industry with the support of a number of Member States, argued that the barrier should be nearer 200mm." The proposal went on to acknowledge that the higher standard foreseen in Stage 2 would probably significantly reduce the number of deaths and injuries, and at minimal cost.

Experts in the research field, representatives from safety, consumer, motoring organisations and MEPs challenged the technical merit of the EC proposal and call upon the European Parliament to drop Stage 1 and go straight to Stage 2. The car industry’s objection that increasing the ground clearance of the barrier was not practicable was met with evidence from Fiat to the 1994 ESV conference that around 30% of Fiat models tested on the road would comply with the criteria at 300mm barrier height. Fiat also provided evidence that the 260mm would lead to a weaker test leading to limited intrusion at the waist line of the test dummy and generally lower intrusion velocities due to the interaction of the barrier face with the car sill.
Having engaged in the technical debate, Parliamentarians subsequently amended the Directive to allow a one stage process with a barrier height to 300mm. The Members of the European Parliament argued that the Commission should have better accommodated the EU Treaty obligation to provide a high level of protection in the harmonisation process 60.

The European Commission subsequently amended their front impact proposal and the new side impact Directive was agreed by the EU Council of Ministers at the end of 1995 61.

2.5 The growth of consumer information

The awakening of public interest in the influence of car design on crash injury in the US in the late 1960s led not only to legislative action, but to the provision of consumer information which could provide impartial advice to assist car buyers. The aim of this information was to provide objective data to pinpoint the maximum level of protection available to the car buying public and to complement regulation which should stipulate a high but minimum level of protection.

The wide variety of crash test-based and inspection-based predictive systems and crash-statistic based retrospective systems developed since the 1970s have evolved largely independently of each other 62. Such systems can contribute to substantial progress in crash protective design to protect vehicle occupants 63-64.

In retrospective systems, safety ratings are based on the actual performance of cars in real crashes. The frequency and severity of injury to car occupants in individual model cars are determined by examination of police crash statistics and/or insurance injury claim data. In 1975, the Highway Loss Data institute (HLDI), as part of the US Insurance Institute for Highway Safety (IIHS), published insurance claims data and provided a safety rating 65.

Predictive systems assess a car's safety performance before it is used on the road. Predictions are based on controlled whole car crash tests of individual
models; tests of components of the car which have been proven to be important in crashes; and/or visual inspections and rating of the interior of cars. The United States New Car Assessment Program (US NCAP) was established in 1978 to provide a safety rating for frontal impact protection, using a full frontal rigid barrier test. Since the US NCAP programme started, the National Highway Traffic Safety Administration (NHTSA) report there has been around a one-third reduction in the probability of a life-threatening injury in NCAP passenger cars as measured by controlled crash test results 63.

In Europe, the late 1980s and early 1990s saw developments which placed new demands on the car industry on the part of consumer, safety and motoring and insurance organisations. The ‘public right to know about vehicle safety’ was promoted by several organisations in Europe. For example, the UK Consumers’ Association aided by members of Vehicle Safety Consultants produced the Secondary Safety Rating System in Cars - a mix of visual inspection and component testing 66. Results were published in WHICH? Magazine 67. This system later became the European Secondary Safety System which was used by the EU-wide umbrella organisation – the European Consumers organisation (BEUC) and International Testing (IT) 68.

Insurance organisations in the Nordic countries published ratings based on retrospective data on real crashes. Folksam in Sweden published injury risk ratings based on paired comparisons of car-to-car crashes from police reports where the injury outcome in both vehicles is considered throughout the 1980s. Folksam rating has indicated that if all cars were designed to be equal to the best current car in each class, 50 per cent of all fatal and disabling injuries could be avoided 69. An analysis of Folksam data on car to car accidents in Sweden between 1994 and 1996 showed a decrease of 35 per cent in the relative risk of fatal and severe injury associated with 'new' car designs compared with 'old' designs 70. A good correlation between Folksam ratings and the European Secondary Safety Rating System was also demonstrated 71.
Since 1987 the Traffic Safety Committee of Insurance Companies, Vakuutusyhtioiden Liikenneturvallisuustoimikunta (VALT) in Finland, have regularly published ratings compiled by the University of Oulu comparing cars on Finnish roads on several factors related to crash performance. The rating concluded that if the crash protection of all the car models in the same weight class matched the best then 27 per cent fewer drivers would be injured in urban car to car collisions.

In 1991 in the UK the first edition of “Car and Driver: Injury Accident and Casualty Rates” was published giving information on comparative accident involvement and injury risks of popular makes and models of car. The rating, based on the risk of driver-only injury in car-to-car injury accidents reported to the police, showed that if the safety of all models were improved to the level achieved or exceeded by the safest twentieth of models then the number of drivers injured in car to car accidents would fall by 12 per cent and the number killed or seriously injured by 22 per cent. However, it was whole car testing for consumer information in Europe that was to become the dynamo for advances in car crash protection change in the 1990s.

Since 1987, the German motoring organisation (ADAC) had published results of frontal offset tests (40 %) with the Offset Deformable Barrier (60 km/h) and a German motoring magazine Auto Motor und Sport carried out and published the results of frontal offset tests (50%) with angled barrier + Anti-Slide Device (55km/h). In 1992, an Australian New Car Assessment Programme (ANCAP) started which rated new cars on their performance in frontal impact tests. Initially ANCAP used FMVSS 208 (56 km/h), but went on in 1995 to use the Offset Deformable Barrier test (ODB) (40% frontal) at (60km/h).

By the mid-1990s, awareness in Europe about the potential of consumer information was becoming clear. A summary of an international meeting of research, testing, consumer and safety organisations indicated wide agreement that:
• Market forces continued to play a major role in crash safety development.

• Consumer information was useful for car buying members of public, car fleet purchasers, insurers and policymakers. It also encouraged manufacturers to go beyond minimum legislative standards.

• Experience with New Car Assessment Programmes in the United States and in Australia had demonstrated the interest of the car industry in responding to NCAP Standards.

• A wide variety of crash tests were being used by NCAP programmes and consumer and motoring magazines. Some were more relevant to real world accident scenarios than others. Partial ODB testing seemed to be the way forward for frontal test procedures to get nearer to accident scenarios.

• While a lot of test data was available, there was no facility currently for pooling information internationally.

• Further international co-operation in this area was highly desirable.

In 1995, the DfT announced a state of the art new car assessment programme at the TRL to start in summer 1995 with 1st phase testing of six models to be published the following year. The UK NCAP included the EEVC frontal impact test, but at a higher speed (64 km/h) than the test proposed for legislation (56 km/h); the EEVC side impact test with the barrier height at 300mm and the EEVC Working Group on Pedestrian Protection (WG 17) pedestrian sub-system tests. This announcement received a high media profile and intense opposition from industry. A big debate had followed the announcement of the new NCAP, particularly about the higher speed of the NCAP frontal impact crash test when compared with the legislative test.

Confirmation that the UK were on the right track came from the US. In 1996, the US Insurance Institute for Highway Safety published results of 14 midsize four-door car 1995 car models crash tests using the EEVC offset deformable barrier test at a speed of 64km/h. This testing was designed to complement the existing US NCAP programme. At the 1996 Melbourne ESV conference,
which for the first time had devoted a full session on consumer information, the IIHS provided further confirmation that the 64 km/h speed used in consumer offset deformable barrier testing was representative of most severe real frontal world crashes - 40 per cent offset test into a deformable barrier at 64 km/h represented a real world crash severity below which about 75 per cent of all Maximum Abbreviated Injury Score (MAIS) 3 or above injuries to car occupants occur in the US 77.

Due to the popular support for the programme received from consumers, safety and motoring organisations and leadership from UK policymakers, based on strong government-funded technical support from TRL and elsewhere, the programme went ahead. An Automobile Association (AA) survey (June, 1996) indicated that 72% of members wanted better information about how cars would perform in the event of a crash 78.

Joined by the Swedish Government and then the Dutch Ministry, EuroNCAP was established in 1996. It now receives wide support from the European Union and several Member States and, after a long battle, the acceptance of the European car industry. In its first tests the programme revealed that the car industry could do more than required by the newly agreed frontal and side impact legislation. Research has since shown that cars with three or four stars are approximately 30% safer for car occupants, compared with two-star cars or cars without a EuroNCAP score, in car-to-car collisions 64. In 1997, the CCIS international symposium held by the VSRC at Loughborough University on real world crashes highlighted the remarkable progress made with the development of consumer safety ratings.

In 2000, the European Commission cited EuroNCAP one of six most cost-effective actions in a progress report on the EU road safety action programme 79.
3 Methodology

3.1 Quantitative Data

Two data sets were used in the quantitative analysis. In the first part the National accident data (STATS 19) for the years 2001-2003 were used and in the second part the CCIS data base for the years 1995-2005 were analysed. In both analyses the vehicles were categorised into two mutually exclusive groups: those distinctly pre regulation and those distinctly post regulation.

Analyses were conducted according to impact type, seating position and collision partner. Provision was also made for occupant gender and age.

Comparisons have been made between the pre and post regulations vehicles in terms of injury outcome. Overall occupant severity (fatal / serious / slight / uninjured) was considered in the STATS19 analysis whilst AIS score by body region injured was considered in the CCIS analysis. Where appropriate, direct comparisons of injury outcome rates were made, whilst in other analyses ‘Odds Ratios’ were calculated. The Odds Ratio is calculated as the ratio of the KSI rate for a given subset in the older vehicles and the KSI rate for the same subset in the newer vehicles. An Odds Ratio equal to 1 (normalised to 0) indicates no change in the KSI rate. To assist the reader the main findings are given in the body of this report (section 4) and supporting charts and comments can be found in Appendix 1.

A basic cost benefit analysis has been carried out where estimates were made of the Department for Transport's staff and research costs related to the regulatory and consumer testing elements under evaluation. Benefits were estimated from national data (STATS19) casualty trends over a ten year period.
3.2 Qualitative Data

The qualitative analysis was based upon eighteen individual and paired interviews, two group interviews and one written response. The interviewees were drawn from government, research, the motor industry and consumer organisations in the UK and Europe. A balanced distribution of interviewees was achieved across these groups:

**Government (UK and the Netherlands):** 3 individuals; 1 group.

**Research:** 5 individuals; 1 pair.

**Motor Industry:** 4 individuals; 1 pair; 1 group; 1 written response.

**Consumer Organisations:** 4 individuals.

Prior to conducting the interviews, background work was necessary in order to define the subject area more clearly and identify the key players from the groups described above. Scoping interviews were undertaken and a time line of key events occurring during the build up to and throughout the course of the evaluation period was collated. The time line (Appendix 2) included milestones in vehicle safety development both from research and political activity. Appropriate interviewees also became evident.

A structured topic guide was then constructed for the remaining interviews (Appendix 3). Most of the guide was consistent for all interviews but some questions and sections were designed specifically for industry representatives.

The interviews, which lasted between one and three hours, were recorded and transcribed in full, and the analysis was based upon the transcriptions. Responses corresponding to each question in the topic guide were extracted from the individual transcripts. The scoping interviews, necessarily more discursive in nature than the structured interviews, were searched for responses that corresponded to issues raised in the topic guide. A comprehensive print-out of responses to each question and prompt was then
produced, and also a set of tables that gave a quick visual indication of the balance of responses to closed questions.

The presentation of the findings of the qualitative analysis broadly follows the structure of the topic guide. The findings are divided into two main sections: impact and process. The impact section considers the difference made by the front and side impact regulations and EuroNCAP to vehicle occupant safety and their effects upon the motor industry, while the process section presents the technical and political issues that underpinned their implementation. In presenting the findings care has been taken to represent accurately points of convergence and disagreement between respondents, with particular attention paid to issues where there were differences of viewpoint between industry representatives and other groups.

The aim is to provide a comprehensive overview of the emergence of the front and side impact regulations and EuroNCAP from the perspectives of expert observers, several of whom were closely involved in their development.
4 Quantitative Analysis

4.1 National Accident Data Analysis

The first stage of the quantitative analysis has involved an analysis of the National Accident Database, STATS 19. The National data offers a complete picture of the injury accident population within Great Britain; it does not contain damage only accidents.

The purpose of this analysis is to examine car occupant casualty trends during the evaluation period. The data does not allow for a detailed injury analysis to be carried out, but does allow analyses based upon the police reported severity of the occupant, the age and gender of the occupant, the impact object, an indication of the impact type (front, left side, right side and rear) and for distinction according to the age of the vehicle. The data can also distinguish between drivers, front seat passengers and rear seat passengers.

The STATS 19 analysis will serve to answer a number of questions:

- Has there been a systematic reduction in the number of KSI car occupants?
- Are there groups by age / gender / seating positions who have benefited more or less than the benefits observed in the overall trends?
- Are there impact types where there has been more of an improvement than others?

One disadvantage of the STATS 19 data, and indeed all available accident data, is that it is collected on an injury basis. In the case of STATS 19, uninjured passengers do not appear in the data, and there is no count of non-injury accidents. This makes it difficult to quantify casualty reduction since the cases where injury has been prevented by some intervention, the vehicle damage only cases are not recorded. It may be possible to estimate the total number of accidents occurring in the UK by using insurance data, but this is not presently readily available and it is not felt practical to collect such information in the time span of this project. However, a record is kept for each
driver in the accident irrespective of injury outcome so it is possible to make some estimation, based on the outcome for drivers, of the shift in injury patterns from fatal to serious through to slight and uninjured. Since government Policy aims to reduce the number of KSI casualties, the limitations in the data can be overcome for the purposes of this project.

4.1.1 Car Occupant Casualty Trends

Table 1: Car Occupant Casualties 1993-2003

<table>
<thead>
<tr>
<th>ALL CAR OCCUPANT CASUALTIES</th>
<th>Driver</th>
<th>FSP</th>
<th>RSP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>114191</td>
<td>43155</td>
<td>26179</td>
<td>183525</td>
</tr>
<tr>
<td>1994</td>
<td>120041</td>
<td>44754</td>
<td>26355</td>
<td>191150</td>
</tr>
<tr>
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<td>119308</td>
<td>44976</td>
<td>25693</td>
<td>189977</td>
</tr>
<tr>
<td>1996</td>
<td>127572</td>
<td>46770</td>
<td>26913</td>
<td>201255</td>
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<td>132618</td>
<td>47748</td>
<td>26885</td>
<td>207251</td>
</tr>
<tr>
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<td>205752</td>
</tr>
<tr>
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<td>45837</td>
<td>24166</td>
<td>202228</td>
</tr>
<tr>
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</tr>
<tr>
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<td>43593</td>
<td>22484</td>
<td>193586</td>
</tr>
<tr>
<td>2003</td>
<td>122362</td>
<td>41117</td>
<td>21268</td>
<td>184747</td>
</tr>
</tbody>
</table>

Table 1 shows how the number of car occupant casualties, distinguished by seating position, has varied year on year since 1993 until 2003. During this ten year period the absolute number of car occupant casualties gradually increased reaching a peak in 1997 then diminished to reach a similar number in 2003 to that observed in 1993.

A slightly different picture is apparent when killed or seriously injured car occupants only are considered (table 2). The number of KSI car occupants increased from 1993 to a peak of 23,639 in 1996. Thereafter the number has fallen consistently year on year to a low of 17,000 in 2003 indicating that, in terms of car occupants, the 2010 casualty reduction target is readily achievable assuming a continued 2% annual reduction in the number of KSI casualties.
Table 2: KSI Car Occupant Casualties 1993-2003

<table>
<thead>
<tr>
<th>Year</th>
<th>Driver</th>
<th>FSP</th>
<th>RSP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>14129</td>
<td>5013</td>
<td>3238</td>
<td>22380</td>
</tr>
<tr>
<td>1994</td>
<td>14724</td>
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<td>14404</td>
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<td>1997</td>
<td>14744</td>
<td>5132</td>
<td>2922</td>
<td>22798</td>
</tr>
<tr>
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<td>2003</td>
<td>10939</td>
<td>3844</td>
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<td>16999</td>
</tr>
</tbody>
</table>

Table 3: Fatal Car Occupant Casualties 1993-2003

<table>
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<th>RSP</th>
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</tr>
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<tbody>
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</tr>
<tr>
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<td>1095</td>
<td>360</td>
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<tr>
<td>1995</td>
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<td>398</td>
<td>249</td>
<td>1723</td>
</tr>
<tr>
<td>1996</td>
<td>1139</td>
<td>398</td>
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<tr>
<td>1997</td>
<td>1162</td>
<td>381</td>
<td>225</td>
<td>1768</td>
</tr>
<tr>
<td>1998</td>
<td>1128</td>
<td>340</td>
<td>209</td>
<td>1677</td>
</tr>
<tr>
<td>1999</td>
<td>1071</td>
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<tr>
<td>2003</td>
<td>1161</td>
<td>380</td>
<td>201</td>
<td>1742</td>
</tr>
</tbody>
</table>

Considering solely fatal car occupants, Table 3 shows an apparent plateauning over the ten year period. However, this result is a little misleading as exposure data needs to be taken into account in the interpretation.
Figure 1: Fatalities by licence holders and Vehicles licensed

Figure 1 shows the fatality rate for drivers as a proportion of the number of licence holders year on year and also the fatality rate for all car occupants as a proportion of the number of licensed cars year on year. The data presented in figure 1 indicate a systematic reduction in the proportion of fatalities since the mid 1990’s, however a slight increase is observed in 2001 (the latest available exposure data). Figure 2 shows an estimate of the distance covered by passenger cars on an annual basis. This has clearly risen year on year. Thus, it would seem that, when exposure is taken into account, fatalities are in fact decreasing, though the situation should continue to be monitored.

Figure 2: Distance travelled by passenger cars
4.1.2 Analysis based on Vehicle Age

There are two possibilities for a methodology to examine the safety improvements of vehicle design resulting from, for example, the front and side impact regulations. On the one hand crashes that occurred before the introduction of the regulations could be compared with those occurring after. The selection of two time periods, one before, one after would mean that vehicles of similar ages at the time of the crash could be compared, ensuring that the effects of wear and tear in older vehicles were minimised. However changes in fatality and KSI numbers are a result of a range of factors including changes in vehicle safety (primary or secondary), road designs, road user behaviour (e.g. travel speeds), enforcement levels and other factors. Many of these change over a period of time in line with national road safety policies. For example continued enforcement of driver alcohol levels may have an effect on reducing accident numbers and it is important to distinguish these effects from those of improvements to vehicle design. In particular the effects of changes in alcohol and speed enforcement levels were considered to be substantial over the period of the 1990s and there were no analytic procedures that could easily be used without considerably more detailed information. Alternatively a comparison of old and new cars involved in accidents during the same time period would inherently imply exposure to a more constant set of traffic, roads, enforcement and other conditions. Analysis of this data would permit a focus on the differences between vehicles and avoid artificial differences stemming from exposure differences. The main difficulty with this approach is that during the years selected, 2001-2003, the new designs had been on the road for only a small number of years whereas the older designs also had been used for much longer and so had incurred more wear and tear. With no ideal analysis methodology available to account for all of these factors it was decided to use the latter approach in the view that vehicles built after the 1980s were generally more far more resistant to the effects of aging.
Both methodologies had the limitation that they compared all changes in vehicle design between the two periods so were not able to isolate passive safety benefits from primary safety improvements.

The National accident data for the years 2001-2003 were used for this analysis and vehicles selected for inclusion in the analysis according to their year of manufacture. Two distinct groups of vehicle were defined:

- Old vehicles manufactured 1990-1992 – distinctly pre regulation

The injury outcome for drivers, front seat passenger (FSP) and rear seat passengers (RSP) have been considered in each of the front, side and rear impact scenarios, for the cases where the collision partner was another car (more representative of the regulatory test procedure) and where the collision partner was other than a car (not covered by regulations).

The impact type is categorised according to the STATS19 variable ‘First point of impact’ as judged by the attending police officer. It does not necessarily imply a strictly ‘frontal’ direction of force for the impact. The data have been further categorised according to driver gender and driver age (<50, 50+).

The first part of the analysis focuses upon drivers and considers the following scenarios:

- Car to car impacts
- Car to non car impacts

The second section of the STATS19 analysis considers the outcome for car passengers, front and rear, for the same impact scenarios listed above.

The main findings are reported in the subsequent sections and the supporting charts and comments can be found in Appendix 1.
4.1.3 Summary of Findings - National Accident Data

4.1.3.1 Car to Car Impacts

Drivers

Front Impacts
The data suggest that in car to car frontal impacts, drivers of newer cars are marginally more likely to receive an injury than drivers of older vehicles, but that the injury is likely to be less severe in the newer vehicles. It is clear that female drivers are more likely to be injured in a frontal impact than male drivers. The proportion of female drivers uninjured is some 20% lower than male drivers. There appears to have been equal benefit for the reduction of KSI for both men and women in frontal impacts. Older drivers (over 50 years) remain more vulnerable to KSI injury outcome on frontal car to car impacts than younger drivers. Although there has been a reduction in the KSI rate for both age groups, the benefit in the newer cars has been greater for the younger drivers than the older drivers.

Rear Impacts
Newer vehicle design appears to have had an effect in reducing the likelihood of all injury severities in rear car to car impacts. Female drivers remain disadvantaged in rear impacts compared to male drivers, but the improvements in terms of KSI injury outcome are more noticeable for women than for men. It appears that modern vehicle design has been beneficial in rear impacts for both younger and older drivers, with the benefit in terms of serious injury outcome being greater for the older drivers than the younger drivers.

Right Side Impacts
Newer vehicles appear to offer better protection in right side car to car impacts than older vehicles. For right side car to car impacts, there is no difference in the KSI rate between genders and there is an equal reduction in the rate of KSI in the newer vehicles. Female drivers however remain more vulnerable to slight injury outcome than male drivers. Modern vehicle design has benefited
both younger and older drivers in right side impacts but the benefit appears greatest for the older drivers.

**Left Side Impacts**
Modern car design appears to have had a positive effect on the likelihood of serious injury outcome for drivers in left side car to car impacts but the rate of slight injury has increased. Newer vehicle design appears to have had a benefit in reducing serious injury outcome for both male and female drivers in left side car to car impacts, the benefit being marginally greater for males than females. Female drivers remain considerably disadvantaged in terms of slight injury outcome compared to male drivers. Although older drivers have a lower rate of overall injury outcome than younger drivers, and the reduction in the rate of KSI is similar for both driver age groups, the older drivers remain disadvantaged in terms of serious injury outcome in left side car to car impacts.

**Front and Rear Seat Passengers**
For front seat passengers the only disbenefit was observed for females in frontal impacts. The greatest benefits were observed in left side impacts across all population variations; for male FSP and young FSP in right side impacts and for old FSP in rear impacts.

For rear seat passengers, disbenefits were noted for all population variations in frontal impacts. In rear impacts disbenefits were seen for the ‘all occupant category’, for female RSP and for the older RSP. In right side impacts disbenefits were apparent for the older RSP, similarly for left side impacts. The greatest disbenefits were for the female and the older RSP in rear impacts and for the older RSP in left side impacts. The greatest benefit was observed for the male RSP in rear impacts (note however that reduced sample size may have an effect on these results).
4.1.3.2 Car to Non Car Impacts

Drivers

*Front Impacts*

In general, the STATS 19 data show that newer vehicles offer better protection for against KSI injury outcome than older vehicles in non car to car frontal collisions. There has been a marginally greater benefit in terms of KSI reduction for male drivers compared to female drivers, but the rate remains higher for men than for women. There are similar KSI rates for both older and younger drivers across both vehicle age groups. The benefit has been marginally greater for the older drivers compared with the younger drivers.

*Rear Impacts*

Considering all drivers, newer vehicle design appears to have had an effect upon reducing the likelihood of all injury severities in rear car to non car impacts. Female drivers are clearly more likely to be injured in a rear impact than male drives and this remains the case irrespective of vehicle age. However, female drivers have seen a greater reduction in KSI injury outcome in modern cars compared with the reduction for male drivers. The data suggest that modern vehicle design has been beneficial for both younger and older drivers and that the benefit has been greater for the older drivers than the younger drivers.

*Right Side Impacts*

Newer vehicles appear to offer better protection for drivers in right side (struck side in the main) car to non car impacts than older vehicles. Whilst female drivers are considerably more vulnerable to slight injury than male drivers and remain so in the newer cars, male drivers have a higher KSI rate in both the newer and older cars. The benefit in the reduction of the KSI rate for both males and females is similar. Modern vehicle design has benefited both younger and older drivers in right side car to non car impacts, but the benefit has been greater for the younger drivers.
**Left Side Impacts**

Modern car design appears to have had a positive effect on reducing the likelihood of KSI injury outcome for drivers in left side (non struck side) car to non car impacts. There has been a considerable benefit in terms of serious injury outcome for the male drivers, but there has been no benefit, in fact a marginal increase, in the rate of KSI injury outcome for female drivers. Both younger and older drivers have a better KSI outcome in the newer cars and the benefit has been greater for the younger drivers.

**Front and Rear Seat Passengers**

For front seat passengers in car to non car impacts benefits are apparent for all except the female FSP in rear impacts. The greatest benefits have been experienced by Male FSP in rear impacts and older FSP in right side impacts.

For rear seat passengers, older RSPs stand out as the only group disadvantaged in the newer cars compared with the older cars. This is the case in front impacts, rear impacts and left side impacts.

The results are further summarised in the following tables 4 and 5. A tick indicates a better or identical outcome in the newer cars when compared with the older cars, a cross indicates a worse outcome.

**Table 4: Summary of National data results – car to car impacts**

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4.2 CCIS Data Analysis

In the second part of the quantitative analysis, the UK CCIS in-depth accident data base has been examined. The UK data analysed were collected between 1995 and 2005 as part of the on-going UK Co-operative Crash Injury Study.

All vehicles in the study were less than seven years old at the time of the crash and were towed away from the crash scene. The CCIS data use a stratified sampling criterion to identify crashes to be investigated. 100% of fatal, 80% of ‘serious’ and 10-15% of ‘slight’ injury crashes (according to the UK Government’s accident classification) are investigated. Consequently, the resulting sample is biased towards the more serious crashes. The data used in this analysis has been weighted to address this sampling bias.

The impact type experienced by the occupants in each vehicle has been classified according to the most significant impact in the crash event rather than selecting out single impact crashes. Selecting on single impact crashes reduces an already small sample size to a point where much of the analysis becomes meaningless. Frontal, struck side and non struck side impacts have been considered. The object struck was also taken into consideration; firstly the data were analysed in their entirety, subsequently specifically car to car impacts were analysed and finally an analysis was made of those cases where the impact object was other than a car.

The cars included in the analysis have been further selected according to the vehicle’s age: old vehicles were those registered between 1985 and 1993; new vehicles were those registered between 1997 and 2005. Throughout the analysis the Odds Ratios have been calculated to compare the injury outcome in the new cars to that in the old cars. Results are considered not applicable when the incidence of serious injury is zero in either the new or old car sample since in these circumstances it is not possible to calculate an Odds Ratio. Results that are susceptible to small changes in incidence rates are highlighted; these are where the incidence count is less than 5 in either or
both of the new and old car samples. In such cases caution is attached to the interpretation of the result.

In frontal crashes both the drivers and the front passengers were belted. For the struck and non-struck side analysis both belted and un-belted occupants were included and the analysis took no account of whether or not there was a further occupant in the front (occupant beside). The rear seat occupant sample was too small to yield any meaningful results.

All injuries in the CCIS data are coded using the Abbreviated Injury Scale (AIS) 1990 revision. Data from medical records were obtained from hospitals to which the crash casualties were admitted. All vehicles in the study were less than seven years old at the time of the crash and were towed away from the crash scene. An in-depth examination of each vehicle was made in recovery-yards and garages within a few days of the accident. AIS 3+ rates (equating to serious injury) were considered for the cranium, face, chest, abdomen, pelvis and thigh. AIS 2+ rates (equating to fracture) were considered for the neck, knee, lower leg and foot/ankle. Further analyses were made according to occupant gender and occupant age (young aged 50 years or less / Old aged more than 50 years).

The main findings are reported in the subsequent sections and the supporting charts and comments can be found in Appendix 1.

4.2.1 Summary of CCIS Analysis Results

Frontal Crashes

Belted Drivers
For all objects struck there was a significant improvement in protection against serious facial injury in new cars. Most of this improvement occurred in car to car impacts. There was also a significant improvement in protection against fracture of the pelvis and lower leg in new cars, again, the gains being most prominent in car to car impacts. There was a significant improvement in
protection against serious injury to the cranium in new cars and this improvement was similar irrespective of the object struck. There was only a modest improvement against serious chest injury overall. The gains were mostly in car to car impacts and there was little change in serious chest injury risk between old and new cars when an object other than a car was impacted.

There was a slight improvement in protection against femur fracture overall but the small gains were seen mainly in car to car impacts. There was a slight improvement in protection against knee and foot/ankle fracture but these gains were seen mainly in impacts with objects other than cars. There was a slight increase in neck fracture and serious abdominal injury in newer cars, mainly in car to car impacts.

Overall, the largest gains in protection against serious cranium and chest injury in new cars are for females. The smallest gains in protection against serious chest injury are for older people.

The largest gains in lower leg protection (fracture) are for females, followed by the older occupants. Females show very large gains in protection against pelvic fracture.

**Belted Front Seat passengers**

For all struck objects, new cars showed a significant improvement in protection against serious neck injury. Most improvement was seen in car to object impacts. However, there was a modest increase in serious injury to the cranium.

In new cars, there was modest improvement in protection against serious chest injury, lower leg fracture and foot/ankle fracture. This increased protection was mainly seen in car to car impacts. In car to object impacts there was however an increase in lower leg fractures in new cars.

No conclusion could be drawn for the face and pelvis, abdomen and thigh injury risks due to limited case numbers.
Overall, the largest gains in protection against neck fracture were for the old, while females showed a disbenefit.

The largest gains in protection against lower leg fracture were for males. The largest gains in protection against foot/ankle fracture were for the old. The smallest benefits for protection against serious chest injury were for females.

**Struck Side Occupants**
Generally, improvements in protection occurred in car to car rather than in car to object impacts.

Overall there was a very slight increase in serious head injury and foot/ankle fracture in new cars (mainly accounted for in car to object crashes). In car to car impacts there is a slight improvement in protection for these body regions. There was insufficient data for comment on improvements in protection for the face, abdomen or lower leg.

Overall, there was a very slight improvement in protection against serious chest injury due to the increased protection in car to car impacts only. Overall there was a slight increase in neck and knee fracture (mainly in car to object impacts).

There was a slight improvement in protection against pelvic and femur fracture (mainly in car to car impacts).

Chest, cranium and pelvis protection has improved more for the old than for the young. But the old have a higher neck fracture rate.

Females have higher rates of neck, femur and foot/ankle fracture compared to males.
Non Struck Side Occupants
Overall, newer cars showed significant improvement in protection against pelvic fracture. In car to object impacts these injuries were rare in both old and new vehicles. In car to car impacts, no occurrence was found at all in new vehicles compared to 7 occurrences in old vehicles. Overall there was a significant decrease in serious abdominal injury in both car to car and car to object impacts.

There was modest improvement in protection against neck fracture (mainly in car to object impacts, with little change in protection in car to car impacts) and males seem to have benefited most.

There was modest improvement in protection against foot/ankle fracture (mainly in car to car impacts) and older people appeared to benefit the most.

There was a slight improvement in protection against serious cranial injury (in both car to car and to car to object impacts). Older occupants appear to have the largest reduction in risk.

There was a slight increase in lower leg fracture in newer cars (seen in both car to car and car to object impacts).

There was a significant increase in knee fracture (mainly in car to object impacts).

For all objects struck, there was very little change to serious chest injury risk between old and new cars. In car to object impacts there was a modest increase in risk to the chest whilst in car to car impacts there was a slight decrease in risk.

It was not possible to come to conclusions about changes in injury risk to the face and thigh due to small numbers of data.
The results are further summarised in the following tables 6-17. A tick indicates a better or identical outcome in newer cars when compared with the older cars, a cross indicates a worse outcome. Cells appearing in bold text indicate results that should be treated with caution.

### Frontal

**Table 6: Car to all objects – Drivers**

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**Table 7: Car to all objects – FSP**

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### Struck Side

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Non Struck Side

Table 15: All objects

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4.3 Discussion

Stats 19 national data and weighted CCIS in-depth crash injury data have been examined to assess whether the development and introduction of new front and side crash test legislation has improved car crashworthiness.
Although the regulations specify single point tests, the rational behind their introduction was to improve crashworthiness over the whole spectrum of real-world crashes.

In reality, it is doubtful whether the effectiveness of legislation can be separated from the effects of the New Car Assessment Programme (NCAP) because this was introduced at about the same time.

The current study utilises Stats 19 data to give a broad picture of the effectiveness of new crash tests in the whole accident population. In-depth CCIS data was interrogated for the details of body regions where injury risk changed. In CCIS serious injury rates (AIS 3+) were considered for the cranium, face, chest, abdomen, pelvis and femur. AIS 2+ rates were considered for the neck, knee, lower leg and foot/ankle because they define fracture and ligament injuries to those body regions. Vehicle manufacturers started changing safety design in advance of the introduction of the new tests. The timing of these changes adds a complication to any “before” and “after” study. Therefore, in order to ensure a valid comparison with new vehicle designs, older vehicles (registered 1985 - 1992) were compared to newer vehicles (registered 1997 – 2005) which were likely to have been designed to pass the new tests.

**In frontal crashes:** National data show that drivers of older cars received serious injury more often than those in newer cars when the object struck was another car. The in-depth data suggests this is due to reductions in AIS 3+ facial injury, pelvic fracture (especially for females) and lower leg fracture (especially for females). The reduction in facia and foot-well intrusion for newer cars appears to help reduce pelvis and lower leg injury to drivers who sit closer to the steering wheel.

Reductions in AIS 3+ head injury also contributed to injury reductions in newer cars. The benefits of driver airbag fitment are seen to reduce head and face injury irrespective of the impacted object.
Serious chest injury, femur fracture, knee fracture and foot/ankle fracture was not reduced greatly in newer cars, irrespective of the object struck. There was also a small increase in neck fracture and serious abdominal injury (mainly in car to car impacts). Modern seat belt systems appear not to show expected benefits in chest injury reduction and a reduction in foot-well intrusion has not resulted in the expected injury reductions to the foot and ankle. Increases in neck fracture need to be investigated but may be due to higher crash pulses with newer vehicles and there may be a need to consider the role of airbag deployment as a contributor to these injuries.

National data show that female drivers were more likely to be injured than male drivers. However the largest gains in protection for the head are for females. Older drivers were more likely to be seriously injured than younger drivers in newer cars, serious chest injury being more predominant for the older drivers. This suggests the need to examine restraint effectiveness for older people.

For front seat passengers, national data show a benefit in newer cars for all genders and ages in car to object crashes. In car to car impacts the same is true with the exception that females appear to have an increased injury risk. In-depth data shows a very modest improvement in crash protection for the chest but none for the head. Older passengers see improvements in protection against foot/ankle fracture and neck fracture, mainly in car to car impacts. Females were seen to have an increased risk of neck fracture despite a general improvement in protection for this body region.

In newer cars, national data show an increased injury risk for all population variations of rear seat passengers in car to car frontal crashes. In car to object impacts the only group of rear passenger at increased risk in newer cars are older occupants. For rear occupants, the major restraint is the seat belt with very little force being put through the knee. Belt to chest loads are generally higher for the rear belt compared to the front and any increase in vehicle stiffness will increase those loads. The number of serious injuries in the in-depth sample was too small to analyse.
In rear crashes: National data show that newer cars have a reduced injury risk at all levels of severity (irrespective of the object struck) for both young and old drivers, although the benefit is greater for older drivers. Females are still more at risk of injury than males; however they show a greater reduction in serious injury in newer cars compared to males, irrespective of the striking object. The number of serious injuries in the in-depth sample was too small to analyse.

For struck side occupants in side crashes: National data show that newer cars are generally safer when struck by another car. Both younger and older occupants benefit but that benefit is greater for the older occupants. In car to other object impacts the benefit is greater for younger occupants. In impacts with cars and other objects the magnitude of the reduction in serious injury risk is similar for both men and women in newer cars. However, in car to object impacts men show a higher overall injury rate than women in both newer and older cars whereas in car to car impacts, men and females have equal rates.

In-depth data also shows that improvements in occupant protection have mainly occurred in car to car impacts. In car to object crashes, serious head injury, foot/ankle fracture, neck and knee fracture show a slight increase in newer cars. In car to car impacts there was a very modest improvement in protection for the head, chest, pelvis, femur and foot/ankle fracture. Overall, head, chest and pelvis protection improved more for older occupants but they still have the highest neck fracture risk. Compared to males, females had a higher risk of neck, femur and foot/ankle fracture.

Crash protection in newer cars has improved, but that improvement is very modest. Additionally, head and foot/ankle injuries have slightly increased in car to object impacts.

For non struck side occupants in side crashes: National data shows an overall improvement in occupant protection in newer cars for all struck
objects. In-depth data show significant decreases in pelvis fracture and serious abdominal injury with modest reductions in neck fracture and serious head injury. Chest injury rates remained similar between old and new cars.

In car to car impacts both men and women are better protected in newer cars, however, in car to object impacts, females have marginally higher KSI rates than males in newer cars. The CCIS data shows that this may be due to slighter higher rates of knee and lower leg fracture.

In car to car impacts older drivers have the same reduction in KSI rate as younger drivers but within the older age group the KSI rate starts at a higher level, therefore the benefit in injury reduction is greater for older occupants. The CCIS data shows that reductions in head injury and foot/ankle fracture contribute to this effect. In car to object impacts, benefits are greater for the younger occupants.

In non-struck side impacts, occupants receive injury from intrusion of the opposite side structures, impacted object or interaction with the struck side occupant. Additionally, belt loads can be high, especially in angled opposite side impacts. The results of this analysis suggest that reductions in intrusion may contribute to the reduced head injury. The reductions in abdominal injury and the little change in chest injury outcome suggest that seat belt loads have not increased significantly in newer cars.

4.4 Basic Cost Benefit Analysis (1990-2002)

4.4.1 Costs

Staff
Throughout the period of the project there have normally been 4 project officers involved, 2 at S grade and 2 at H grade. They have always been assisted by Administrative grades. For the areas involved costs have been calculated according to 4 staff from TTS at S grade. This allows for work to have been carried out by the heads of branch and the administrative and finance grades.
At today’s prices the average annual cost is therefore 4 x £35k = £140k. Annual depreciation back over the evaluation period is based upon salary increases matching inflation estimated at 3%.

The annual staff costs are shown in table 18.

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<td>1999</td>
<td>120,765</td>
</tr>
<tr>
<td>1998</td>
<td>117,248</td>
</tr>
<tr>
<td>1997</td>
<td>113,833</td>
</tr>
<tr>
<td>1996</td>
<td>110,517</td>
</tr>
<tr>
<td>1995</td>
<td>107,298</td>
</tr>
<tr>
<td>1994</td>
<td>104,173</td>
</tr>
<tr>
<td>1993</td>
<td>101,139</td>
</tr>
<tr>
<td>1992</td>
<td>98,193</td>
</tr>
<tr>
<td>1991</td>
<td>95,333</td>
</tr>
<tr>
<td>1990</td>
<td>92,556</td>
</tr>
<tr>
<td>Whole Period</td>
<td>1,445,524</td>
</tr>
</tbody>
</table>

Thus, the estimated staff costs across the evaluation period, 1990-2002, amount to £1,445,524.

**Research**

The research costs (by project as provided by the TTS) are shown in tables 19 and 20. They are distinguished into those that are considered of direct relevance to the programme and period under evaluation, those that are indirectly related. The cost of each project is corrected to reflect a figure for the project up to and including 2002.
## Table 19: Directly related projects

<table>
<thead>
<tr>
<th>Code</th>
<th>Year</th>
<th>Title</th>
<th>Cost £K</th>
</tr>
</thead>
<tbody>
<tr>
<td>S071J/VF</td>
<td>97-01</td>
<td>Accident Report Analysis</td>
<td>93</td>
</tr>
<tr>
<td>S0015/VF</td>
<td>01-04</td>
<td>Advanced Side Impact Dummy: Biomechanics and Evaluation</td>
<td>76</td>
</tr>
<tr>
<td>S081F/VF</td>
<td>93-96</td>
<td>Airbags for European Cars</td>
<td>262</td>
</tr>
<tr>
<td>S084F/VF</td>
<td>92-93</td>
<td>Airbags for the Protection of Occupants</td>
<td>16</td>
</tr>
<tr>
<td>S080D/VF</td>
<td>92-96</td>
<td>Biomechanics and Dummy Development</td>
<td>1,176</td>
</tr>
<tr>
<td>S095B/VF</td>
<td>95-99</td>
<td>Compatibility of Cars in Crashes</td>
<td>2,979</td>
</tr>
<tr>
<td>S240A/AC</td>
<td>91-96</td>
<td>Computer Modelling Crashworthiness</td>
<td>860</td>
</tr>
<tr>
<td>S0212/VF</td>
<td>02-03</td>
<td>Development and Test of a Back Plate for EuroSID 2</td>
<td>15</td>
</tr>
<tr>
<td>S0220/VF</td>
<td>02-05</td>
<td>Development of Harmonised Side Impact Test Procedures</td>
<td>123</td>
</tr>
<tr>
<td>S085D/VF</td>
<td>99-02</td>
<td>Dummy Development: Modelling of Abdominal Injuries</td>
<td>60</td>
</tr>
<tr>
<td>S084D/VF</td>
<td>97-04</td>
<td>Dummy Development: Brain Injury Modelling</td>
<td>282</td>
</tr>
<tr>
<td>S082D/VF</td>
<td>96-00</td>
<td>Dummy Development – Next Generation Biomechanical Dummies</td>
<td>1,412</td>
</tr>
<tr>
<td>S083D/VF</td>
<td>98-03</td>
<td>Dummy Development – To Evaluate Spinal Injuries</td>
<td>418</td>
</tr>
<tr>
<td>S310C/CA</td>
<td>95-99</td>
<td>Effect of Car Weight Reduction and Downsizing in Safety</td>
<td>120</td>
</tr>
<tr>
<td>S0051/VC</td>
<td>01-01</td>
<td>EuroSID 2 Back Plate Testing</td>
<td>14</td>
</tr>
<tr>
<td>S0048/VC</td>
<td>01-08</td>
<td>EuroNCAP: Testing Programme</td>
<td>778</td>
</tr>
<tr>
<td>S090B/VF</td>
<td>92-95</td>
<td>Frontal Impact Test</td>
<td>1,856</td>
</tr>
<tr>
<td>S096B/VF</td>
<td>99-03</td>
<td>IHRA/EEVC Compatibility and Frontal and Side Impact Test Procedures</td>
<td>1,704</td>
</tr>
<tr>
<td>S086D/VF</td>
<td>00-06</td>
<td>Improved Injury Criteria</td>
<td>433</td>
</tr>
<tr>
<td>S0013/VF</td>
<td>00-02</td>
<td>Interior Headform Tests</td>
<td>184</td>
</tr>
<tr>
<td>S091D/VF</td>
<td>95-98</td>
<td>New Car Assessment Programme</td>
<td>3,365</td>
</tr>
<tr>
<td>S092E/VF</td>
<td>99-01</td>
<td>Review of Frontal and Side Impact Directives and SID Development</td>
<td>613</td>
</tr>
<tr>
<td>S082F/VF</td>
<td>94-95</td>
<td>Safety Steering Wheel with Airbag</td>
<td>60</td>
</tr>
<tr>
<td>S096A/VF</td>
<td>97-01</td>
<td>Side Impact Head Protection Phases 2 and 3</td>
<td>294</td>
</tr>
<tr>
<td>S090A/VF</td>
<td>92-96</td>
<td>Side Impact Research</td>
<td>1,812</td>
</tr>
<tr>
<td>S095A/VF</td>
<td>96-03</td>
<td>Side Impact: Barrier Design and Evaluation</td>
<td>338</td>
</tr>
<tr>
<td>S091B/VF</td>
<td>92-96</td>
<td>Steering Wheel Face Form Tests</td>
<td>140</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>19,483</td>
</tr>
</tbody>
</table>
Table 20: Indirectly related projects

<table>
<thead>
<tr>
<th>Code</th>
<th>Year</th>
<th>Title</th>
<th>Cost £K</th>
</tr>
</thead>
<tbody>
<tr>
<td>S070Q/VF</td>
<td>96-99</td>
<td>Car Fatals: Trends, Rear Seat Users and Fires</td>
<td>234</td>
</tr>
<tr>
<td>S082E/VF</td>
<td>00-04</td>
<td>Child Occupant Protection</td>
<td>279</td>
</tr>
<tr>
<td>S094A/VF</td>
<td>94-96</td>
<td>Interior Pillar Padding</td>
<td>123</td>
</tr>
<tr>
<td>S250B/VF</td>
<td>93-96</td>
<td>Laminated Glazing Safety versus Security</td>
<td>26</td>
</tr>
<tr>
<td>S090D/VF</td>
<td>92-94</td>
<td>Low Cost Car Secondary Safety Method Development</td>
<td>4</td>
</tr>
<tr>
<td>S0014/VF</td>
<td>00-03</td>
<td>Evaluation of Child Dummies</td>
<td>92</td>
</tr>
<tr>
<td>S080E/VF</td>
<td>90-00</td>
<td>Protection of Children in Cars</td>
<td>1,132</td>
</tr>
<tr>
<td>S093A/VF</td>
<td>94-97</td>
<td>Seat Test Programme</td>
<td>158</td>
</tr>
<tr>
<td>S070N/VF</td>
<td>95-96</td>
<td>Serious Injuries to Child Occupants of Cars</td>
<td>40</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>2,088</td>
</tr>
</tbody>
</table>

Thus, the following two research costs have been estimated:

- Directly related research : £19,483,000
- In-directly related research : £2,088,000

Combined Staff and Research

Combining the staff and the research costs gives the following two estimates of the programme expenditure:

- Directly related research and staff: £20,928,524
- Direct and Indirect research and staff: £23,016,524

4.4.2 Benefits

Casualty Reduction Targets

An initial question worthy of consideration is whether or not the KSI 2010 casualty reduction target, in particularly car occupants, is likely to be met. This requires a reduction of 40% in the number of car occupants killed or seriously injured in the year 2010 compared with 94/98 average.
Using the STATS 19 data for the appropriate years, the average number of KSI car occupants for 1994-1998 is **22,839**

Table 21 shows the number of car occupants killed or seriously injured year on year between 1999 and 2003. It also gives the % reduction each yearly figure represents over the 94/98 average and the year on year % reduction.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number KSI</th>
<th>% Reduction on 94/98 average</th>
<th>Annual % reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>19,915</td>
<td>12.8</td>
<td>n/a</td>
</tr>
<tr>
<td>2000</td>
<td>19,360</td>
<td>15.2</td>
<td>2.8</td>
</tr>
<tr>
<td>2001</td>
<td>19,000</td>
<td>16.8</td>
<td>1.9</td>
</tr>
<tr>
<td>2002</td>
<td>18,454</td>
<td>19.2</td>
<td>2.9</td>
</tr>
<tr>
<td>2003</td>
<td>16,999</td>
<td>25.6</td>
<td>7.9</td>
</tr>
</tbody>
</table>

The average annual reduction in the number of car occupants killed or seriously injured between 1999 and 2003 is 3.9%. If the annual reduction continues at on average 3% for the years 2004-2010, then the number of KSI car occupants in 2010 is estimated to be 13,735. This represents a 40% reduction on the 94/98 average. Thus, in order to meet the 2010 targets with respect to car occupants, KSI numbers need to continue to fall at a rate of 3% per annum.

Reduction in KSI injury outcome can be attributed to a number of factors and not solely improvements in car crashworthiness. These include changes in medical care, in road infrastructure and in enforcement. However each year the age of the fleet changes and around 8% is made up of the most recent model vehicles (based on the National accident data). Therefore the benefits seen in newer car design become more wide spread with each successive year.
Costs of casualties

At 2001 prices, the UK government's calculated costs of accidents resulting in fatal, serious and slight injury outcome are as follows:

Fatal = £1,194,240
Serious = £134,190
Slight = £10,350

All other things aside, assuming car occupant casualty reduction is solely due to improvements in car safety and primarily due to the introduction of regulations / EuroNCAP, in order for the programme to have been broadly cost effective it needs to have prevented around 19 fatalities or 170 serious injury outcome accidents (using the costs associated with both directly and indirectly related research). Alternatively a shift from fatal outcome to serious outcome in 22 accidents needs to have been achieved. Table 22 shows the year on year counts of fatal and serious car occupant casualties.

<table>
<thead>
<tr>
<th>Year</th>
<th>Driver</th>
<th>FSP</th>
<th>RSP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatal</td>
<td>Serious</td>
<td>Fatal</td>
<td>Serious</td>
</tr>
<tr>
<td>1993</td>
<td>1091</td>
<td>13040</td>
<td>393</td>
<td>4620</td>
</tr>
<tr>
<td>1994</td>
<td>1095</td>
<td>13629</td>
<td>360</td>
<td>5060</td>
</tr>
<tr>
<td>1995</td>
<td>1076</td>
<td>13334</td>
<td>398</td>
<td>5003</td>
</tr>
<tr>
<td>1996</td>
<td>1139</td>
<td>13747</td>
<td>398</td>
<td>5078</td>
</tr>
<tr>
<td>1997</td>
<td>1162</td>
<td>13589</td>
<td>381</td>
<td>4751</td>
</tr>
<tr>
<td>1998</td>
<td>1128</td>
<td>12558</td>
<td>340</td>
<td>4423</td>
</tr>
<tr>
<td>1999</td>
<td>1071</td>
<td>11791</td>
<td>357</td>
<td>4179</td>
</tr>
<tr>
<td>2000</td>
<td>1076</td>
<td>11495</td>
<td>369</td>
<td>4010</td>
</tr>
<tr>
<td>2001</td>
<td>1158</td>
<td>11294</td>
<td>347</td>
<td>3926</td>
</tr>
<tr>
<td>2002</td>
<td>1140</td>
<td>10791</td>
<td>381</td>
<td>3795</td>
</tr>
<tr>
<td>2003</td>
<td>1161</td>
<td>9778</td>
<td>380</td>
<td>3464</td>
</tr>
</tbody>
</table>
Clearly reductions seen in absolute casualty numbers over the past decade are due to reductions in serious rather than fatal outcome. It would appear that fatal numbers have plateaued a little but, as has been mentioned previously (Fig. 1, Sect. 4.1.1) the number of license holders has increased substantially so in real terms the number of fatalities per 1000 vehicles on the road has decreased.

Considering serious injury outcome and comparing 2003 for example with 2002 there were 1,463 less seriously injured occupants in 2003 than in 2002. Assuming only one serious casualty per accident this equates to a saving of £196,319,970 (2001 prices). Even if each accident now became slight rather than serious, the reduction still represents a saving of £\textbf{181,117,920} in a single year. This is an order of magnitude greater than the total investment in the programme calculated above. Therefore, in this basic analysis, the conclusion is that the programme has been cost effective.

These savings are based upon absolute numbers of casualties. As has been mentioned, the fleet is evolving year on year to include proportionally more of the newer vehicles and the fleet is also growing in size. The implication of this is that the savings in the future due to the effects of the programme will continue to become more apparent.
5 The Qualitative Data

The qualitative analysis had two dimensions: impact and process. The first represented respondents' views on what difference the front and side impact regulations and EuroNCAP, separately and together, had made to the levels of protection offered to occupants in a car accident. The second reported their views and experiences of the processes which had brought the regulations and EuroNCAP into being.

The quotes from individuals reflect their personal views, based upon their professional expertise and, in many cases, upon their direct involvement in the events that led to the regulations and EuroNCAP. The analysis presented below reflects the balance of opinion across the interview group. Quotes have been used to introduce key points, to illustrate the thrust of majority opinion and also, where appropriate, dissenting views.

5.1 Part 1: Impact

5.1.1 The Regulations

The general effect of the regulations upon car occupant safety

When asked an overarching question about the difference made by the introduction of the front and side impact regulations, a clear majority of those interviewed said that the regulations had led to improvements in the levels of protection offered to occupants in a car accident. This assertion was more frequently underpinned by professional judgements about the necessary consequences of a more rigorous testing regime than by findings from real world data. Where such data was mentioned, the respondent tended to assume that it would demonstrate positive change, without making specific reference to existing statistical evidence. One person did mention Stats 19 as providing supporting evidence of improvements, although it was not clear whether he had personally reviewed the data, and a motor industry
representative was convinced that recent crash data showed a pattern consistent with a positive effect from the introduction of the regulations:

“Maybe some of it has to come back to real world data analysis. We can definitely see that the nature of serious injury crashes in the UK has changed, in very loose terms, front and side impacts used to be predominant, now they are not, so we must have done something right in frontal impact”

Others felt, however, that it was simply too early to gauge the effect of the regulations from accident data. Given that these were not implemented until the latter part of 1998, there were doubts that enough cars conforming to their requirements had since featured in road accidents in sufficient numbers to make comparisons viable.

Professional assessments about the qualitative superiority of the regulation tests to previous testing regimes featured strongly in the responses. Although two respondents felt that the additional requirements were marginal for those manufacturers already complying with US regulations, others stated that the regulations introduced important new elements that enabled the tests to offer a more accurate prediction of performance in real accident conditions. The side impact test and the offset barrier test for frontal impact were singled out as critical elements:

“… it introduced an offset test, which is obviously the most commonly injurious crash we see on the roads. As it’s an offset crash at 56kph, it would be more demanding than the previous R12 regulation and obviously there wasn’t a side impact regulation before that, so yes it would have offered an increased level of protection from where we were before “

A respondent who had been closely associated with the subsequent introduction of EuroNCAP judged that the regulations had already begun to have a visible impact upon car design by 2000 when EuroNCAP’s first round of tests was completed. The performance of new cars in crash barrier tests showed considerable improvement over that of older models. The implication that the regulations had provided a basic platform for car occupant safety was echoed elsewhere:
“I think it does improve in the way that these regulations have avoided having bad cars, in the way that all the cars have a minimum requirement. That minimizes the big differences between cars. Of course it is not optimised but it's a push in the right direction. “

Underlying the broad agreement that there had been improvements in occupant safety were differing opinions about the importance of regulations in achieving this outcome. Those who felt that the regulations had been the single most significant factor in driving change were balanced by others who asserted that other factors had been more important, notably the prior US testing requirements that had shaped the production of global manufacturers and EuroNCAP which had subsequently ratcheted up the minimum standards for European manufacturers. Most of those interviewed, however, took an intermediate position in which they argued that improvements had resulted from the front and side impact regulations in conjunction with other developments. EuroNCAP, the campaigning activities of NGOs and competitive pressure between manufacturers to give themselves an edge in the marketplace were variously cited as operating alongside the regulations to create new incentives to improve occupant safety. Although many thought that the impact of these parallel developments, particularly EuroNCAP, had subsequently been greater than that of the regulations themselves, there was a fair level of agreement that the regulations had formed a necessary platform upon which further improvements could be built:

“I think that the regulations have played a very large part in stimulating these improvements but we also have to take into account that EuroNCAP has also acted as an enormous driving force and I am sure has had a further influence over and above the Regulations. But in the absence of EuroNCAP there still would have been a significant improvement, I’m sure, through the regulatory process.”

“…the big advantage is that the regulation did create a kind of level playing field from a consumer perspective.”

However, the regulations were not regarded, as a trigger for continuous improvement in crashworthiness performance. The general view was that they had produced a step change at a particular moment by setting minimum standards that were then fixed. They thus lacked an internal dynamic to drive
change, or, as one respondent put it, they defined a status quo that, in technical terms, tended to become the lowest common denominator, stimulating compliance rather than progress. Several of those who expressed this opinion acknowledged that the regulations were indeed open to subsequent review and refinement through the European legislative process. However, the complexity of this process along with the contentious nature of the issues involved was seen to favour inertia over progressive change.

“They’re not promoting a continuous improvement because it’s only one regulation, which on the whole is based on a single point of time. It isn’t as if the regulation is being improved and therefore making safety design change…. there is a place for the regulatory process. The trouble is that at the European level it is so much like walking in treacle that the actual rate of change and the time it takes for a directive to come from the debating stage to an agreed one is anything between 5 and 10 years.”

One member of the research community was optimistic that the need for the upgrading of regulatory requirements was better recognised than in the past, referring to the proposals to review the side impact and pedestrian regulations after two or three years in order to incorporate findings about their effects into future planning, with the possibility of incrementally increasing safety targets. But he too observed a tension between a willingness to revisit legislation and the practical impediments to revising regulations swiftly enough to keep pace with a changing safety environment:

“Because we need the agreement of too many people the process is slowed down.”

The impact of the regulations upon motor manufacturers

When asked whether the manufacturers would have introduced the same safety design features and overall levels of protection without the regulatory requirement, most of those interviewed concluded that although piecemeal improvements would have taken place as the necessary technology became available, these would not have created a consistent safety standard across the industry. The effect of regulations, according to this view, had been to speed up and systematise the introduction of safety features that were often
already available but had previously been viewed by manufacturers as optional extras rather than basic requirements. In the process, the views of vehicle safety engineers within the manufacturing organisations were accorded a new importance:

“They would have done some things along the line of improvement but we do know from confidential correspondence and discussions with some of the engineers that they themselves have difficulty persuading their bosses to provide money for improvement unless they can demonstrate an absolute need. Will it sell more cars? Do we have to have it for regulations? So I think even the engineers involved in producing safer vehicles know that the regulations helped them get it through so I’m sure that something would have happened without it but nothing like the level.”

Developing this theme, some suggested that the manufacturers would not have voluntarily acted to improve safety unless this produced a perceptible financial benefit in the market-place:

“I am a bit cynical… my experience of working with the manufacturers is that they only do what they have to do. The whole ethos is compliance with regulatory requirements; you don’t do more than you have to do”.

A strongly competing view from within the industry was that far from stalling on safety in order to contain costs, manufacturers had invested considerable resources over a long period in the research and development of improved safety for vehicle occupants and indeed had made considerable advances prior to the introduction of the front and side impact regulations in 1998. One particular motor group, for example, had investigated offset frontal impact long before it entered the regulatory discussion as a key issue, and had independently developed a side impact test. In this capacity it considered that it had acted as a driving force for new safety tests and technologies that were subsequently reflected in the regulations. From this perspective, the industry had anticipated a growing awareness of safety issues among consumers and had worked independently to develop a dynamic safety culture in order to create for themselves a distinctive market position:
“There was certainly a competitive edge to it, manufacturers were looking for an edge and safety was one that hadn’t been exploited significantly. There was pressure from government, from consumer organisations to improve safety. There was the availability of technology which gave us possibilities that we couldn’t do before or do at economic levels so there is a whole range of different things and there was just a culture growing that there was a tide to do more to improve occupant safety”.

Although views thus differed about the motives and the performance of the manufacturers prior to the introduction of the regulations, there was a convergence of opinion about the helpfulness of the regulations in consolidating the technical progress that had been made on occupant safety and translating this into a set of universal minimum requirements. Even those manufacturers who believed that the regulations had had little effect upon their own operations because of the advances they had already made, acknowledged that there had been a considerable impact upon the industry as a whole.

Aspects of the regulatory testing procedure

The interview group was questioned about aspects of the regulatory testing regime, in order to define the benefits and any potential disadvantages for occupant and pedestrian safety.

Whole vehicle versus component testing

“There is no substitute for actually banging the car into the barrier and seeing what happens.”

While both whole vehicle and component testing were regarded as important and complementary, the former was widely regarded as the indispensable basis of an effective safety regime. Only two respondents considered that component testing could on its own provide an accurate and comprehensive prediction of car performance under crash conditions.

The detailed arguments in favour of whole vehicle testing were:
• without whole vehicle testing, it is impossible to achieve a holistic representation of the impact on the car and its occupants. The sub-system is too disconnected to give a really good feel for exactly how the structure will perform under very high stress loads.

• the need to test the restraint system and the vehicle characteristics at the same time is increasingly urgent as these elements become more complex; the interaction between the seat belt, the airbag, the vehicle crush and the deceleration forces can only be gauged through whole vehicle testing.

• component testing does not take into account different car designs whereas whole vehicle testing allows safety performance to be defined within each car model.

• with component testing there will always be more of an artificial single point test with a risk of some optimisation. With complete full-scale testing, there are a far lower number of configurations that can be tested. Optimisation still takes place but this time it will be an optimisation of all the systems according to one crash classification.

Of the two respondents who dissented from the general view, one said that, although he had not given careful thought to the issue, he could not immediately see any advantages of whole vehicle testing versus component testing and that the former had possibly been pursued because it was more convenient rather than because it delivered specific benefits. The second identified distinct advantages in component testing in terms of time, cost and repeatability.

Optimisation
There was a high level of agreement across the interview group that the introduction of the front and side impact regulations had resulted in manufacturers optimising the design of their cars to ensure that they would meet the test requirements. However, many pointed out, that the risk of optimisation was not confined to the regulations and was intrinsic to all safety testing procedures, including those of EuroNCAP. Views differed as to whether optimisation for the front and side impact regulations had created
significant disbenefits or whether it had simply created fewer additional benefits for some vehicle user groups than for others. Some respondents felt that, whatever the risks of optimisation, it was important to begin somewhere and that the regulations had at least created greater transparency and consistency because manufacturers were now optimising for the same tests:

“Optimisation is always going to occur, it is just when you have got a regulated test, everyone is going to be optimising around the same condition, otherwise every product is going to have a particular crash scenario, occupants, speed, impact direction partner vehicle which it is optimised for, but if there is no regulation they are all going to be naturally optimised at different levels, and I think you would find that probably with pedestrian protection at the moment because they understand so little about it that they are all optimised at different levels, whereas front and side impact they are optimising around either the regulated speed test or the NCAP scenario”

On the other hand, there were concerns that the speed of the tests and the characteristics of the dummy used had led to optimisation for highly selective configurations of passenger and speed that did not necessarily represent a realistic scenario. As one respondent put it:

“…35mph with a dummy that is meant to represent a healthy male is not what we are looking at in the real world.”

Three kinds of risk were identified as a consequence of optimisation. The first and most frequently expressed was that the optimisation of safety for the average male driver disadvantaged other vehicle users. It was said that even in the 30mph flat barrier test, vehicle users would be exposed to increasing levels of risk the more they diverged from the putative average. Stiffer structures, sharper restraint systems and airbags, all designed to minimise intrusion injuries, nonetheless contributed to a more hostile environment at low speeds for such ‘non-standard’ users, particularly in small cars. Thus, the small, post-menopausal woman driving a small car was likely to be exceptionally disadvantaged by optimisation and, even fit older men would fare significantly less well than the young, healthy male. This caused one observer to comment that the whole issue of variation in the population and
variation in the types and severity of crashes was the next big challenge for the regulatory process.

“I would just say there is always sub-optimisation to a test standard and that sub-optimisation is very sensitive to the way it’s tested. We test with 50th percentile dummies that are themselves compromised. These groups that you indicate here, women, children, pregnant women, elderly, whatever, are always disadvantaged. I would say that particularly they are more disadvantaged. What I’m thinking about here is the offset regulation leads to generally stiffer vehicles and the restraint systems are therefore more rigorous or more severe in their operation and therefore I would say that elderly people and pregnant women are at a disadvantage because of the aggressiveness of the restraint systems as they need to deal with the forces of the offset.”

“…for small women it leaves them vulnerable to interactions with airbags, for example, that are completely undetected by the current dummy. For the larger adult, the heavy male he may be in a restraint system which is completely incapable of holding him.”

The second and related issue was that optimisation for the adult front seat passenger had made things worse for those in the rear seats, who were not covered by the current tests. It was suggested that these passengers would almost inevitably be compromised by the higher deceleration pulses released when anti-intrusion safety features caused only the front of the vehicle - rather than the front plus the passenger compartment - to be crushed in a collision, thus stopping the car more quickly.

As predominantly rear seat passengers, children were seen as particularly vulnerable and one respondent was clearly scandalised by the lack of attention to their specific safety needs, both in the design process and in the regulatory testing regime:

“Children certainly have been horribly neglected in regulations and there is just an extraordinary situation that we are in at the moment where as a parent you have to go somewhere and try and chose a child restraint off the shelf, based on how it looks to you, and yet you as an adult are enjoying restraint that is highly tuned to the particular vehicle and it is full of sophisticated features, load limiters and pretensions and things, but with our children we are still in the dark ages, shopping for bits of polystyrene, choosing really on the basis of the cover, so it is a massive difference in the approach to adult protection and child protection that I think is unjustifiable….”
Finally, there was a concern, closely linked to both the above issues, that optimisation at a specific speed could lead to vehicle structures that created more hostile environments at lower speeds, particularly for those who diverged furthest from the model of the healthy average male. As discussed further below (The correct speed for the front and side impact regulations), this led several respondents to oppose the raising of the speed of the regulatory test, with one arguing for an actual reduction in the speed.

**Compatibility**

Most respondents were reluctant to commit themselves on the question of whether the vehicle modifications designed to meet the requirements of the regulations had resulted in additional problems of compatibility. Their answers tended to be phrased in terms of hunches and probabilities. Those who felt that the problem had become slightly worse, pointed to the incompatibility between newer cars that met the requirements of the regulations and older cars that did not:

“It has probably got slightly worse, or there is probably more incompatibility than there used to be, that is almost certain to be the case...Certainly in front to front, I don’t think it makes a great deal of difference in front to side, but in the front to front it will have affected it. I think it becomes more noticeable when you have got a new car hitting an old car and if it had been two old cars hitting each other then they would have not had a brilliant chance of survival anyway, just makes it more pointed when they walk out of one car and they are dead in the other.”

There was nonetheless a degree of optimism that the problem would ease as the vehicle fleet renewed itself and as adaptive solutions were developed. It was thought likely that incompatibility between large and small cars would remain a problem, although, once again, improvements were feasible.

A slightly larger group of respondents considered that the regulations had probably not made things worse given that previous vehicle structures were not especially benign; at the same time, they considered that very little had been done to improve compatibility. One felt that a lack of progress in
addressing the problem lay in an incorrect interpretation of the nature of compatibility:

“Compatibility is very much a geometric problem rather than a mass problem that people have traditionally focused upon. So I think there needs to be much more harmonisation of vehicle structure in terms of geometry, heights of bumpers, heights of chassis rails etc… There needs to be more in regulation about compatibility but it needs to be focused on the problem and I believe the problem is as much geometry as it is mass and stiffness.”

Placing the issue in a broader perspective, it was noted that although the increased sales of 4x4s and Sports Utility Vehicles (SUVs) had led to greater incompatibilities within the car fleet, the main danger for vehicle users remained the incompatibility between cars and heavy goods vehicles:

“Massively important to get front and rear guards properly compatible with car structures, a lot of compatibility discussions assume it is a car to car problem but if you look at the fatal causalities particularly, then incompatibility with heavy goods vehicles is absolutely dominant.”

**Pedestrian friendliness**

None of the interviewees believed that the vehicle modifications designed to meet the requirements of the front and side impact regulations had resulted in vehicles that were less pedestrian friendly. Nor did they consider, on the other hand, that they had had much positive impact on pedestrian safety. Most felt that they had made no difference, while a few believed that there had been marginal improvements. Where such improvements were identified, they were seen as coincidental spin-offs of the modifications rather than as having been planned for the benefit of pedestrians:

“I have the feeling that the pedestrian has been improved in safety in relation to car design by chance up to now and if the car is less aggressive to the pedestrian it is not because of the industry or because of the regulation. It is because of the streamlined shape of the car, the introduction of more plastic material and less steel. Except for a few things on the external shape, which is one regulation, all the rest is just by chance up to now.”
One manufacturer was singled out as having made a commitment to pedestrian safety and some practical progress, but the industry in general was accused by members of the research community of doing the minimum it could get away with, thus effectively disengaging itself from the pedestrian safety issue, despite the minimal cost of designing pedestrian protection into vehicles. The voluntary agreement on pedestrian protection was said to have provided an escape route for the industry:

“I don’t think that is driving it at all. I think that again is an example of the industry watering down the requirements”

The technical challenges of achieving progress in pedestrian safety were, however, acknowledged to be complex and reminded one researcher of the competing issues that shaped the evolution of the front and side impact regulations:

“...we have got exactly the same issue going on now between industry and government as there was earlier on with the resistance to the test speed in frontal impacts and the sort of barrier height in side impacts. It is difficult to design the car to protect pedestrians when you think of the difference between a tall male and a child and where they are going to hit and there is a three part test there where they have got to design their vehicle to mitigate head injury for a child and adult and then you have got the hip and then the knee level, and to get all those right.”

**The correct speed for the front and side impact regulations**

Opinion was divided about the advisability of raising the speed of the regulatory tests for front and side impact to conform to that used by EuroNCAP. On one side it was argued that a higher speed should have been implemented from the outset and that the reasons originally put forward for keeping the speed down (principally concerns about compatibility) had not been fully supported in practice:

“I don’t think we should raise the EuroNCAP speed, but I think the regulatory speed should equate to whatever the accident people are saying is the best speed to mirror. The most number of accidents, and that is what should decide it.”
Moreover, it was suggested, the EuroNCAP speed for frontal impact had superseded that of the directive and cars were now being designed routinely to perform at the higher speed. One respondent also pointed out that a recently published review of the regulations by the EEVC, using experimental data, had concluded that the speed was too low for side impact.

Ranged on the opposite side were a larger number, including all the industry representatives responding to this question, who were unconvinced about, or actually opposed to raising the speed. One manufacturer expressed the view that an increase in speed would be counterproductive in terms of compatibility, and that the inevitable increase in weight would compromise fuel economy and environmental performance. The benefits and disbenefits of testing would thus move from a positive to a negative ratio.

A frequently stated argument among those opposing an increase in the speed of the regulatory test was that an enhancement of the performance of cars at higher speeds risked making them more hostile for vulnerable groups in crashes at relatively low speeds:

"Around 80% of all the people who get AIS 2 and less injuries, if you don't mind me getting a bit technical, are in crashes well below 35 mph, or 40 mph if you take the offset barrier test. My view is that, if anything, decrease the speed but lower the threshold levels that are acceptable on the dummies. You go down to 750 for Head Injury Criteria (HIC) and 40Gs for the chest and 15lb for the legs. That is the way you begin to address all of the relatively vulnerable people who are all having crashes in the sort of 30mph range and they make up the bulk of those people that get seriously hurt and killed. This quest for having a higher crash speed, a more severe test by making it more extreme in terms of the population of crashes, is misconceived."

While only one other respondent put forward a case for reducing the speed of the regulatory test, there was more support for the view that an increase in the speed without a reduction in the injury thresholds would be counterproductive.
Several argued the case for maintaining a separation between the requirements of the regulations and EuroNCAP in order to discourage optimisation at a single point. While some saw virtue in continuing to differentiate primarily by speed. It was also suggested that that the value of having two tests might be maximised by allowing them to address different kinds of impact:

“Having two impacts which are different is a more preferable situation, you are testing different scenarios. So therefore I would think it was probably appropriate that if the regulation were to raise the EuroNCAP specification, EuroNCAP would drop that and go for something else… Or if EuroNCAP keeps what they are doing they should change regulation 94 to be a different impact scenario all together. Lower speed, lower offset, whatever.”

Making a similar point, another respondent felt that incorporating lower injury thresholds into the regulations would ensure more safety gains than simply increasing the speed of the test. According to this view, to stay with the existing performance criteria while increasing the speed would not overcome the problem of sub-optimisation of design.

Finally, one research expert concluded that any debate about changes in the speed of the side impact regulation was premature because of the acknowledged deficiencies of the test and uncertainty about how it should be reconfigured:
“Well the test procedure is wrong, the test dummy is inadequate. I think that’s probably the main thing, mainly the test procedure. In other words we’re back to this barrier. What should be done?... I don’t know whether the speed should be higher. We are fairly sure that the ground clearance should be greater on the barrier. Now is it just the ground clearance and not the speed because the speed comes from the deformation that is affected? We don’t know that.”

The burden to industry of meeting the requirements of the front and side regulations

Some interviewees from outside the motor industry acknowledged that they had had little idea at the time about the cost to manufacturers of meeting the front and side impact regulations. Their only preoccupation had been with the promotion of safety. Among the others, including representatives from the industry, there was a fair level of agreement that the burden had been slight, although it was said to have been somewhat greater for side impact than for frontal impact. Although vehicles needed to be redesigned in order to meet the new requirements for frontal impact protection, redesign and its associated research and development costs was already a continuous element within vehicle production. For side impact protection, redesign was not in itself sufficient to meet the new standards and additional materials were required, notably padding and airbags (although one research expert considered that padding added to a cleverly designed side structure would have been sufficient for the purposes of the regulations). Since relatively little was known about how to manage side impact collisions, the up-front engineering research costs were also higher.

Several accused the industry of having exaggerated the financial burden in order to fuel its resistance to the regulations:

“It is interesting really because the industry position was that basically you will put us out of business if you required these sorts of levels of performance and then the researchers initially developed the thing not particularly with an eye to the cost but just saying this is what you actually need to do to reduce injury. I think the early tests, with the proposed test procedures, showed that there were production vehicles that did pretty well with the new procedure and then it became clear to the consumer groups particularly that these claims of devastating costs to the industry were completely unfounded.”
This was backed up by a respondent who had worked both in industry and in government research. He concluded that the real cost of engineering a solution for frontal impact was a fraction of what his company had been claiming in public: £10 as opposed to £200-£300. Furthermore, the actual part component cost was in his view likely to be less than £1.00, the remainder of the £10.00 being devoted to “engineering glamorisation over the life of the product.” Another industry representative suggested that the cost to his company of meeting the regulations had not been much more than 50 euros, although this figure took into account the opportunity to incorporate the new requirements into the normal design process well ahead of the date for the introduction of the regulations.

On the whole, however, the manufacturers’ representatives were unwilling to estimate the cost of meeting the regulations. The calculations were complex and it was also evident from their responses that companies had differed in their preparedness for the regulations so that while some needed to embark on major research and development programmes, others which had already made substantial investments in safety design found that much smaller adaptations were required. Some safety products became a universal requirement with an associated development and testing cost for all manufacturers but it was pointed out that these initial costs usually fell dramatically once the product entered mass production. Thus the high costs of the new technology for airbags were balanced by a much lower production cost over the life of the vehicle once the airbag became a routine rather than a luxury safety item.

A question arose during the interviews about whether those manufacturers producing cars for the US market had had a cost advantage in meeting the regulations because they were already conforming to the US side and front impact test standards. While one research expert considered that this was indeed the case, others felt that the opposite was true and that manufacturers conforming to the American directives had possibly underestimated the extent to which they would need to adapt their products to meet the very different requirements of the European regulations. The few companies selling in both
markets were effectively required to design for two different regulatory regimes whereas those selling only in Europe were able to focus exclusively on the regulations and, later, EuroNCAP.

The timescale allowed for industry's investment decisions
The general view among the non-industry respondents was that while the timescale followed for the introduction of the front and side impact regulations was not explicitly planned in order to meet the needs of the industry, the delays were such that manufacturers were given ample lead time for making investment and production decisions. Indeed, most believed that the stalling tactics employed by the industry throughout the regulatory process, particularly in the motor vehicle working groups, had been used to buy time rather than to air legitimate objections:

“Well, they use it as a … negotiating tool, they always do, I have been involved in the revision of virtually all the regulations in the last 20 years and that is just the pattern of what they do, they just say we must have a huge lead time and it is not related to reality it is just a negotiating position … to make sure that nothing that happens in regulation influences their natural investment cycle, that is the key thing.”

It was generally agreed that the specifications for the regulations had existed long before the regulations came in, with one observer estimating that the intervening period had been around 15 years during which the industry had managed to delay implementation without any sound technical basis for doing so. Once the regulations were introduced, the immediate impact upon the industry was further softened by allowing a lengthy period to elapse before new models had to comply, thus giving manufacturers considerable notice of the changes required. The regulations were then applied incrementally to existing models so that the process of implementation was extended over a period of several years.

The cost of the UK government research programme
Although exact figures were not available, the former head of the TRL crashworthiness research programme estimated that between £750,000 and
£1 million per year was spent on research into front and side impact and compatibility from the mid 1980’s until the mid 1990s. The amount of work undertaken remained fairly constant throughout. There was no single, identifiable budget to support the research programme for most of this period and the estimated spend was derived from annual contributions from customer held budgets. By the time funding moved to a contract system, most of the work on front and side impact had been completed but the volume of spending, now directed mainly towards compatibility, was thought to have remained at about £750,000. A colleague who worked at TRL from 1994/5 until 1999 remembered a somewhat higher figure of around £1.5 million devoted to front impact research at the beginning of this period, tailing off towards the end.

A non-government research expert point out that the impact of the Department for Transport’s financial commitment could not be measured solely in terms of the regulations:

“It is used by lots of people, by the manufacturers, by the suppliers, by consumer groups to advance their agenda, well outside the specifics of development of regulations or EuroNCAP. …it sharpened up the industry, for example, in a number of ways and resulted in the industry doing things which were way beyond what the regulations had required.”

5.1.2 EuroNCAP

The general impact of EuroNCAP upon car occupant safety

Across the interview group, all but two respondents were convinced that protection for car occupants had improved since the introduction of EuroNCAP, which was considered to have raised the performance of the motor manufacturers substantially beyond the levels that would otherwise have been achieved by the front and side impact regulations. A key piece of evidence for this view was the range of standard safety features now being fitted in European cars, well in excess of the regulatory requirements:
“You can go back very many years, from the NCAP reports ... and try to see what they've got in the cars that are partly market forces driven of which NCAP is a part and are not there just to meet the directive. They can take out the side airbag, all front airbags, probably take out all airbags and I don't know what else and still meet the directives. So all those extra safety aids that are not there to meet the directives are there for another reason. They are really there because they think it will help to sell their car.”

An insurance expert quoted findings from road safety investigations to the effect that EuroNCAP had stimulated manufacturers to increase safety levels across successive models, with the result that vehicles now obtaining four or five stars in the EuroNCAP tests, compared to one or two stars for previous models of the same vehicles, were demonstrating many fewer casualties in similar impact scenarios. The superior performance in terms of occupant protection of highly-rated vehicles was also highlighted:

“There is some very good data from the IIHS that is again showing where they have tested vehicles that get a good or a best pick, they are considerably better (and it's a factor of 10) in terms of occupant protection. So I would certainly say that EuroNCAP as a body has moved the safety game on far more than government and regulations can possibly.”

Pointing to the complexity of the interaction between the factors that contribute to a car's performance in an accident, a researcher took a somewhat different line, arguing that EuroNCAP's achievement lay in pushing forward safety in a global way rather than in defining narrow safety differentials between vehicles:

“It is not necessarily the question of the car that has 5 stars being better than the one that has 3 stars but a push for the industry to have better, safer cars and to avoid weak points. There are so many parameters involved, including the driving population, that are not the same in the small or large car, in the expensive or not expensive, so it is complicated to know really if the car is safer in an accident.”

Despite such differences in interpretation of the impact of EuroNCAP upon vehicle performance, there was broad agreement that it had succeeded in harnessing market forces in the interests of occupant safety so that evidence of superior safety performance became a powerful marketing tool. The
element of competition introduced by EuroNCAP’s star ratings was said to have created a far more dynamic impetus to improvement than the minimum requirements of the regulations and also a greater convergence in the safety performance of cars:

“When EuroNCAP first started in 1997 there was a huge disparity between the best and worse vehicles, that gap has narrowed enormously and at the same time standards have improved so we have offered a very wide range of performance to a narrower and higher level of performance.”

For manufacturers whose safety specifications differed across Europe, EuroNCAP prompted an up-grading to the highest existing level. In one case, cars designed for the UK, North European and South European markets had been fitted with progressively lower levels of occupant protection, which meant that South European versions were less likely to have features such as airbags and Antilock Braking System (ABS). This suddenly changed with the introduction of EuroNCAP:

“When NCAP came in and the UK Government started testing the lowest specification available in the European market, suddenly (the company) fitted all the Southern European ones with the same level of kit and that was a big change and that affected a number of manufacturers.”

The speed of change following the introduction of EuroNCAP attracted specific comment from a government observer:

“I think what in particular is surprising is the speed with which it was possible to introduce more or less continuous improvements in the level of passive safety”

One researcher, while strongly endorsing the general belief about the positive impact of EuroNCAP, qualified his view by pointing out that the benefits of consumer testing could apply only to those vehicles that actually went through the process and that while EuroNCAP, by selecting on a sales basis, would test the majority of vehicles, there were “variants and even models and manufacturers that are never assessed.”
The two respondents who expressed uncertainty about the positive impact of EuroNCAP upon car occupant safety were both industry representatives. One questioned whether the resources devoted to gaining the maximum star ratings might not be better spent in pursuing active safety solutions that could have a more substantial impact upon real world safety. The other considered that the impact of EuroNCAP had been felt more strongly in the restraint systems of vehicles than in their structure, and therefore had mixed views about its overall effect upon occupant safety.

For the majority of respondents who had a strongly positive view of the impact of EuroNCAP, consumer testing was seen to be the single most important factor now driving safety improvements because of its observable impact upon the behaviour of manufacturers over a relatively short period. They were nonetheless aware of prior developments that had been significant in preparing the ground for EuroNCAP and in supporting its effective performance. In particular, the front and side impact regulations were said to have provided an essential foundation:

“*My view is that there had been an inter-relationship between the legislative side and the consumer information side, I don't think we would have had the good development of EuroNCAP had there not been that initial front and side impact legislation there to show that the government was serious, to show that they would have to do something by a certain date.*”

Factors such as insurance costs and consumer awareness were also considered to have been influential:

“There is impact from the insurers in terms of increased litigation costs and increased personal injury claims. There is a heightened awareness now from the buying public that vehicle safety is important and vehicle manufacturers themselves are jumping on the consumer bandwagon, which isn’t bad, but advertising their vehicles as passing safety regulations or doing well in consumer tests.”

And it was suggested that competitive market forces were in any case working in the direction of improved safety.
“Partly through NCAP, partly through just market forces because, remember, airbags were in the steering wheel before NCAP came in for the larger cars but they didn’t want to force the cost onto their cheap cars.”

While the new safety culture was seen to be the product of an interaction between EuroNCAP and other trends, EuroNCAP was nonetheless regarded as the prime mover because of its efficacy in consolidating existing achievements and driving safety to a new level. As indicated by the last respondent, safety features which manufacturers had already introduced for larger cars or in parts of Europe with relatively rigorous safety requirements were rapidly extended across the fleet and across the European Union. None of those interviewed believed that the same levels of safety protection for car occupants would have been achieved in the same time frame without EuroNCAP:

“I think that a lot of the things that are in an average passenger car that are available now might have been there but it might have taken much longer to have got them into the market place and also it might not have been so widespread, it might have been limited to the manufacturers that see safety as their market image.”

EuroNCAP was widely seen to have stimulated a continuous improvement in crashworthiness performance. In contrast to the front and side impact regulations, which were said to have brought about a step change towards a minimum safety standard, EuroNCAP was said to be driving safety ‘from the top’; in other words, it was working to diffuse the most advanced levels of protection throughout the industry:

“As it’s not a pass/fail criterion like the regulation – regulation has to appeal to the lowest common denominator and a regulatory body therefore has to consider the slowest people whereas a consumer test can consider the slowest and the fastest and really drive from the top end. It can be driven by the very best to say this manufacturer can do this well in this test therefore we want everybody to catch up and we will tell every body to buy car A because it’s the best and that will make car B, C and D catch up because they will lose sales.”
Competition in the market-place was widely regarded as the principal dynamic in the process of improvement. It was said that once manufacturers believed that superior safety ratings could give them an edge in selling their vehicles, the impetus for change no longer depended upon external pressure but became embedded in their own planning and design processes:

“With EuroNCAP it is a process of continuous improvement because there is something for the manufacturer to gain from producing safer vehicles, which is not the case with the regulations. Once he’s got past the base line he doesn’t need to do any more but with EuroNCAP you get credit for doing something.”

Some respondents considered, however, that the rate of improvement was unlikely to be as rapid in the future as it had been in the years immediately following the introduction of EuroNCAP when the gap between the worst and best performing vehicles had narrowed sharply. It was suggested that a safety plateau might be reached, beyond which there would certainly be changes as technology evolved, but not on the scale observed so far. This would pose new challenges for EuroNCAP in maintaining the interest of consumers and the industry:

“I think it is a lot harder now to make the incremental improvements than it was initially… I think when we come to talk about the future of EuroNCAP I think EuroNCAP have still got to try and maintain the level of publicity to get the driving force behind it all and if it becomes like the USNCAP which nobody seems to know about, which they spend a huge amount of money on each year, then it starts to get very difficult to make things happen.”

Support for the idea that EuroNCAP had stimulated a process of continuous improvement was not, however, universal and the four respondents who dissented from this view were all industry representatives. One acknowledged that there had been continuous change but did not equate this to continuous improvement, highlighting specific problems with the upgraded dummy for side impact tests:
“When EuroNCAP changed the side impact dummy from EuroSID 1 to EuroSID II, some of the items they were requiring were certainly for the good because we now know that EuroSID 1 had some deficiencies. On the other side, some of the other requirements introduced by EuroNCAP that forced car manufacturers to change design like T12 (thoracic rib 12), like the back plate modifier, were not always for the good, sometimes completely the opposite.”

Aspects of the EuroNCAP testing procedure

Optimisation

Views about the tendency to optimisation under EuroNCAP closely mirrored those reported above in relation to the front and side impact regulations. With one exception, those interviewed believed that optimisation was an inevitable consequence of modifying vehicles to perform well at the EuroNCAP tests. The exception was an industry representative who said that while sub-optimisation was certainly possible, some manufacturers, including his own company, made efforts to avoid it.

As in the discussion of the regulations, there were some who considered that the effects of optimisation were relatively benign or at least neutral and a larger number who considered that they disadvantaged the non-50th percentile male, with some disagreements about the extent and dangers of these disbenefits to other groups.

Several respondents pointed out that EuroNCAP enjoyed flexibility in its implementation that contrasted with the fixed nature of the regulations and felt that it was now appropriate for it to use this flexibility by varying its testing procedures to cover a range of speeds, accident scenarios and types of vehicle user:

“I think probably what we have touched on already is the business of making sure the cars are not optimised for one particular sort of accident, getting in different sorts of accidents looking at the protection of small people, large people, perhaps looking at different speed etc. those are the sorts of areas you can start to expand on.”
It was said that although manufacturers were already testing to a range of scenarios, it was the desire to achieve good scores in EuroNCAP that was most likely to lead to design changes. All the more important therefore that the EuroNCAP tests involved a range of scenarios that were credible in terms of real world accidents and improved protection for a range of vehicle users. Even so, an expansion of the EuroNCAP tests would undoubtedly be expensive and difficult to fund.

“There are conversations about older people, there are conversations about small females, what about 95th percentiles in small cars, so there are a lot of possible impact scenarios that could more robustly test the restraint system and the crashworthiness of the individual vehicles. But …that is very costly and not an easy thing for EuroNCAP to fund 3 additional vehicle tests to maintain its objectivity and its independence. There is lots of good clear thinking on the EuroNCAP group about what they need to do but unfortunately funds restrict what can be done. Therefore additional government support could be tremendously beneficial to increase overall vehicle crashworthiness.”

Specific questions were raised about the formulation of the side impact test, which had proved unexpectedly benign and which was seen to require reviewing and upgrading in order to provide an appropriate level of protection. A key problem, as identified by one research expert, was that side impact was such a dramatic event over such a short period that it was difficult for structures alone to provide protection. Side air-bags were likely to offer an important extra safety dimension but were not currently a necessity for meeting the EuroNCAP test requirements:

**Compatibility**

When asked whether the requirements of EuroNCAP had resulted in additional problems of compatibility, the interviewees' responses were, if anything, more tentative than those they had given to a parallel earlier question about the effect of the front and side impact regulations. Most said that they were uncertain whether EuroNCAP had made any difference to compatibility, while tending to believe that it had not made it worse. While some thought that increased structural stiffness in cars meeting the EuroNCAP regulations could disadvantage older partner vehicles in an
accident, others suggested once again that stiffness was not fundamental to the problem of compatibility:

“I still believe that compatibility is as much a geometric problem as it is a structural stiffness problem. As EuroNCAP doesn't drive geometry one way or the other, specifically, it's not all their fault.”

The importance of achieving compatibility in frontal impact was emphasised on the grounds that if frontal compatibility was achieved, it became easier to factor in other elements such as stiffness, geometry and the road interface in order to achieve optimisation. One respondent was convinced that optimisation would nonetheless inevitably involve moral choices and compromises in vehicle design:

“The compromise means that maybe for the larger car, for example, we will have introduced not such a high internal protection because we need a slighter weaker structure to have optimisation.”

**Pedestrian friendliness**

The interviewees gave a broadly neutral response when asked whether the requirements of EuroNCAP had resulted in vehicles that were less pedestrian-friendly, mirroring their answers to an earlier question about the impact of the front and side impact regulations upon pedestrian safety. The general view was that EuroNCAP had as yet resulted in few improvements in pedestrian friendliness but, at the same time, had probably not made things worse. Two respondents felt that the tendency was towards less pedestrian friendliness, although they agreed with the majority opinion that little difference had been made overall.

There were some expressions of optimism about the industry having begun to address pedestrian protection, including this comment from a European government representative:

“My impression until they really started to focus and highlight the pedestrian issue in 1998, it was with the launch of the (make and model quoted) in Amsterdam I recall, until that time they didn’t care, and I think we didn’t find any response by the industry to pay any
attention to the issue of pedestrian protection, the only thing that mattered was the cost and design - and from that time on at least there was some kind of response, some kind of awareness that it is an issue to bear in mind.”

The respondents agreed, however, that EuroNCAP had not succeeded in producing the continuous and rapid improvements in pedestrian safety that had been evident in vehicle occupant safety. One reason given was that the pedestrian component of the test was inadequate and that potentially helpful vehicle modifications had had only a partial effect. While the fronts of new cars had become less aggressive for pedestrians than those of older vehicles, in that they were less angular and sharp, they nonetheless remained too stiff.

Another view was that manufacturers had been let off the hook by a lack of consumer pressure for improvements in pedestrian safety. Although they were complying with the pedestrian test procedure, very few had positively engaged with the challenge of embedding pedestrian safety in the design of their vehicles. One manufacturer was once again singled out as a leader in this field. While the likely effect upon real world pedestrian safety through exposure to its new cars was acknowledged to be small, the positive behaviour of one manufacturer could potentially have a measurable impact on its competitors.

**The effect of safety ratings upon consumer attitudes towards purchasing cars.**

Most of those interviewed believed that EuroNCAP had influenced consumer attitudes towards purchasing cars. They believed that the publication of test results had brought safety to the fore and, by increasing safety awareness, had influenced consumer purchase criteria. This higher profile given to safety performance was not attributed primarily to consumers seeking out EuroNCAP rankings – although a EuroNCAP representative in the interview group did note that the hit rate for its website had expanded phenomenally - but from manufacturers using good results as a positive marketing tool:
“From the information that I have from (one manufacturer) they have seen a big increase in sales and in analysis of their increased sales one of the principal reasons has been an increase in safety. They were a vehicle manufacturer perceived as being less safe than the average and therefore they have sort of rewritten that… so clearly there has been a tremendous benefit in that a manufacturer that does well in consumer tests, and also advertises the fact, can increase public perception.”

At the same time, negative findings for certain cars and manufacturers had found their way directly to consumers and had devastated their markets in the UK. This had made manufacturers aware of the potential of EuroNCAP for influencing their position in the market-place:

“It was one or two real scares like that in an industry that is massively over capacity anyway, so one or more than one big player is going to go to the wall. So that is the coincidence why EuroNCAP is so important because a) it can cripple your market and b) it isn’t a time where you can afford to have a big problem.”

Not everyone was convinced, however, that there was a demonstrable relationship between performance in the EuroNCAP tests and consumer purchasing behaviour. It was suggested, for example, that the consumer’s decision to buy a particular car was based upon a range of criteria, of which safety was an element. The weight it carried in the final choice remained unknown. As one industry representative put it:

“Things you know about will influence you but no marketing specialist will ever be able to tell you that it has sold one more vehicle because it achieved 5 stars.”

Another claimed that the fundamental reason for providing consumers with information about safety was not to influence sales but to enable the consumer to make a more fully informed choice. Some people would no doubt continue to choose their car on the basis of styling or speed but at least its safety performance would be a known rather than an unknown quantity, whereas prior to EuroNCAP it would have been almost impossible for consumers to gauge critical safety differences between vehicles.
By breaking the link between consumer safety awareness and sales, such arguments would appear at first sight to demolish the manufacturers’ principal incentive for improving their EuroNCAP ratings. But various respondents made the intriguing suggestion that manufacturers were influenced more by their perception of EuroNCAP’s influence than by the actual behaviour of consumers:

“The important thing about EuroNCAP is not that we are informing consumers about the safety of cars. The important thing about EuroNCAP is that manufacturers feel that we have that effect on the consumer and they modify their cars because they worry about what we are telling consumers. …So it is very important that we operate on the basis of manipulating the manufacturers to improve their cars and as part of that you have got to tell the consumer but the number of consumers you actually influence has very little effect.”

According to this analysis, the important thing was that the information was ‘out there’, with the potential to influence sales and destabilise the manufacturers’ position in the market-place, with the development of better-informed consumers very much a secondary benefit.

Whatever the precise mechanism at work, there was near unanimity within the interview group that EuroNCAP ratings exercised a powerful positive impact upon investment in improving car crashworthiness. Accustomed to seeking competitive advantage for their own cars in the market place, manufacturers had seized upon the ratings as another means of demonstrating the superiority of their product:

“I would say vehicle manufacturers strive for every half point and because there is a certain simplicity in the ranking undertaken with EuroNCAP, more so than with the IIHS offset test, the manufacturers will not be happy just to have 5 stars but want to have 35.5 points and not 35. They will strive to do as well as they possibly can.”

This imperative to maximise performance in EuroNCAP was also said to have altered the dynamics of decision-taking within the industry, giving vehicle safety engineers much greater influence than before in the design process.
“In fact we have heard this many times from manufacturers that the safety engineers have been empowered by EuroNCAP because what they can now say when they sit round in their design meetings and they say ‘Do we do this or do we do that’ and if the sales director says ‘I must have this because I can’t sell the cars unless this particular thing is added’ the safety engineer would say ‘On your head be it, in that case it will not be a four star car it will be a three star car’ and the decisions get reversed.”

Respondents’ views were also sought about the value of consumer-oriented publications, such as the Department for Transport’s “Choosing Safety”, which are based upon the retrospective analysis of real world accident data. Opinions were divided. Supporters believed that they promoted a better flow of information to the public and increased transparency. They were also seen to be more comprehensive in their coverage than EuroNCAP, which of necessity has to test vehicles selectively. Another argument in their favour was that they were less susceptible to bias than consumer tests and therefore fairer and more accurate. The Folksam insurance reports were singled out as a particularly useful resource:

“If the basis is real life safety in crashes like Folksam, I think that the validity of such a rating is much higher, as there is no assessment which in case of Euro NCAP is quite often subjective and not related/evaluated against real life safety.”

Practical booklets issued by the Department for Transport on subjects such as choosing and installing head restraints and child safety seats also drew praise for their “good, down-to-earth guidance for consumers.”

Others were more sceptical of their value and impact. It was said that they had a relatively low public profile and were of more interest to motor industry ‘insiders’, whether researchers or manufacturers, than to the average consumer. One respondent felt that “Choosing Safety”, in particular, was disadvantaged by its status as a government publication since many potential readers would perceive it as boring or at least as less dynamic and interesting than the reports of consumer organisations. Consequently, rather than trying to devise a more consumer-friendly image for its reports, the government might be better advised to use consumer groups to get its message across.
Some expressed doubts about the accuracy of the data contained in the various accident-based publications but a more fundamental problem was seen to lie in the retrospective nature of their reports, which meant that they were analysing the performance of cars within the existing fleet rather than influencing the nature of that fleet by assessing vehicles prospectively. As one industry respondent noted, it was difficult to use such information:

“The difficulty with the retrospective rating systems is it is very hard for manufacturers to know how to respond to them, so if you have got two vehicles one that seemed to be good in an insurance rating and one that seemed to be bad, you normally don’t know why, by the time you have got enough data to come to a conclusion, the vehicle is long out of production and it’s replacement or it’s replacement’s replacement is the vehicle you are currently working on, so although it is useful information for measuring progress it is not very useful for guiding future design, so we have probably been less affected by those types of ratings than we have by the predicted ones which are either crash testing programmes or the expert assessment carried out by organisations like Which.”

Even within the second hand car market, retrospective ratings were seen to carry little weight:

“…A real problem I think this: that something like half the cars are bought as fleet cars. So you have got to influence those new car purchases because that defines the fleet for the rest of us who buy second hand cars. If the fleet is absolutely full of bad cars they are going to influence casualties so it has got to be the purchase of new cars and the industry has to feel a vulnerability in producing a bad new car and you cannot induce that feeling of vulnerability in them by studying accident data.”

The same respondent went on to say that it was nonetheless critically important to undertake accident studies to check the validity of test-based predictions of vehicle accident performance.
The potential of EuroNCAP in achieving further improvements in crashworthiness

While there was general agreement about the benefits so far delivered by EuroNCAP for vehicle safety and a shared belief that it should continue, the interviewees offered a range of different perspectives on its future priorities and mode of operation. These included:

- EuroNCAP should in effect be incorporated into the regulations so that manufacturers should be forced to have a EuroNCAP assessment before selling their cars.
- The star ratings system should separate crashworthiness from other factors, such as ergonomics, the latter including such things as warning systems for occupants to fasten belts. The effectiveness of crashworthiness and the restraint systems should be separately tested because of the forces on different sizes, ages and gender of occupants.
- Rollover and rear impact should be included in the tests.
- The impact on older children and adults in rear seats should be looked at separately from child restraints.
- There should be a stronger emphasis on aspects of secondary safety that are still not properly covered, such as compatibility, whiplash and vulnerable adults.
- There should be more experimentation with virtual testing, particularly in relation to pedestrian safety.

There was a plea that, given the significance of EuroNCAP in improving safety, government should look to sustaining and improving its funding for research and that a similar commitment should be sought from the European Commission.

Some respondents felt that EuroNCAP was approaching a crossroads in terms of deciding whether to continue to develop secondary safety standards as its first priority or to divert resources into primary safety. Although some
important aspects of secondary safety remained to be tackled effectively, notably compatibility and pedestrian protection, it was felt that returns from EuroNCAP testing would almost certainly diminish in the future as acceptable common standards for secondary safety were reached. This risked making the requirements of EuroNCAP routine and predictable for the industry, with the consequence that they would cease to drive design.

Although the promotion of primary safety was seen as a possible new departure for EuroNCAP, some felt that this would play to the preferred marketing strategies of the industry – “they absolutely love all that stuff, brakes and gismos and electronic Houdinis and lighting”) - without bringing demonstrable safety benefits. In particular, primary safety improvements were thought likely to increase risk compensation on the part of drivers, thus increasing the dangers faced by other vehicle and road users.

The burden for industry to achieve good ratings in EuroNCAP

Very little information was obtained from the interviews about the unit costs of producing vehicles that would achieve good ratings in EuroNCAP. One industry representative volunteered a figure of 300-400 euros per vehicle for his company but this was the only specific estimate on offer. Another said that the initial cost of a new engineering solution could be high - the example given was a £1000 starting cost per unit for his company in developing an innovative bonnet designed to achieve good ratings on the EuroNCAP pedestrian protection test – but acknowledged that this would diminish sharply once it was incorporated into the standard manufacturing process.

Although financial information was in short supply, the manufacturers evidently experienced the requirements of EuroNCAP as burdensome. A major issue for them was the unpredictability of the EuroNCAP test requirements and, linked to this, the short lead times allowed to manufacturers for anticipating these requirements.
One industry representative complained about the difficulties of budgeting for changing requirements that were often, in his view, hardly safety related. He explained that once the car was “benchmarked”, a two-year period ensued during which it was developed and evaluated and a sales campaign launched:

“You don’t expect anything to go further because the product should be good enough if you do it like that. But if six months before it enters the market the requirement is popping up, everybody is rushing and maybe trying to improve the car is a huge investment and it is maybe not really improving very much.”

Another manufacturer spoke of the difficulty and expense of adapting vehicles to new test requirements when they were part of a running series. It looked for stable, objective lead times that would enable it to build the test requirements into the design from the very beginning. Someone else said that the very short and sometimes negative lead times allowed by EuroNCAP led to inefficiencies for manufacturers that diminished the effectiveness of their safety investments. Whereas the regulatory process was reasonably well-defined and easy to plan for, EuroNCAP was seen to be:

“…a maverick organisation which can change direction very quickly, can delay making decisions for a very long time and make them rapidly with retrospective effect. Those sorts of things have a very serious effect on the way manufacturers can respond to them; it doesn’t bring the best out in what we are capable of doing.”

The subjective and fluid nature of the EuroNCAP test requirements was a particular bone of contention for the manufacturers. It was said that however carefully a car had been designed to meet a requirement, there remained a considerable element of uncertainty in the assessment process, with the consequent risk that the car could be marked down in the final vehicle assessment and points withheld. This was felt to be both unfair and wasteful of time and resources.

The relevance of EuroNCAP test requirements to real world safety was raised several times by the manufacturers’ representatives. One company complained that although its cars already had an excellent record for
protecting drivers and occupants against knee injuries, it was being forced to introduce new knee airbags at a cost of 100 euros per car in order to meet EuroNCAP requirements – money it felt could have been better spent on other safety improvements. The same company remarked that EuroNCAP assessments were quite narrowly focused and sometimes did not recognise safety features that manufacturers had already incorporated into their designs. The example given was a 'child present orientation detection system' that had been installed in the passenger seat of all its cars but whose future was now being questioned by management because EuroNCAP did not take account of it in the assessment process.

A more specific issue was the extra cost to manufacturers of carrying out all testing related to EuroNCAP at independently accredited laboratories. It was suggested that where supporting test data was required to justify EuroNCAP’s conclusions, it should be acceptable for manufacturers to present that data from in-house tests, often carried out in superb conditions. As it was, manufacturers with 'state-of-the-art' testing facilities were being required to duplicate their own testing or to use outside laboratories for pre-testing at considerable expense to themselves.

Outside the sub-group of industry representatives there was scant sympathy for any burdens imposed upon manufacturers by the EuroNCAP tests. One research expert, closely involved in the setting up of the programme, acknowledged that the costs to manufacturers had never been worked out at the EuroNCAP end:

“I think we put it round the other way: 'What is the burden on pedestrians if we haven’t improved these cars, how many people have died?', so we weren’t very interested in what the cost was to industry. That was not an issue to us. The thing is these are the things they should have been doing.”

Another pointed out that, in contrast to the regulations, EuroNCAP was very much a voluntary scheme and that manufacturers had a choice about how much to spend to improve their vehicles beyond the minimum safety levels.
Furthermore, they were unlikely to make a significant investment unless they were confident that they would be compensated by extra sales and/or higher prices for their vehicles.

Other respondents acknowledged that, despite its voluntary nature, EuroNCAP had effectively locked the manufacturers into a competitive battle for top ratings. (Indeed, one major manufacturer in the interview group spoke of “being forced to reach five stars.” Whether this involved an additional burden on the industry was, however, a matter of debate. One view was that for companies already meeting the regulations the extra costs of performing well in EuroNCAP were minimal compared to the benefits they were likely to receive from top ratings, especially where the test requirements could be incorporated from scratch into the design of new models. Against this, it was said that while EuroNCAP had involved significant extra investment on the part of manufacturers, for example where technical barriers had to be overcome or major changes made to the styling of a vehicle, this investment should be evaluated in terms of overall safety improvements for the vehicle user rather than against a company’s profits. Similarly, although the costs of pushing a vehicle up to a five star rating could be heavy, the process frequently brought rapid safety gains because the timescales of EuroNCAP required the manufacturer to address and rectify a fault within a defined six-month window.

For a safety expert from the consumer sector, the additional investment stimulated by the striving for safety ratings was a cause for celebration since it was evidence that EuroNCAP had succeeded in spreading sophisticated safety technology throughout the vehicle fleet and across Europe far more quickly and efficiently than could have been achieved by the regulations alone:
“The extraordinary thing that EuroNCAP has achieved is that it used to be acceptable that a) it was only the expensive cars that had the safety kit on and b) if you were selling that same car in Greece no one needed the kit, but now EuroNCAP is saying that a life in Greece is as important as a life in the UK and the life of someone in a small car is just as important – so don’t tell us that safety is only available if you have got £20,000 to spend.”

5.2 Part 2: Process

5.2.1 The Regulations

The driving forces behind the introduction of the front and side impact regulations

The accounts given by the interviewees show that the process leading up to the introduction of the front and side impact legislation was highly complex and extended over many years. It was widely accepted that the technical knowledge required to frame the regulations was available long in advance of their actual appearance and that their timing and content were crucially shaped by political pressures and negotiations between manufacturers, national governments and European institutions. The main driving forces behind the regulations can perhaps be seen as inter-connecting strands of influence. The following analysis seeks to identify these different strands and also to demonstrate the interplay between them. It should be read in conjunction with the timeline analysis in Appendix 2.

**Technical research and crash testing**

Technical research into key aspects of occupant safety, notably seat belt restraint systems, frontal impact protection, side impact protection and dummy improvements, was identified as a primary driving force, providing the detailed knowledge of crashworthiness that was critical to the sound formulation of the front and side impact regulations. Whole car crash testing was integral to this research and the UK government was acknowledged as a leader in this field because of the work undertaken in TRL from 1980 onwards. The importance of pioneering work undertaken in Germany by the consumer organisation ADAC and the German magazine Automotor und Sport in the late 1980s was
also noted by some respondents because of its introduction of more systematic test procedures and its effect both in increasing awareness of safety and in raising the temperature of debate about which kinds of tests were appropriate.

Certain manufacturers considered that their own internal testing procedures had made an important early contribution; for example, a particular manufacturing group had made conference presentations based upon tests undertaken in their own laboratories and, given that its products were designed for a global market, had had to deal with the requirements of crash testing in the United States some time before such tests were required in Europe. Commenting on the Swedish car industry, another respondent noted that considerable technical knowledge existed among manufacturers long before the introduction of the regulations, although not all considered the maximisation of safety to be financially viable.

“…they clearly had the insight, they had the accident research teams, they know about the problem, but again you have to be competitive and you sort of balance all the time what can I introduce? How much weight penalty will there be? Can I actually raise the price and get my money back, and so on, so it is always a balancing act there and so I would say that the awareness was probably there for maybe 5-10 years and then some manufactures decided to do things even if there were not a regulation, and some manufacturers did not.”

Developing the correct tools to undertake tests that would provide a realistic simulation of real world accidents was identified as an important and difficult aspect of the technical research. The prior UNECE Regulation 12 for frontal impact protection, which was adopted on a voluntary basis by national governments, was based upon the crashing of cars head on into a rigid concrete barrier. This was derived from US testing standards for both frontal and side impact involving rigid flat barrier testing with 100% overlap. Emerging accident data alerted researchers at the TRL and elsewhere in Europe that the levels of intrusion being experienced in real world front impact crashes were not being replicated in the laboratory tests, leading them to question the appropriateness of the existing barrier. A rigid offset barrier and an angled
barrier were variously proposed as better alternatives, and a number of car-to-
car and barrier tests were accordingly carried out at the TRL. Further work on
frontal impact was put on hold in the UK until the effects of introducing seat
belt legislation could be gauged and European research priorities shifted
towards side impact protection. When it was resumed in the early 1990s as
part of a research programme on frontal impact co-ordinated by the European
Experimental Vehicle Committee (EEVC), attention once again focused upon
the nature of the barrier. The official in charge of the TRL crashworthiness
research programme at the time described the mixture of intuition and careful
investigation that informed the decision to develop a barrier that was offset
and deformable.

“…basically I did a crash test and it didn’t look like an accident at all,
and I did the first deformable one using the American side impact
barrier because that seemed as though it would take the load and I just
thought ‘Crikey that looks good!’”

However, at this early stage little was known about the reasons for the
superior performance of a deformable barrier in replicating real world crashes,
and considerable work was required to develop the requisite technical
understanding. A further challenge was to create a barrier that would offer the
necessary consistency of performance and therefore repeatability of results
from crash to crash. TRL researchers at first considered adapting an early
deformable barrier face made from polyurethane foam that had been
developed by European car manufacturers for side impact tests, but this was
subsequently rejected because of the problems associated with CFC
emissions. A lightweight version of an aluminium honeycomb material used in
aeroplane structures eventually provided a solution.

Despite the deficiencies of available tests and tools, frontal impact research
benefited from an existing knowledge base. In contrast, very little work had
been carried out on side impact protection when it was taken up by the TRL
and Birmingham University in an in-depth accident research project between
1978-81, the results informing the work of the EEVC from 1982-88 to develop
a standardised test procedure. No injury criteria or tolerance data were
available and the necessary tools had to be built from scratch. In particular, there was the challenge of creating a suitable dummy:

“...with frontal impact we had a dummy we could use. There was much less disagreement about hybrid III - it was a modern dummy at the time. You could work on the crash test speed or the configuration, these were areas of disagreement, or the barrier type, these were technical issues to be resolved. But in side impact we had those technical issues and also there was no dummy that was properly suitable. There were experimental dummies.”

However, in the opinion of one expert, the priority given from the outset to the development of EuroSID, the side impact dummy, diverted attention from the construction of the barrier, with the result that the final efficacy of the test was undermined:

“When I was involved I was given a relatively trivial task it seemed to them, sorting out the barrier face. What I was starting to do was to find out that this was very, very important and had a very big effect, and it showed that all the way through the very earliest stages of specifying it was all wrong, but you couldn’t change all of that. So it has always been the poor relation, the dummy was, the criteria for the dummy was the thing and the barrier was a bit of low level engineering. But actually what affects the barrier face was much more important.”

Technical research for frontal and side impact protection ventured into territory that was largely unexplored before the 1980’s, involving a rapid expansion of knowledge and practice from a very limited base. Although it was often highly experimental in nature and marked by disagreement about priorities, the testimony of close observers suggests that it succeeded in developing robust recommendations about what was needed and what was possible in terms of front and side impact protection. These provided a vital reference point during the highly politicised process through which the regulations were subsequently debated and put into effect.
The influence of individuals

“At the time there happened to be certain individuals in certain positions and they had a certain view which was very pro safety, who made it happen.”

A point repeatedly made by those who were closely involved in the formulation of the regulations was that they were driven by the personal and professional commitment of individuals. These individuals were variously to be found in research, consumer and government institutions, both national and European. Typically they came from the UK, the Netherlands and Sweden where strong safety cultures were already established. They held in common a passionate concern to improve vehicle safety and frequently pursued this agenda in the face of inertia or even active opposition from within their own organisations. They tended to know each other from collaborative work, conferences and meetings and in effect formed a pro-safety interest group that cut across established networks.

The TRL, at that time based within the UK’s Department for Transport, was singled out by several respondents as providing a particularly sympathetic environment for safety champions. Lead researchers within the test team were accustomed to initiating research on safety issues and had the freedom to spend money to develop a research programme, provided that they could convince the department of the usefulness of their ideas. They recalled that the Department was prepared to pick up and support issues arising from research and place them within the political agenda, even in those areas such as frontal impact where scepticism and a degree of opposition had been expressed at first. Among the researchers who had been most closely involved with the TRL programme leading up to the front and side impact regulations, there was a belief that this ethos was specific to that time and that the subsequent contracting out of the TRL along with changing patterns of financial control and policy initiation within the Department meant that it was no longer possible for research to drive UK policy:
“I don’t think the things I have done on frontal impact, side impact will ever occur again now in this present, in the way they are subcontracting, contracting out. I started this thing as a one man band, me and a test team… I was incredibly fortunate in that unlike lots of other people I had ideas and people either could not stop me spending money or they gave me money to do it, they may not always have wanted me to do it but they did do it and I was able to do that in a way that I don’t think would happen now”.

The critical influence of individuals within the legislative process also emerges from the accounts of those closely involved at the time. One such individual was the President of the FIA, a convert to the safety camp following the death of Ayrton Senna, who put himself and his organisation firmly behind the improvements advocated by members of the UK Department for Transport and other international safety experts. His role was said to have been central in lobbying the European Parliament to reject the Commission’s original draft directives on front and side impact, much weakened in their progress through the Commission by pressure from the industry. Another important player at this late stage was a British MEP who approached TTS and offered, in his role as rapporteur, to put forward amendments to the Commission’s proposals. A member of the TTS team at the time remembered producing around 40 pages of highly specialized technical amendments in a week, “putting in the drafts that the UK had pressed for about 15 years and the EEVC and European (Commission) resisted”. The rapporteur duly presented the amendments, giving the Commission the choice to accept them or to withdraw the proposal. It chose to accept them and thus the safety lobby was able to outflank its opponents at a late stage in the legislative process.

*Real world accident data*

While the analysis of real world accident data had begun at the Medical University of Hanover and the Birmingham University Accident Research Unit in the late 1960’s and 1970’s, it was the establishment in 1983 of the CCIS as a joint initiative between Birmingham and Loughborough Universities, the Department for Transport and the motor industry that was considered by several respondents to have injected an urgency into the safety agenda by demonstrating a level of personal catastrophe and cost to society that was
simply not politically acceptable. It influenced the work undertaken in research laboratories by identifying front and side impact as the two biggest clusters of risk of killed and seriously injured car occupants and it placed vehicle safety squarely in the political arena in a way that could not have been achieved by laboratory testing alone. Vital ammunition was provided to interest groups campaigning on vehicle safety:

“Research from real world data supported research groups, governments (UK and Sweden in particular) and NGOs such as ETSC in campaigning for appropriate regulations – the problem couldn’t be ignored any longer.”

From the testimony of the respondents, it seems clear that real world data and technical research interacted to give a powerful impetus to the political process that led to the formulation of the regulations.

**European co-operation**

Respondents offered different paradigms to describe the process by which the front and side impact regulations were formulated and put into effect. Some believed in a cycle of discrete stages whereby research was followed by testing, which led to recommendations that required further research, and so on. Others saw the process as much less defined and linear, one respondent comparing it to the turning of a dial on a radio, moving backwards and forwards in response to changing conditions.

Whatever the model used, there was general agreement that co-operative effort across European countries was an indispensable pre-condition for successful implementation. This effort was evident at a number of levels and settings. The development of the European Union in itself provided new opportunities for devising and enforcing harmonised safety standards across its member countries:
“...This is my personal view, that the European Union created the possibility to put a pressure on the industry and come up with these regulations and enforce them rather than in the old situation where there were so many political aspects from different manufactures so in my view the creation of European Union is probably the answer.”

At a different level, the EEVC provided a collaborative forum for research on the technical issues underpinning frontal and side impact. According to one member of the UK research community, the benefits of co-operating with European colleagues in the research phase rather than going it alone were considerable, not only in terms of focusing more research effort on the problem but also by enabling discussions and arguments to be pre-digested before reaching the regulatory stage. He also pointed out those efforts by the UK government to push through research recommendations unilaterally, for example in the context of motorcycle research and the steering wheel face form test, had been unsuccessful.

Non-governmental bodies such as the ETSC were commended for their role in bringing European interest groups together to raise awareness and drive action on vehicle safety. Created in the early 1990s out of a sense of frustration that vehicle safety harmonisation in Brussels and Geneva was not proceeding quickly enough, the ETSC launched a review of the impact of vehicle safety design upon traffic injuries, resulting in a 1993 report which demonstrated that vehicle safety standards were around 20 years behind the state of knowledge and identified priority needs based on UK and other international research:

“Basically ETSC co-ordinated the campaign for the most part in identifying what needed to be done, based on the ETSC’s and others research, in bringing together the technical briefing material. For example, VSRC’s stuff on side impact in terms of the ground clearance of the barrier.”
The policy agenda of national governments

It was agreed that national governments differed markedly in the extent to which they promoted vehicle safety in their own countries and in Europe. The UK and the Netherlands, with Sweden in a supporting role, were consistently described as safety advocates. Some respondents felt that the governments of France and Germany had also been a positive force in the safety debate, although a degree of ambivalence about safety was ascribed to them because of the close identification of the national interest with that of their indigenous car industries. The UK and the Netherlands, with their small and declining industries, were better able to establish safety as a priority. They could, moreover, build upon a public consensus already established in their countries about the benefits of regulation to promote safety. As a representative of the Dutch government pointed out, the European arena offered governments opportunities to better protect their populations by addressing vehicle safety issues that could not be tackled at a national level:

“At least for us in the Netherlands we were at that time working on a clear integrated safety programme where we defaulted a lot of attention and money to the improvement of the road network in particular at local and regional level and by that time we already had clear indications that behavioural policies would be required, a road improvement scheme alone would never get us to our targets of -25% fatalities in 2000. So for that reason we have always been very eager to look at additional measures at the supra-national level in the domain of motor vehicle policy”.

When asked to rate the UK contribution against that of other European governments as a driving force behind the front and side impact regulations, the majority of respondents described it as outstanding or important. The background technical work paid for by the Department for Transport and carried out at the TRL was recognised as having provided a sound scientific basis for the new safety proposals. Moreover, this had been complemented by a well-informed and determined political campaign in Europe, waged by those who were familiar with the intricacies of European political structures, to persuade others of the necessity for regulation.
Questions of timing

When asked about the reasons why regulation came in when it did, most respondents described a series of circumstances which triggered the process and made regulation both possible and necessary. They described the movement towards regulation more as a fitful evolution than a planned, linear development. Progress frequently stalled as competing interests fought over the detail of the proposals, and rival attempts to dominate the legislative process in Brussels kept the outcome balanced on a knife edge until the very last stages.

Nonetheless, certain factors emerge as highly influential. As noted earlier, the collection and analysis of accident data had been given a higher profile and influence through the setting up of the CCIS, whose findings were used to inform the whole vehicle crash testing programme at the TRL. Once the numbers of people killed and injured in accidents, running at around 6,000 per year in the mid-1980s, were made known to the public, the issue could no longer be ignored by governments.

Although considerably more work had been done historically on frontal impact and various regulations were already in place, there was a perceived need to evaluate the effect of seat belt legislation in the UK before moving towards European regulation. It was for this reason that side impact was taken up first by the EEVC. When attention turned once again to frontal impact, the context had changed in that most car occupants were now wearing seatbelts and it was decided that simply tweaking the existing regulations was not enough to make a significant difference:

“You couldn’t get a major improvement by tweaking any individual one but what you actually needed was a new frontal test with dummies on board and biomechanical requirements. So that’s what started off the idea that we needed to develop a more representative and realistic vehicle crash test with dummies on board.”

The efficiency with which the EEVC accomplished the technical work necessary to support recommendations for both front and side impact
regulations was attributed to its domination at the time by research experts in the field, with light representation from industry. One expert who was closely involved at the time judged that industry had made a serious miscalculation by focusing its attention upon the subsequent regulatory debate in the European Commission and Parliament, which it was confident of dominating, instead of ensuring that it had a handle on the background scientific work. Although this made the debate all the more stormy and contentious, those backing the proposed regulations had the advantage of thoroughly developed recommendations. The same respondent observed that the industry had learned from its errors in taking its eye off the EEVC and had since ensured, for example in the development of the pedestrian regulations, that it was closely involved in the research phase.

Some believed that the prior establishment of a regulatory regime in the US (and in other countries such as Australia) had provided an example and a spur to Europe. Various explanations were offered about why the US had acted much earlier on front and side impact regulation. Mention was made of the work of Ralph Nader in the 1960s and early 1970’s which “sent the snowball rolling down the hill”, raising public consciousness of safety issues much earlier than in Europe and preparing the ground for the regulation of vehicle design. Some pointed out that the US had not had to face the European problem of how to reconcile different national structures and interests: from the outset it had been able to put in place an integrated regulatory system managed by a dedicated agency, the National Highway Transport Safety Authority (NHTSA). The superior efficiency of the US system allowed regulations to be devised, put into effect and revised more quickly than in Europe but there were said to be some negative consequences. In particular, the requirement to demonstrate the effectiveness of a regulation through prior technical research was much less stringent, leading, it was said, to tests that simply did not mirror real accident conditions:
“I wouldn’t say that the regulations that they have brought in were better - they may have brought them in earlier; they certainly weren’t better. The fact that we took into account the research that TRL did for front and side impact meant that we had far better regulations than they had. Their front impact Regulation is just smashing the car into a solid block, we know that is not right.”

While acknowledging the important role played by the US in driving forward global standards, most respondents did not believe that US regulation on front and side impact had provided an appropriate model for regulation in Europe. Although the various European standards already in place were drawn from the US, there were serious questions about their technical basis and also their relevance to the European situation where vehicle fleets, road structures and approaches to seat belt legislation were so different. In formulating the front and side impact regulations, Europe needed to create a separate regulatory system attuned to its own distinctive circumstances.

The extent of industry opposition to the front and side impact regulations

There was a striking difference of perspective between the representatives of motor manufacturers and other respondents about the nature and extent of the industry’s opposition to the introduction of front and side impact regulations. The former insisted that the industry had been broadly supportive of the regulations because of its desire to see a basic safety standard for all vehicles, and that any disputes had centred on the technical correctness of the regulations rather than on the principle of standard setting. Certain manufacturers had been confident that they had already had the technical knowledge to meet the required safety standards and said that they had welcomed the enforcement of improved standards in the remainder of the fleet.

“I think at the time we didn’t really mind this becoming a regulation, because this, we felt, was …the basic level of safety that should be guaranteed for all vehicles and we really felt that it could make a difference in the entire vehicle fleet if everybody has to mind those requirements. We cover only a small percentage of the overall vehicle fleet, so it certainly does something to protect people’s lives.”
One of the research experts supported this version of the industry’s response to the regulations, remembering that there had not been a great deal of opposition, apart from “some fuss about the barrier height in the proposed side impact test.” It was, however, a version strongly disputed by other researchers and the remainder of the respondents in the interview group. What they described was a sustained, hostile and vociferous campaign by the industry, largely spearheaded by the European manufacturers’ body ACEA that resulted in a delay of up to a decade in the introduction of the regulations. They acknowledged that the campaign was directed more towards the detail of the regulations than the principle of their introduction but considered that this was a matter of paying lip service to regulation as a public relations necessity rather than a willingness to promote safety improvements.

The tactic of objecting to key elements of the regulatory proposals, such as the speed of the tests, the barrier used, the height of the barrier, and so on, with the aim of minimising the impact of the regulations upon the manufacturers, was said to have been highly effective in stalling progress:

“I don’t believe there is anything else that research is done on where there is such concerted effort to stop you. Let us take speed cameras or something. The public may not like it but they are not an organised group, there is not a big commercial activity of a load of major manufacturers coming together, spending large amounts of money to stop you doing what you want to do.”

Some respondents also remembered an excessive influence being exerted by industry within the various groups and committees that formulated the proposals, often with the naked support of national governments.

“…It is important to realise that the regulatory process is almost entirely dominated by industrial interest. So either directly by the industry, or by those governments who perceive themselves to be arguing in favour of their industry… and basically the idea is to prevent any change in legislation for as long as possible so they bring up as many technical smoke screens as possible. When change seems inevitable then, to make sure that change is as small as possible so that doesn’t influence your current production practice, and then if you have lost that paddle then to ensure you have massive lead times so that your current investment in plant isn’t adversely affected by any change in
regulations, and the whole regulatory process, time and time again, follows that pattern.”

National government manoeuvrings to support the industry position were said to have been most vigorous in those countries with large indigenous car industries, such as France and Germany, and least evident in those such as the UK where the industry was residual. Even in the latter, however, the manufacturers proved adept at exploiting the different perspectives of government departments for industry and transport, appealing to the former in order to modify the influence of the latter.

The effectiveness of the industry’s lobbying strategy was acknowledged even by those most critical of its intent. Many different channels were used to put forward its viewpoint, including media briefings, regular lunch-time meetings with European Commission members, involving a certain amount of “entertainment and flattery” along with pertinent discussion, and frequent representations to national governments. Such a well-resourced and coordinated approach could not be matched by competing interests, such as the European consumer groups. Much of the lobbying was conducted on the industry’s behalf by motor manufacturers’ organisations such as the Society of Motor Manufactures and Traders (SMMT) in the UK and ACEA in Europe, although the latter did not include the Japanese and Korean manufacturers, which had their own industry bodies. One representative of a European consumer organisation described ACEA as following a particularly negative line on safety legislation, right through to the present time, “promoting the lowest level of anything and sometimes not any level at all.” It was their view that ACEA had also tended to block the more progressive and constructive manufacturers who were sympathetic to improvements.

Whatever the disagreements between the manufacturers’ representatives and other respondents about the extent of the industry’s opposition to the regulations and the motives behind it, they concurred in their recollection of the main sticking points in the formulation of the regulations. These were technical in nature, centring on the tools and procedures that were being
proposed for the tests, largely on the basis of the work that had been carried out by the TRL in the UK.

**Crash testing versus computer simulation for side impact crashes**
A computer-controlled test procedure (CCTP) involving computer modelling to simulate the effects of side impact crashes was funded by the industry and proposed as an alternative to real-life crash testing. Non-industry researchers among the respondents had dismissed it from the outset, one describing it as "*complete nonsense*" which "*took forever to do*". Although eventually abandoned, it was the cause of considerable delay.

**The nature of the barrier for frontal impact crash testing**
As described above, the offset deformable barrier had been developed by TRL in response to the poor performance of rigid barriers in simulating the kinds of intrusion that were experienced in real world crashes. It was, however, strongly resisted by the industry, and the accounts of those who were closely involved in discussions at the time suggest something of a competition of ideas for the most appropriate barrier. Industry representatives put forward a proposal to the Global Road Safety Partnership’s (GRSP) group on passive safety for a 30 degree angled barrier test with an anti-slide device as an alternative to the offset deformable barrier. Researchers from TRL had been convinced by evidence from their own work in the 1970’s that a rigid angled barrier was ineffective because vehicles could slide off it. When the GRSP decided to support the industry’s recommendation against the advice of TRL representatives, the latter decided to run a series of tests on the anti-slide device and succeeded in demonstrating that the test could be beaten by fixing a pedestrian bumper to the barrier. This was critical in ensuring acceptance for the offset deformable barrier in the crash-testing regime adopted for the regulations.

The barrier debate was also said to illustrate the industry’s tactic of proposing a two-stage process for regulatory reform, the first stage (e.g. the angled barrier proposal) involving minimum impact upon the industry in terms of investment and redesign while the second stage (e.g. the offset deformable
barrier) was presented as a goal to be worked towards at some future date. According to critics outside the industry, the objective was to ensure acceptance of the first stage proposal, with the expectation that the second stage would be quietly dropped. As noted earlier, it was the FIA intervention in the European Parliament that ensured that the second stage proposal for frontal impact was actually pushed through.

**The height of the side impact barrier**
The correct height of the side impact barrier proved to be one of the most contentious and bitterly fought issues. The TRL research had indicated a height of 300mm in order to replicate the collision of the front of a vehicle with the ‘softer’ side structures. Analysis of the CCIS database carried out by the VSRC supported these findings. The industry was arguing for a lower barrier height of 260mm, which, according to TRL, would undermine the test fatally, since the collision would be directed towards the sill, the stiffest element of the vehicle side, and would not replicate any threat to the main compartment. One researcher remembered stalling tactics being deployed by the industry right to the last moment:

“I remember meeting in 1994 when we were just presenting the final EEVC Side Impact Regulation and the French said, “Yes, Yes, we just want two tiny changes and we’ll agree with it”. But the two tiny changes were to reduce the size of the side impact sledge to hit the sill and not miss the sill, which would have completely destroyed the effect of the Regulation, and reduced it to being useless.”

**The speed of the tests**
The speed of the tests emerges from the respondents’ accounts as an issue about which there was a difference of opinion between the industry and external safety professionals but which was not as bitterly contested as the nature and height of the crash barriers. It appears that the industry continuously advocated a lower test speed than that advocated by the TRL research, and some felt that its principal aim was to make the test as benign as possible for the manufacturers rather than to maximise safety for the occupant:
“...the speed was wrong, I mean it was 30 miles per hour when it should have been 40 miles and hour. So all the way through they managed to just bring it down all the time to the lowest common denominator.”

Looking back at the protracted debate about the detail of the regulations, two respondents considered that there had been merit in delaying the implementation of the regulations. One was a European government representative, the other a vehicle safety expert within the industry. The former said that the manipulation of the time-frame had been helpful in easing conflicts of interest by allowing manufacturers more time to prepare for the introduction of the new standard. He also felt that it had enabled alliances to be formed between the main proponents of the regulations and sub-groups within the industry who were committed to the safety agenda. Pursuing a more technical point, the industry expert believed that the delay had helped to bring about an improvement in the quality of the frontal test by allowing it to be designed more specifically for the Hybrid III dummy. A third respondent, with both government and industrial experience, did not believe that the delay had been justified but conceded that the additional research undertaken because of industry’s complaints had brought about some enhancements, particularly to the side impact dummy EuroSID and the barrier.

In strong contrast, most respondents could not identify any benefit from the late implementation and several expressed themselves forcefully on the subject, pointing to the large numbers of unnecessary deaths and injuries that had followed:

“It was disgraceful the way it was delayed, quite disgraceful.”

“My view is that it was a totally wasted opportunity in the way it was delayed. Many lives could have been saved by bringing it in 2 or 3 years earlier I’m sure.”

While most blamed the sustained use by manufacturers of stalling tactics and negative lobbying, one observer pointed out that the power of industry had
been amplified by the unbalanced nature of the decision-taking process in the European arena:

“You have the first step when you get the scientists who work for EEVC going to Geneva many times for EC regulation then they go to Brussels for the application for Europe. After that the scientists are not involved anymore and the views of industry become stronger. That delayed the decision. For me, the delay is partly due to the process of decision taking which does not involve the scientific bias at the time the decision is taken.”

Opinions differed about the extent to which industry opposition had resulted in modifications to the front and side impact regulations. One view was that although the views of industry had been taken into account at every stage, the regulations had emerged remarkably unscathed from the legislative process. In particular, the original EEVC recommendations regarding the nature of the barrier for frontal impact and its height for side impact, had been rescued by the intervention of the FIA in the European Parliament. Others felt that there had been significant compromises, particularly in the speed of the tests, and that the opposition of industry had exercised a generally conservative influence. There had been an implicit acceptance, in their view, of the industry’s claim that the regulations were pushing it to the outer limits of its technical capacity whereas, in reality, certain manufacturers had already surpassed the requirements of the regulatory tests and EuroNCAP was subsequently to demonstrate that most were capable of achieving more demanding standards:

“The classic example of that is the way that the frontal impact regulations were watered down. When we could have had a 64 kph, it was watered down to 56 kph…. It was all based upon what was realistic to do in the short term and it’s been shown that reg. 94 is really completely outmoded now because manufacturers aim for good EuroNCAP performance of 64 kph. It was obtainable.”

When asked whether the introduction of the regulations could have been managed differently, a few respondents pointed to changes in approach that could have made the process less contentious and more firmly centred upon the consumer interest. One said that the European Commission had been too
weak in standing up for the people of Europe against the interests of the motor industry and could have pushed the regulations forward more vigorously. Two others, both industry representatives, felt that the introduction of public hearings along the lines of those used in the United States, would make the process more transparent and identify the costs and benefits of safety improvements more clearly. Another industry respondent advocated closer cooperation and discussion between the authorities and industry at a much earlier stage in the process of formulating regulations, and expressed concern that the greater responsibilities now vested in the European Commission and Parliament gave greater weight to the political rather than to the technical end of the debate.

On the whole, however, the respondents expressed a pragmatic resignation about the difficulties of enacting legislation in the European arena because of the complexity of the structures and the powerful interest groups involved:

“I think the answer is the system is there because of the way it is set up within Europe and you will never ever change it. You have these huge motor vehicle working groups when you have probably upward of 50 people in the room all with the chance to say something, you have the industry you have the consumers you have governments and you have governments that support the industry and you have governments who want the safety for people on the road, and the whole thing is a big sort of shouting match and the lowest possible common denominator comes out of it.”

The point was also made that industry will always see its first duty as maximising its profits for its shareholders and will resist improvements that add to its costs unless they create a market advantage. This was said to be the definitive case for strong leadership from government in bringing forward vehicle safety legislation.
5.2.2 EuroNCAP

The driving forces behind the introduction of EuroNCAP
The accounts given by the interviewees indicate that EuroNCAP gained its initial impetus from the fraught and difficult process of introducing the front and side impact regulations, leading safety champions to look to consumer testing as a potentially more effective route for achieving improvements in crashworthiness. Once again, individuals within research and government played a decisive role in formulating the new initiative while the backing for it, necessary to become a truly European initiative, came from national governments, consumer bodies and from within the European Commission. Existing consumer testing models were important in demonstrating the viability of the new approach in promoting safety.

Exasperation with the regulatory process
A sense of exasperation with the regulatory process pervades the recollections of those respondents who were involved at the time as representatives of what might loosely be called the 'safety lobby': government, research and consumer organisations with a mission to improve safety for car occupants. From their perspective, the process had been marked by illegitimate objections from industry, lengthy and unnecessary delays in bringing the regulations forward, compromises made on key requirements and weakness on the part of the European Commission in protecting the public interest. There was a consequent disillusionment with the potential of regulation for maximising safety, leading some of the key players who had been most active in pursuing regulation to consider an alternative route for achieving their goals. For the UK Department for Transport, which had supported the pioneering crash-testing programme by the TRL, it was time to take stock:

“We alighted on this idea, well it was a sense of frustration on how crash working standards were developing in the late eighties early nineties and from that frustration grew out the idea of doing something serious about consumer information as a way of driving crash
worthiness standards forward in parallel and perhaps to overtake what we were doing in a legislative way. I think that was at the time not identified as a particularly conscious policy decision but it was something that happened and sent us off in another policy direction.”

**Individual champions**

Several of the same individuals who had been instrumental in pushing for regulation now became active in promoting consumer testing as another and possibly quicker means to achieving improved safety. Frustration with the regulatory process was running particularly high among key players within the TRL who had experienced opposition at every turn from the motor industry during discussions in Europe. Moreover, TRL had effectively completed its research on front and side impact and was ready to move in a new direction. Compatibility had already been agreed as a new theme, and an NCAP proposal was floated rather speculatively as an additional element;

So I got to the end of one week, Friday night 5 o’clock and I thought now might be an appropriate time to put my bit together for my compatibility work… I did that and then afterward I sort of thought well that isn’t really enough necessarily to keep the thing going. Is there something else I could do? And of course (his predecessor) had tried to start up an NCAP programme shortly after the Americans had done it. His problem was he had to devise test procedures and things like that… I sort of thought well I wonder whether we could start it now. I’d always fancied the idea of doing it and I thought the big stumbling block was the test procedures and justification. I thought, “We’ve got them, the frontal, side and pedestrian, all on a plate, all developed by EEVC”

This account is striking because of the nature of the initial proposal but perhaps the more crucial point is that this was embedded in the research that had already been undertaken under the aegis of the EEVC for the front and side impact regulations, enabling the new programme to be built upon agreed testing regimes.

Support from individuals within the European arena was also described as influential in assisting the evolution of UKNCAP into EuroNCAP. The President of FIA, who had played a critical role in the final stages of the regulatory process, offered his backing to the new organisation as its first Chair, and two individuals (one British and one Dutch) from the Directorate-
General for Transport (DG7)/ Directorate-General for Transport and Energy (DG TREN) within the European Commission were highly supportive, helping to give it a Commission stamp.

**Existing consumer testing models**

Those seeking to develop consumer testing as an alternative or complement to regulation were able to refine their ideas by examining a number of existing approaches, among which USNCAP, established in the United States in the mid-1970s, was the earliest and probably the most influential. USNCAP showed how an independent testing regime could provide meaningful information to consumers on car crashworthiness, enabling them to rate one vehicle against another. It used the tests that had been developed for regulatory purposes but increased the speed by five miles per hour and, instead of expressing performance in terms of pass/fail, indicated through a system of star ratings by how much each car had exceeded this new threshold. Thus it simultaneously raised the minimum performance standard and introduced a new competitive dynamic into the process. Although EuroNCAP was to differ significantly from its US counterpart in its detailed operation, these two elements were recognisably the same.

Respondents pointed to several other crashworthiness information initiatives that gave weight to the emerging consumer testing proposals. These variously involved whole car crash testing, accident data analysis and inspection based approaches. Among the former was a 64kph offset barrier test carried out by the Insurance Institute for Highway Safety (IIHS) in the United States and a series of tests undertaken in Germany by ADAC and Automotor and Sport magazine. Accident analysis reports, such as those produced by the Folksam insurance organisation in Sweden and by the UK’s Department for Transport, using its STATS19 data, offered a comparative retrospective analysis of vehicle performance in real world crashes. And at the beginning of the 1990s, the Consumers Association in the UK developed an inspection-based approach for rating safety features, such as head restraints and safety belts, using a points system when publishing their results. A common thread running
through all these initiatives was a comparative assessment of identified vehicles using a simple rating method:

“So in the space of about 5 years you have got three different measures. You have got the basic question we feel the consumer ought to know which cars are safest and which are the least safe.”

The consumer testing approach was also given weight by the backing of European consumer organisations, notably the ETSC, BEUC and AIT.

National governments

The UK government was widely credited with having initiated EuroNCAP through its support for the UKNCAP research programme at the TRL, followed by its political orchestration of cross-national support for an expanded European programme. When asked how they rated the UK’s contribution to EuroNCAP, virtually all the respondents said that it had been indispensable and that EuroNCAP would not have come into existence without UK government backing. The continuing involvement of the UK in guiding the development of the programme and keeping it on a firmly research-based path, was also highlighted. It was recognised at the same time that the UK could not have launched EuroNCAP without the support of other governments. Sweden and the Netherlands were repeatedly identified as early allies: together with the FIA, they quickly transformed EuroNCAP into a multi-national initiative that was a force to be reckoned with, seen to be drawing support from governments and powerful motoring interest groups.

The International Research Council on the Biomechanics of Impacts (IRCOBI) also provided a useful opportunity for promoting EuroNCAP. Responsibility for developing the new European programme was vested in the EEVC, and this was once again an astute political move, as one of the key players at TRL at the time recalled:
“Why did we do things in the EEVC and not do them ourselves, because if you actually look at most of these things, the UK DfT paid for most of it and did most of the work at TRL. So why didn’t we just do it at TRL and be done with it? Because you’d get the “not invented here” syndrome. Basically we did it within the EEVC and tried to bring all the rest of Europe along with us. Basically it was an EEVC thing and not a UK thing.”

DG7/ DGTREN within the European Commission
Support from key individuals within DG7/DGTREN of the European Commission has already been noted. This was seen as highly significant within the politics of the Commission in counteracting the influence of the Directorate-General for Trade and Industry (DG3), which was said to be strongly influenced by the industry and opposed to either regulations or consumer initiatives that would prove costly to manufacturers. Proactive lobbying by DG7 succeeded in persuading the Commission to get on board and provide funding for EuroNCAP

The extent of industry opposition to EuroNCAP
Almost all respondents agreed that individual manufacturers and bodies representing the industry had been hostile towards EuroNCAP at the outset. Just three dissented from this view: one representative of a Japanese manufacturer who said that his company had not taken a position on EuroNCAP because of its low profile in Europe at the time, and two others who felt that industry had not been given any choice but to support it.

The recollections of the majority, however, suggest a ferocity and intensity of opposition exceeding even that engendered by the regulations. The ‘name and shame’ approach intrinsic to consumer-based testing was said to have been a central issue for manufacturers who were fearful of their products being exposed as unsafe or less safe than those of their competitors. Previous consumer ratings developed in Europe, notably by ADAC and Automotor and Sport, had been based upon physical parameters whereas EuroNCAP introduced a subjective, inspection-based element which the industry distrusted. There was, moreover, said to be a widespread perception within the industry that EuroNCAP raised the bar impossibly high and that the
standards needed to obtain, for example, a four star rating were beyond the reach of current vehicle technology.

At its inception, EuroNCAP was a UK project, in effect an extension of DfT’s research programme. The fledgling UKNCAP soon found itself in confrontation with the SMMT, as the industry’s representative body for the UK, and also with the Department of Industry, which took the manufacturers’ line that consumer testing would be bad for the industry. Even at this early stage, however, there was said to have been a duality about the industry’s response: implacable opposition at one level coupled with a willingness to talk about the detail of the new approach. Someone who was at the DfT at the time and closely involved in the setting up of NCAP remembered this clearly from an early meeting:

“We had the first meeting with industry down at TRL…It was a meeting not to tell industry but to inform industry this is what we are doing, this is where we are. OK in the morning there was war but in the afternoon we started talking about items on the agenda.”

A former colleague also remembered being surprised that industry was taking the new initiative seriously, despite the UKNCAP being a rather late entrant into the field, following on the heels of consumer crash tests in Europe and NCAPs set up abroad. He concluded that the backing given by the UK government had been significant:

“The clear thing was that the industry saw that the credibility was much higher because it was a government department - the UK Department for Transport supporting NCAP. Not a magazine, not a motor club. It made all the difference, which we never foresaw.”

The early hints by the industry that it would consider the new proposals was coupled with a recognition on the Department’s side that overtures would be needed in order to overcome industry’s opposition:

“We did modify. We had to take note of what was being said in the right way in that we realised right at the early stage that we had to engage industry… If industry was going to ignore what we were trying to do or
to rubbish it all the time, then we wouldn’t have succeeded and we had to get industry coming along with us saying ‘OK that’s fair we will go away and try and do it.’ That’s important and it didn’t happen straight away.”

The support of the FIA, whose President agreed to chair the NCAP steering group, was identified as an important endorsement for the new project, further raising its profile within the industry. Opposition nonetheless continued to grow and intensify as UKNCAP was transformed into EuroNCAP at the end of its first year. The conflict with industry now began to be played out on a European stage, drawing in some of the most powerful European manufacturers. Those involved at the time recollected vitriolic meetings, threats on the part of manufacturers to sue EuroNCAP and, as during the regulatory discussions extensive and vigorous lobbying of national governments and European bodies, with complaints that EuroNCAP represented legislation by the back door. This time around, however, consumer organisations were involved as major players and, unlike some national governments, were not susceptible to pressure from the industry. Thus the balance of influence had shifted somewhat from that which prevailed during the regulatory debate.

The manufacturers’ representatives within the interview group had not been personally involved in the early discussions about EuroNCAP and it is therefore less easy to view this developmental phase from the industry’s perspective. They were aware, however, of issues of concern to the industry at the time, some of which remained unresolved. These included the higher test speed for cars (compared to that used for the regulations), the subjective rating system and the absence of weighting factors based upon accident research. It was clear that the exclusive reliance upon predictive crash testing as opposed to real world performance had continued to be troubling for some:

“The industry’s attitude in general was that it is overall safety that counts and you don’t know that until you have ten years of lifetime of the car when you have enough crashes and so on, so even if you don’t perform well in one situation you may be so much better in another and I think there were instances where some cars performed badly in EuroNCAP but came out very well in rating scales and things like that.”
The opposition to EuroNCAP was coordinated by ACEA and its national member groups but while ACEA, the public face of the industry, remained implacably hostile in the motor vehicle working groups in Brussels and elsewhere, individual manufacturers began to be won over. A respondent who was closely involved in the setting up of EuroNCAP recalled holding confidential meetings with every design team in Europe in which the objectives of the programme were carefully explained and guarantees of fair treatment given. He believed that a point was reached at which major manufacturers began to perceive the advantages of running with the programme as outweighing the disadvantages.

The public breaking of ranks by one manufacturer was said to be a defining moment in the early history of EuroNCAP, fatally undermining further opposition. One observer suggested that earlier resistance on the part of the French had been a pragmatic response to their lack of preparedness for the tests and that it was quickly dropped when the time was right for them to perform well:

*The French opposed and tried to lower the influence of EuroNCAP because they were not ready to reach a good rating. At the same time they prepared their new cars and then, when they were ready, they changed completely their position about EuroNCAP.*

Similarly, a safety expert who had worked with another manufacturer recalled that its initial opposition had been triggered by awareness that its cars had been engineered for performance and reliability rather than safety, and that it was unprepared for a safety-based assessment. A good performance in EuroNCAP demanded a change in the company’s policy and profile that had been difficult to accept at the time.

There was a consensus among the respondents that industry opposition to participation in EuroNCAP had since been overcome. Even if doubts remained on the part of some manufacturers about the validity of its approach, EuroNCAP had become too influential to be ignored and the risks of staying outside too great once competitors began to benefit from the ratings they had
achieved and, moreover, to use these ratings to improve their image with the public through advertising campaigns.

Looking back over the introduction of EuroNCAP, most respondents said that it had not been modified to meet the industry’s concerns. One reason given was that EuroNCAP was in essence an up-grading of the front and side impact regulations, which had already been subject to intensive discussion. Another was the power of the consumer organisations, which had enabled the proponents of the new programme to resist pressure from ACEA and SMMT. A third perspective was that a purist approach had been taken to the development of test and assessment protocols and that while there had been a degree of consultation with industry, there was little cooperative activity at that stage. Three respondents dissented from this majority view, two of whom had been part of the team at the DfT that set up EuroNCAP. They remembered a willingness to take on board reasonable objections and comments from the industry, although not blanket opposition on principle. “Touches on the tiller”, was how one person described it:

“I don’t think it has made any great difference to where we were going or what we wanted to do, but it is just a question of listening sensibly to what people are saying and sometimes say ‘Yes, perhaps we haven’t got that quite right we will just amend that’”

In both camps there were those who felt that the relationship between EuroNCAP and the industry had become more constructive and cooperative over time:

“I think in the beginning they were not so sure but as they found EuroNCAP to be effective and more quickly reactive, then they considered that they wanted to be involved to control these activities.”

But questions specifically directed at the manufacturers’ representatives elicited a lingering dissatisfaction about the extent to which their concerns were listened to. Specifically, there was a suggestion that some of the requirements introduced most recently did not bring a direct safety benefit and increased the risk of single point optimisation, thus compromising safety for some road users. More generally, resentment was expressed at the
assumption believed to be common among safety professionals that the industry was anti-safety and had little to contribute to the safety debate.

**The success of EuroNCAP in boosting industry performance, as compared to earlier consumer tests**

Respondents were asked whether EuroNCAP had exerted a greater pressure upon car manufacturers to improve their safety performance than earlier consumer tests, such as those conducted by ADAC and Automotor and Sport in Germany. Most agreed that EuroNCAP had indeed been more successful than its predecessors in engaging manufacturers in a search for good ratings once the initial threats of non-compliance had been overcome. Several reasons were given. The endorsement by the European Commission and the backing given by various national governments with a good pro-safety record were said to have established EuroNCAP as an independent and credible organisation:

“I think that gave it a lot more cachet for people to say ‘Not only have we got governments involved but also the Commission’ To sell it to people as being a responsible and well set up organisation was quite important.”

EuroNCAP was thus more difficult for manufacturers to ignore than the ADAC tests, which were seen to be a German rather than a European initiative and one which, moreover, was directed towards a selective membership rather than European consumers at large. There were also some doubts about the appropriateness of the ADAC tests to the European market and, according to one respondent, the extent to which the parameters of the tests were influenced by the major German manufacturers. EuroNCAP, by contrast, was not only seen to be independent of specific interest groups but also offered the industry a unified testing system, based upon the regulatory tests with which it was already required to comply and which had been the subject of extensive research and discussion. This simplified things considerably for manufacturers:
“There was their own growing awareness that it is better to have one EuroNCAP test than passing a test with every different automotive magazine in Europe which, at least, they were aware of as also being a kind of a burden.”

Although EuroNCAP had subsequently outpaced the regulations in some respects, the two were based upon the same test protocols, so that those manufacturers which sought to do well in the consumer testing programme were not presented with the dilemma of whether to design for one rather than the other.

Another factor generally agreed to have given EuroNCAP greater leverage over the industry than earlier consumer tests was its star rating system for individual vehicles. Initially highly controversial across the industry and the focus of almost universal opposition, it was said to have gained acceptance quickly among those manufacturers whose vehicles began to do well. Good ratings provided manufacturers with a valuable opportunity to distinguish themselves within a crowded marketplace and simultaneously improved safety for their customers:

“They like it when they get five stars, as you know one manufacturer have made a big thing of it, they have got a huge advertising campaign, I would think they would thank EuroNCAP for its position in the market today, where they sell everything with the EuroNCAP slogan on it, and they have made a huge amount of money because they have played the game the way they wanted to - and to our benefit, because their cars are safer.”

Some believed that obstructive tactics deployed by industry at the outset were inspired principally by manufacturers’ fears of poor ratings and their desire to slow down the process in order to give themselves time to adjust. This view was not, however, widely supported among the industry representatives in the interview group. Of the three who represented the viewpoint of Japanese manufacturers, only one agreed that EuroNCAP had been seen as a threat at the beginning because its cars were not expected to perform well. The others said that a culture of safety had already been established within their organisations. Moreover, Japan had already adopted the frontal offset test,
and companies with a large US market were already having to meet USNCAP regulations, with the result that: “It was not a sub-optimised car for any kind of crash scenario which means We already had the advantage of being cautious for safety.”

From the perspective of a German manufacturer within the group, opposition to the publication of rating results did not reflect fears about its own performance but, rather, doubts about the validity of a simple rating system in expressing complex safety questions:

“We were not really happy about publication of such rating results, as we said before our strategy is to focus on real life safety and EuroNCAP tests can only cover a small part of real life safety and when you communicate in such a simple way with stars, one to five stars, that a car is safe, then this may lead to misinterpretations by our customers.”

This manufacturer did not use EuroNCAP ratings in its advertising campaigns, believing that it was better to convince customers of the superiority of its individual safety solutions. The other industry representatives agreed, however, that the ratings were a useful publicity tool for their companies.

The management of EuroNCAP’s introduction
A question about whether the introduction of EuroNCAP could have been managed differently elicited a mixed response. All but one of the manufacturers’ representatives were critical of what they believed to have been inadequate consultation with the industry, although some did acknowledge that the industry’s outright opposition at the time would have made detailed consultation difficult. There was a specific criticism that EuroNCAP had relied exclusively upon safety researchers for its technical advice and had not been prepared to engage specialists with specific expertise in vehicle design. Another source of complaint was a lack of advance warning about changes in the test protocols, making it difficult for manufacturers to plan the research that was required to meet new specifications.
Half the industry representatives said that they had become more comfortable with the EuroNCAP development process over time, while the remainder expressed continuing doubts about how well it worked and/or its benefits in terms of real world safety. A particular issue was raised about whether the extra resources required to achieve good ratings might not be more beneficially spent on different approaches to safety:

“We have said that the requirements should be based on real world relevance and on the actual benefits that you get for the investments and if you look at that certainly it has been mentioned before that 100 euros for a knee bag may not be the most valuable investment you could make because with the same 100 euros you could do maybe a lot in software for a pre-crash type system”

The researchers and representatives of government and consumer organisations, who made up the remainder of the interview group, were mostly of the opinion that the EuroNCAP development process had functioned remarkably well given the obstacles and objections it encountered. Some acknowledged that while more extensive consultation would have been ideal, the reality of the circumstances at the time demanded that a decisive lead be taken, short-circuiting debate about the basic principle of consumer testing. The commitment of the UK government to press ahead regardless with an NCAP for the UK was seen as critical to the effective subsequent introduction of EuroNCAP. One respondent commented that if instead there had been an attempt to create EuroNCAP by drawing key players together in a European forum, the initiative would have run aground quickly on the assembled range of conflicting interests. Another commented that while the discussions about process and responsibilities had been difficult, the work done on the content and technical detail of the protocols was sound and was in effect “the condition that has made all the other things possible.”

There was, however, a dissenting voice from a safety expert based within the consumer movement who considered that undue efforts had been made to appease the industry throughout the development process and indeed that a certain amount of control had been ceded to it, with undesirable effects in terms of the transparency and comprehensiveness of EuroNCAP:
“There is a feeling among a lot of people that one of the things you have got to do is carry the industry with you… I think you have got to be much more transparent and be very straight down the line in the consumers’ interest, and those are two things that EuroNCAP is not good at and there is a lot of industry manipulation going on and that is something that EuroNCAP is going to have to review. One very important thing we have got to do is rescue EuroNCAP from being controlled by the industry and the industry is very powerful at the moment in working the system so that the worst vehicles don't get tested, and that is unacceptable.”

5.3 Summary of Qualitative Data

5.3.1 Regulations versus Consumer Testing

Respondents’ views were sought about the relative importance of EuroNCAP and the front and side impact regulations in driving car crashworthiness performance. Their replies show a widespread conviction that the two have worked in a complementary manner to improve safety, and that neither one would have been as effective without the other. A considerable majority also believed that the continuing co-existence and development of EuroNCAP and the regulations will be necessary in future if improvements in safety are to be maintained:

“My view is that there had been an inter-relationship between the legislative side and the consumer information side, I don't think we would have had the good development of EuroNCAP had there not been that initial front and side impact legislation there to show that the government was serious, to show that they would have to do something by a certain date. And then EuroNCAP really helped to bring out best performance in various models.”

Within this two-pronged approach, the regulations were most usually represented as the baseline or long-stop that has ensured a minimum standard for all vehicles, while EuroNCAP was seen as the dynamic, cutting edge that has encouraged manufacturers to compete to raise standards. For this reason, EuroNCAP was generally believed to be the more speedy and effective in terms of driving forward safety technology and securing the widespread deployment of innovative safety features:
“I think I would probably say consumer testing brings a quicker change; it is probably one of its bigger differences. NCAP forced the manufacturers to do a lot very quickly, so you get more of a curve like that…The regulations, they know there is a cut off when it must be done by, well they delay it for as late as possible until they can come up with a cheap engineering solution and then it will rise steeply whereas on NCAP they will just do it a lot quicker.”

EuroNCAP was also seen to have the advantage of being more readily intelligible to the consumer, thus adding consumer power - or at least the manufacturers’ perception of consumer power - to the incentives for improving safety.

The effectiveness of the regulations was judged rather differently in terms of their capacity to capture all cars in the fleet and ensure their conformity to acceptable standards. The safeguard offered by the regulations was felt to be particularly important for cars produced by low-volume manufacturers, which would never be tested by EuroNCAP, and for cheap imports which, without guaranteed safety standards, could put large numbers of European consumers at risk. Furthermore, the regulations were necessarily more comprehensive in their coverage than a consumer ratings system, including the detailed specification of components such as seat-belt buckles.

Although the regulations were regarded as the more static element, several respondents emphasised the importance of updating them and ensuring that they continued to provide a challenge to manufacturers. In other words, they opposed any drift away from the regulations in favour of exclusive reliance on EuroNCAP, on the grounds that the regulations would then come to be regarded as a rock-bottom standard rather than one that moved upwards in line with changing capacity to improve safety. They felt that it was important, therefore, to maintain the linkage, through research and agreed test protocols, between the regulations and EuroNCAP. In this way, the advances stimulated by EuroNCAP would drive forward the regulatory standards and EuroNCAP would draw strength from the technical expertise underpinning the regulations. It was noted that where EuroNCAP testing was not solidly grounded in
legislative standards – the pedestrian test was mentioned specifically – the manufacturers found it easy to disregard. Compatibility was identified as another issue that required regulation:

“I think it’s already been proved that EuroNCAP lifts the game beyond a regulatory approach in certain areas… Pedestrian safety hasn’t delivered that – no. With some things that are easier to do such as seat belt reminders and a few other things, it’s easy for industry to tweak around, via EuroNCAP. With big structural things, like compatibility, we’re going to have standard compatibility, we’re going to have standard pedestrian protection. I believe you need a legislative basis for that and it needs to be in Brussels.”

Not everyone was sanguine, however, about the capacity of regulatory action to challenge manufacturers. One respondent in particular believed that there was an over-reliance upon a consensus-based approach to securing changes in the regulations and that this made the process very open to subversion or dilution by the industry. In their view, “As long as they have the basic mindset that they are only going to do regulations if the industry agrees, they are never going to get anywhere.”

A small number of respondents dissented from the majority view that the regulations and EuroNCAP were equally necessary and should continue to complement each other in driving improvements in crashworthiness. Two manufacturers felt that improving the regulations was a better way forward, and this reflected their lack of confidence in the continuing relevance of EuroNCAP testing procedures. Elaborating this point of view, one said that the largest safety benefits in the future could arise from the active and pre-crash safety features now being developed by the major manufacturers and that this approach was less susceptible to a ratings scheme than established secondary safety technology:

“They may be suited for a regulatory approach to the degree that again you set a certain base standard, that may be meaningful as we have for the braking effective safety for many systems and the same in the passive safety for the crashes, but if you try to regulate or rate the high end, I think this will fail, because one thing you cannot keep track of is progress. There will always be somebody a step ahead of you which
you have not covered in the rating so it is not fair to him because he has done something that should be rewarded and is not - and to really map that into such a simple picture as a number of stars, is not feasible any more."

A diametrically opposed viewpoint was that expressed by a government representative who considered that EuroNCAP had effectively superseded the regulations and offered a far quicker and more streamlined means of achieving safety improvements. His own experience of the regulatory process had led him to question its capacity for change and thereby its continuing relevance:

“It’s the Commission’s responsibility and even if you do try, aren’t you running the risk of it getting blocked anyway by all those 25 member states and the Commission who won’t propose it. We’ve been exasperated for years - spending money trying to get them to improve it and going over there for meetings. So if you go to your NCAP resources instead you are free to change it very quickly and find out how safe or unsafe the cars are in another area, like primary NCAP, which could be developed at some cost”

The role of the European Commission and European Parliament in promoting car crashworthiness

An appraisal of the European Commission’s role by the interviewees suggested that it had offered less than wholehearted support to the development of the regulations and EuroNCAP. Some felt that the emphasis placed by the Maastricht Treaty on the removal of barriers to trade had resulted in too much weight being given within the Commission to concerns about the burden to industry that would result from better safety standards. This position was said to have been promoted particularly strongly by the Directorate (DG3) with responsibility for industry and enterprise. For some time DG3 was a more forceful voice within the Commission than DG7, the Directorate for Transport and Energy, which had not been strong on vehicle safety issues at the outset, although it was later to provide some powerful and influential safety champions. One consequence was a long-running tussle between the EEVC, led by member states and primarily a forum for technical development, and discussions in Brussels formally led by DG3. Even though many people attended both forums, they did so in different roles,
with the result that the research-based initiatives for safety improvements emanating from the EEVC were often deflected in the Brussels forum. It was suggested by one industry observer that these tensions had lessened in recent years and that there was now a more cooperative and rational relationship.

“…They realised in Brussels and Geneva that if they could come to some sort of agreement then they wouldn’t duplicate each other, since it is the same people so that the way it has worked out now, Geneva tends to develop a lot of the safety regulations which are then purely rubber stamped and applied in Brussels as directives, and I think it is true to say that Brussels have taken the lead more on environmental regulations which then get fed back to become ECE regulations, so that way they avoid too much interaction. There are exceptions like pedestrian protection.”

When EuroNCAP was proposed, the different viewpoints of DG3 and DG7 were even more sharply underlined, the former expressing open hostility while the latter, mainly through individuals who supported the initiative, successfully lobbied for the new initiative to receive funding from the Commission and enabled it to set up its secretariat in Brussels. The formal position of the Commission was seen by one observer to have shifted dramatically over a short period:

“…It changed from threatening the UK Government with legal action, to putting money into it and claiming all the credit for it, so they have done a fairly significant about turn, although the Commission should not be all labelled as one probably because this is when we got DG3 for industry which is what the regulations were done under and DG7 which was more about road safety.”

Those with recent knowledge of the Commission’s stance towards EuroNCAP described it as highly supportive politically but administratively fraught – to the extent that there were currently significant issues about the non-payment of bills. The Commission was urged to attend to its financial support arrangements to ensure that these actually enabled EuroNCAP to fulfil its objectives. There was little doubt that EuroNCAP was in its turn helpful to the Commission in enabling pressure for change to be applied to the vehicle industry in parallel with the regulatory process:
“I would say (the Commission) helps to drive EuroNCAP and my impression is that European Commission also likes to drive the car industry a little bit quicker into a special direction, through rating systems like EuroNCAP. This process seems to be easier and quicker than the legislative process.”

The same respondent considered that the Commission should take more of a technical lead within EuroNCAP, opening up discussion around issues such as assessment protocols and collision types. Others, however, felt that the capacity of the Commission to take on board technical issues was undermined by the frequent movement of personnel, which meant that knowledgeable people tended to be replaced after a short time by those who were less familiar with the subject. Becoming ensnared in bureaucracy and paperwork at the expense of a broader vision was believed to be another hazard for Commission staff.

In comparison, the role of the European Parliament in promoting vehicle safety was presented in an unambiguously positive light. The introduction of the co-decision procedure in 1993/94 was identified as the mechanism that enabled the Parliament to transform itself from a body that rubber-stamped Commission initiatives to one that began to take an independent stance on issues brought forward by MEPs on behalf of their constituents and by European consumer groups such as the ETSC and BEUC. In doing so, it showed a willingness to challenge the industry-friendly perspective on vehicle safety that had previously dominated the Commission and to remind the Commission of its obligations to promote the safety of the public. As noted earlier, the European Parliament was credited with rescuing the front and side impact regulations, assisted by judicious lobbying by the FIA and expert behind-the-scenes briefing of an MEP rapporteur, who was one of the first to be successful in using the co-decision procedure to represent his constituents.
6 Conclusions

The history of vehicle safety policy in Europe shows that the 1990s were a period of unprecedented progress. An expanding body of authoritative research based on the analysis of car accident data and predictive whole vehicle crash testing lent urgency to the debate about the upgrading of safety legislation. The enlargement of the European Union simultaneously provided a new impetus and opportunity for co-operation on vehicle safety.

The two principal markers of progress during the decade were the agreement of the front and side impact directives in 1995 and 1996 and the setting up of EuroNCAP in 1996. The UK government, through the research programme at the DfT, made a substantial contribution to both developments and the present study has addressed the question of whether this investment has helped the government to meet its primary policy aim of road casualty reduction. The broad conclusion is that UK government support for the regulations and EuroNCAP has been justified by consequent improvements in vehicle user protection.

Effect of regulations and EuroNCAP on vehicle safety

The quantitative analysis of national accident figures undertaken for this project suggests that the front and side impact regulations and EuroNCAP have exercised a positive and sustained impact upon car occupant safety in the UK.

This conclusion is strongly supported by qualitative evidence from interviewees across governments, the safety research community, motor manufacturers and NGOs, who described the regulations as a basic safety platform that has ensured a minimum standard for all vehicles, to which EuroNCAP has added a new dynamic by harnessing competition between manufacturers to raise safety standards. In this way, best design and the latest safety features have been diffused throughout the industry far more quickly than could have been achieved by regulation alone.
Without the regulations and EuroNCAP, it is clear that vehicle safety would have improved in line with evolving technology but that such improvements would have been made in a piecemeal way, heavily influenced by market judgements, with the likelihood that many safety features that are now standard would have remained luxury options.

EuroNCAP in particular has provided a powerful stimulus to the industry’s investment in vehicle safety, and safety requirements have been given much higher priority in the design process. Safety features are now advertised prominently by manufacturers. The precise effect on consumer behaviour is difficult to discern but the greater transparency provided by EuroNCAP has undoubtedly made manufacturers aware that consumers now have ready access to information about safety and are therefore able to use that information in their purchasing decisions.

**The role of the DfT/TTS research programme**

Whole vehicle testing has been the indispensable basis of effective predictive tests and much credit can be given to the UK government for providing technical leadership in this field through the work undertaken at TRL during the 1980s.

The commitment of individuals was critical to the formulation of the regulations and to the promotion of EuroNCAP. Countries where strong safety cultures were already established, principally the UK, Netherlands and Sweden, nurtured safety champions in government, research institutions and NGOs, with the UK Department for Transport providing a particularly supportive environment.

At national government level, the UK’s contribution to securing progress in frontal and side impact protection through the regulations and consumer testing was clearly very substantial and indeed indispensable in the case of EuroNCAP, which would not have come into existence without the prior UK commitment to launching UKNCAP within the TTS research programme.
At the same time, it is evident that neither the regulations nor EuroNCAP would have been implemented without wider European support and ownership, particularly from the governments of The Netherlands and Sweden, the EEVC, the ETSC, the FIA, the European Parliament and DG7/DGTREN within the European Commission. UK government representatives often played a vital political role in orchestrating this support in the European arena.

**Value for money of the DfT/TTS research programme**

The basic cost benefit analysis has concluded that the investment in the broad-based research programme at the TTS division of the DfT between 1990 and 2002 has yielded substantial benefits in terms of the progress made towards the Government’s KSI target for 2010 and in substantial cost savings associated with the sustained fall in KSI casualties over the period.

The combined cost of the TTS programme (encompassing staff costs and all research costs, both direct and indirect), was just over £23 million. On the benefit side, an average annual reduction of just under four per cent in KSI casualties has been achieved between 1999 and 2003.

The year on year reductions in KSI rates have been associated with absolute reductions in serious injuries rather than fatal outcomes (although numbers of fatal outcomes have decreased substantially relative to the size of the fleet). Year on year reductions in casualties on this scale bring very large cost savings. For example, the decline in number of seriously injured car occupants between 2002 and 2003 represents a saving of over £196 million and even if each accident had been slight rather than serious, the saving would be in the region of £181 million.

It is evident that reductions in KSI injury outcomes can be attributed to a number of factors and not solely to improvements in crashworthiness prompted by the front and side impact regulations and EuroNCAP. Changes
in medical care, road infrastructure, enforcement and vehicle user behaviour are clearly important.

Nonetheless, the decline in seriously injured casualties since the mid 1990s indicates that changes in vehicle design associated with the front and side impact regulations and EuroNCAP have indeed had an important influence. Moreover, given that the age of the fleet changes from year to year and around eight per cent is made up of the most recent vehicles, the benefits of newer car design will become widespread with each successive year. This evidence therefore points to the conclusion that the TTS research programme has been highly cost effective.

**Effectiveness of programme in reaching policy objectives**

Car occupants are less likely to be killed or seriously injured in a road accident now than in the early 1990s. Provided that the reduction in KSI casualties achieved between 1999 and 2003 can be sustained at an average rate of three per cent, per annum between 2004 and 2010, the Government’s target for 2010 of a 40 per cent reduction in KSI casualties over the 1994-98 average is achievable.

The evidence from this project shows that improvements in secondary safety resulting from the front and side impact regulations and EuroNCAP and reflecting the priorities of the TTS research programme, have made a vital and effective contribution to the key policy objective of reducing serious road casualties.

It is a cause for concern, however, that the numbers of fatalities have remained static relative to those for serious injuries and it is possible that this aspect needs to be addressed through a more specific target.

**Impact of programme and recommendations for improvement**

Using STATS19 and CCIS data to analyse the outcomes of accidents involving old and new cars over similar time periods, it has been possible to give precise indications of the safety benefits delivered by improvements in
vehicle design arising from the regulations and EuroNCAP. This methodology was chosen in preference to a ‘before and after’ approach involving two time periods in order to minimise the effect of other changes (road design, enforcement policy, road user behaviour etc.) on fatalities and serious injuries.

The results from STATS19 show that KSI outcomes have improved for all drivers of new cars in all types of impact and whether car to car or car to non car. With the exception of females in front impacts, front seat passengers have also benefited. However, the results do give rise to concern about the lack of benefit to rear seat passengers in new cars who, irrespective of age or gender, have all experienced worse outcomes in front impacts, whether car to car or car to non car. Older people and women have also been disadvantaged in other types of impact.

The CCIS data, which provide detailed information about injury type, confirm a general improvement in injury risk for car occupants in all types of impact, whatever the object struck. The data have also pinpointed areas of concern where gains in protection have been less significant than might have been expected or where there have been disbenefits. For example, serious chest injury, knee fracture and foot/ankle fracture are not reduced greatly in newer cars involved in frontal impacts and there is also a small increase in neck fracture and serious abdominal injury, mainly in car to car impacts.

These findings suggest that modern seat belt systems have not delivered the benefits expected in terms of chest injury reduction in this type of impact and that reduced foot well intrusion has not provided the expected extra protection for the foot and ankle. Increases in neck fractures may be due to higher crash pulses with newer vehicles and there may be a need to consider the role of airbag deployment as a contributor to these injuries.

These quantitative results tend to confirm the observations of a majority of interviewees in the qualitative part of the study, namely that the front and side impact regulations and EuroNCAP have brought significant improvements in the levels of protection for car occupants but that aspects of the vehicle
design process may have disadvantaged some user groups. In particular, the optimisation of vehicles is widely thought to be an inevitable side effect of predictive testing, with the result that user groups which diverge most from the 50\textsuperscript{th} percentile male receive the least benefit from crashworthiness improvements and, in some cases, actual disbenefits.

It also seems clear that little progress has been made towards improving the pedestrian friendliness of vehicle design or in resolving problems of compatibility. Moreover, during the evaluation period compatibility had been considered principally in terms of car-to-car impacts whereas the consequences of collisions between cars and heavier vehicles such as lorries are potentially even more devastating. These remain as challenges for the regulations and EuroNCAP to address through improvements to their testing regimes. However, these issues are being currently explored within the DfT VCCOMPAT programme of research.

Further improvements to the front and side impact legislative requirements have since been identified by the EEVC and others and, as noted by the DfT in its latest review of its road safety strategy, sustained reductions in casualties can be expected only if vehicle design and secondary safety continue to evolve.

Although the motor industry’s initial hostility towards both the regulations and EuroNCAP has been replaced over time by a more compliant and cooperative approach, it is apparent that there are lingering concerns about aspects of the EuroNCAP programme, including its benefits in terms of real world safety, its cost and what the industry sees as a degree of unpredictability and subjectivity in the EuroNCAP test requirements. It is clear also that some within the industry would prefer EuroNCAP to divert resources into primary safety while the balance of opinion outside the industry points towards an extension and refinement of the existing approach.

The history of the front and side regulations and EuroNCAP since their implementation suggests that they have acted in an effective and
complementary way to promote car occupant safety. Neither element would have been as effective without the other and attention should be given in the future to maintaining the link between them so that they continue to be mutually reinforcing in the interest of improved safety for vehicle users.

**Lessons for policy-making and programme delivery strategy by government**
The leading edge research into crashworthiness undertaken at the TRL laboratories from the 1980’s onwards provided the critical underpinning for a government policy that was to prove highly controversial in terms of the constraints it imposed upon a powerful industry. The full weight of industry opposition, including a formidable research capability, was brought to bear upon the front and side impact regulations and EuroNCAP. It is doubtful whether the government’s policy on regulation and its delivery of the NCAP and EuroNCAP programmes could have been sustained without the backing of the robust and innovative research conducted in the TRL laboratories.

Individuals with a passionate commitment to vehicle safety were important at all stages of the development of the regulations and EuroNCAP, often making waves and attracting opposition within their organisations. The Department for Transport encouraged individual champions to contribute to the safety research agenda and acted upon key issues arising from this research, translating them into policy proposals which the UK government then promoted strongly within the European arena.

Although the lead provided by the UK government was indispensable in putting the regulations and EuroNCAP on the European policy agenda, it is unlikely that implementation would have been achieved without a committed working partnership with other national governments and institutions and a sense of shared ownership of the process. Technical co-operation within the EEVC was an important dimension of the partnership, and the involvement of consumer organisations in the political process was vital in pushing the public interest into the foreground of European debate.
The history of the front and side impact regulations and EuroNCAP reveals how the UK government repeatedly seized the initiative on vehicle safety and made the industry respond to its concerns. When the regulatory process threatened to stall, the momentum was maintained through the development of NCAP and then EuroNCAP. It is clear that although impressive strides have been made through the implementation of both programmes, there has subsequently been a loss of momentum on issues such as pedestrian safety and compatibility (with car to HGV compatibility remaining a particularly salient issue). Past experience suggests that resolute initiatives from government will be required to push the industry towards systematic and sustained improvements in these areas.
7 References

15. EUROPEAN EXPERIMENTAL VEHICLES COMMITTEE (EEVC now the European Enhanced Vehicle-safety Committee) www.eevc.org.


HIGHWAY LOSS DATA INSTITUTE (HLDI), Insurance Institute for Highway Safety, 1975.


8 Acknowledgements

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## 9 Glossary

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AA</td>
<td>Automobile Association</td>
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<tr>
<td>ABS</td>
<td>Antilock Braking System</td>
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<td>ACEA</td>
<td>Association des Constructeurs Europeens d’Automobiles</td>
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<td>ADAC</td>
<td>German Automobile Association</td>
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<td>AIS</td>
<td>Abbreviated Injury Scale</td>
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<td>AIT</td>
<td>Alliance Internationale de Tourisme</td>
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<td>ANCAP</td>
<td>Australian New Car Assessment Programme</td>
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<td>BEUC</td>
<td>Bureau European dea Consommateurs</td>
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<td>CCIS</td>
<td>Co-operative Crash Injury Study</td>
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<td>CCTP</td>
<td>Computer Controlled Test Procedure</td>
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<td>DETR</td>
<td>Department of the Environment, Transport and Regions</td>
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<td>DfT</td>
<td>Department for Transport</td>
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<td>DoT</td>
<td>Department of Transport</td>
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<td>DSIR</td>
<td>Department of Scientific and Industrial Research</td>
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<td>DTLR</td>
<td>Department for Transport, Local Government and the Regions</td>
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<td>DG 3</td>
<td>Directorate-General for Trade and Industry</td>
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<td>DG 7</td>
<td>Directorate-General for Transport</td>
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<td>DG TREN</td>
<td>Directorate-General for Transport and Energy</td>
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<td>ECE</td>
<td>Economic Commission for Europe</td>
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<td>EEC</td>
<td>European Economic Committee</td>
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<td>EEVC</td>
<td>European Experimental Vehicle Committee</td>
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<td>ERGA</td>
<td>European Regulations Global Approach</td>
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<td>ESV</td>
<td>Experimental Safety of Vehicles (conference)</td>
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<td>ETSC</td>
<td>European Transport Safety Council</td>
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<td>EU</td>
<td>European Union</td>
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<td>EuroNCAP</td>
<td>European New Car Assessment Programme</td>
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<td>EuroSID</td>
<td>European Side Impact Dummy</td>
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<td>FIA</td>
<td>Federation Internationale de l’Automobile</td>
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<td>FMVSS</td>
<td>Federal Motor Vehicle Safety Standards</td>
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<td>FSP</td>
<td>Front Seat Passenger</td>
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<td>GRSP</td>
<td>Global Road Safety Partnership</td>
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<td>HIC</td>
<td>Head Injury Criteria</td>
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<td>HLDI</td>
<td>Highway Loss Data Institute</td>
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<td>IIHS</td>
<td>Insurance Institute for Highway Safety</td>
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<td>IRCOBI</td>
<td>International Research Council on the Biomechanics of Impact</td>
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<td>IT</td>
<td>International Testing</td>
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<tr>
<td>KSI</td>
<td>Killed or Seriously Injured</td>
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<td>LAB</td>
<td>Laboratoire Accedontologie et Biomechanique</td>
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<td>MAIS</td>
<td>Maximum Abbreviated Injury Score</td>
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<td>MEP</td>
<td>Member of the European Parliament</td>
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<td>NHTSA</td>
<td>National Highway Traffic Safety Administration</td>
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<td>NGO</td>
<td>Non Governmental Organisation</td>
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<td>ODB</td>
<td>Offset Deformable Barrier</td>
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<td>PACTS</td>
<td>Parliamentary Advisory Committee on Transport Safety</td>
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<td>Acronym</td>
<td>Full Form</td>
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<td>RRL</td>
<td>Road Research Laboratory</td>
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<td>RSP</td>
<td>Rear Seat Passenger</td>
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<td>SMMT</td>
<td>Society of Motor Manufacturers and Traders</td>
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<td>STATS 19</td>
<td>(GB Road Accident Statistics)</td>
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<td>SUV</td>
<td>Sports Utility Vehicle</td>
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<td>TRL</td>
<td>Transport Research Laboratory</td>
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<td>TRRL</td>
<td>Transport Road Research Laboratory</td>
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<td>TTS</td>
<td>Transport Technology and Standards Division (of DfT)</td>
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<td>UKNCAP</td>
<td>United Kingdom New Car Assessment Programme</td>
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<td>UN</td>
<td>United Nations</td>
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<td>UNECE</td>
<td>United Nations Economic Commission for Europe</td>
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<td>USNCAP</td>
<td>United States New Car Assessment Programme</td>
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<tr>
<td>VALT</td>
<td>Vakuutusyhtioiden Liikenneturvallisuustoimikunta</td>
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<td>VSE</td>
<td>Vehicle Standards and Engineering Division (of DfT)</td>
</tr>
<tr>
<td>VSRC</td>
<td>Vehicle Safety Research Centre</td>
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<td>VTS</td>
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<tr>
<td>WG 9</td>
<td>EEVC Working Group on Side Impacts</td>
</tr>
<tr>
<td>WG 17</td>
<td>EEVC Working Group on Pedestrian Protection</td>
</tr>
<tr>
<td>WP 29</td>
<td>UN (Inland Transport Committee) Working Party on the Construction of Vehicles in Geneva</td>
</tr>
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Appendix 1
Quantitative Analysis Figures and Charts
STATS 19 Data Analysis

Drivers

Car to Car impacts

*Frontal Impacts (Frontal Impact Directive)*

Figures 1 – 3 compare the killed or seriously injured (KSI) outcome between old and new cars for drivers in car to car frontal impacts. This scenario is covered by the regulation and EuroNCAP.

![Figure 1 Drivers – car to car frontal impacts](image)

- The KSI rate in frontal impacts for drivers of newer vehicles is 3.9% compared with 5% for drivers of older vehicles. This is a reduction of almost 22%.
- The proportion of uninjured drivers is higher in the older vehicles than the newer vehicles.
- The data suggest that in car to car frontal impacts, drivers of newer cars are marginally more likely to receive an injury than drivers of older vehicles, but that the injury is likely to be less severe in the newer vehicles.
• It is clear that female drivers are more likely to be injured in a frontal impact than male drivers. The proportion of female drivers uninjured is some 20% lower than male drivers.

• The uninjured rate for male drivers is slightly higher in older vehicles than newer vehicles, the converse being the case for female drivers.

• The KSI rate for male drivers is 5.2 in the older vehicles and 3.9 in the newer vehicles, a reduction of 25%.

• The KSI rate for female drivers is 5.6 in older vehicles and 4.2 in newer vehicles, a reduction of 25%.

• There appears to have been equal benefit for the reduction of KSI for both men and females in frontal impacts.
Figure 3 Drivers by Age – car to car frontal impacts

- Older (>50) drivers are marginally more likely to be injured in a frontal crash than younger drivers. The uninjured rate for younger drivers is 54.8% in the older vehicles and 54% in newer vehicles indicating a very slight increase in the rate of injury in newer vehicles. The uninjured rate for older drivers is 51% in older vehicles and 51.9% in newer vehicles indicating a very slight decrease in the rate of injury in newer vehicles.
- The KSI rate for younger drivers is 5.1% in older vehicles and 3.7% in newer vehicles, a reduction of 27%.
- The KSI rate for older drivers is 7.7% in older vehicles and 6.1% in newer vehicles, a reduction of 21%.
- Older drivers remain more vulnerable to KSI injury outcome than younger drivers. Though there has been a reduction in the KSI rate for both age groups, the benefit in the newer cars has been greater for the younger drivers than the older drivers.

**Rear Impacts (No Directive)**

Figures 4 – 6 compare the KSI outcome between old and new cars for drivers in car to car rear impacts.
The proportion of uninjured drivers in car to car rear impacts has risen from 40.1% in older vehicles to 45.1% in newer vehicles. This is mainly accounted for by a reduction in the proportion of slight injuries.

The KSI rate in older vehicles is 1.4% and this falls to 1% in newer vehicles, a reduction of 29%.

Newer vehicle design appears to have had an effect in reducing the likelihood of all injury severities in rear car to car impacts.
Female drivers are clearly more likely to be injured in a rear car to car impact than male drivers. This is largely accounted for by an increase in slight injuries, most likely to be soft tissue neck injuries. The rate of uninjured drivers has risen in the newer vehicles for both genders, but remains over 20% lower for females than males.

The KSI rate for females is 1.7% in the older vehicles and 1.1% in the newer vehicles, a reduction of 35%.

The KSI rate for men is 1.2% in the older vehicles and 0.9% in the newer vehicles, a reduction of 25%.

Female drivers remain disadvantaged in rear impacts compared to male drivers, but the improvements in terms of KSI injury outcome are more noticeable for females than for men.

![Figure 6 Drivers by Age – car to car rear impacts](image)

Older drivers are less likely to be injured in a rear car to car impact than younger drivers. The rate of uninjured drivers rises for both age groups in the newer vehicles. This is predominantly accounted for by a reduced propensity towards slight injury outcome in the older age category.

The KSI rate for younger drivers is 1.3% in older vehicles and 1% in newer vehicles, a reduction of 23%.
The KSI rate for older drivers is 1.9% in older vehicles and 0.9% in newer vehicles, a reduction of 53% (note smaller sample size may reflect in this result).

It appears that modern vehicle design has been beneficial for both younger and older drivers, with the benefit in terms of serious injury outcome being greater for the older drivers than the younger drivers.

**Right Side Impacts – Struck side (Side Impact Directive)**

Figures 7 – 9 compare the KSI outcome between old and new cars for drivers in car to car right side impacts. This scenario is covered by the regulation and EuroNCAP.

The rate of uninjured drivers in right side car to car impacts is marginally higher (47.3) in newer vehicles than in older vehicles (45.3%).

The KSI rate in older vehicles is 4.9% and 3.8% in newer vehicles, a reduction of 22%.

Newer vehicles appear to offer better protection in right side impacts than older vehicles.
Female drivers are clearly more likely to receive an injury in a right side car to car impact than male drivers. The uninjured rate for female drivers is 29.7% in older vehicles and 33% in newer vehicles representing a reduction in overall injury in the newer vehicles. A similar observation applies to male drivers, though the proportion of uninjured drivers is some 20% higher than the female drivers for both vehicle ages.

The KSI rate for male drivers is 5.1 in older vehicles and 3.9% in newer vehicles, a reduction of 24%.

The KSI rate for female drivers is 5.1% in older vehicles and 3.9% in newer vehicles, a reduction of 24%.

For right side car to car impacts, there is no difference in the KSI rate between genders and there is an equal reduction in the rate of KSI in the newer vehicles. Female drivers however remain more vulnerable to slight injury outcome than male drivers.
Older drivers have a higher uninjured rate than younger drivers in both old and new vehicles when considering right side car to car impacts. This is particularly noticeable in the newer vehicles where the difference in the uninjured rate between the driver age categories is 6.7% compared with 1.1% in the older vehicles.

- The KSI rate for younger drivers is 4.3% in the older vehicles and 3.3% in the newer vehicles, a reduction of 23%.
- The KSI rate for older drivers is 8.5% in the older vehicles and 5.6% in newer vehicles, a reduction of 34% (smaller sample size may have an effect).
- Modern vehicle design has benefited both younger and older drivers but the benefit appears greatest for the older drivers.

**Left Side Impacts – Non-struck side (No Directive)**

Figures 10 – 12 compare the KSI outcome between old and new cars for drivers in car to car left side impacts.
The rate of uninjured drivers in left side car to car impacts is higher in the older vehicles (51.3%) than in the newer vehicles (49%) representing a slight increase in overall injury rates for newer cars compared with older cars.

The KSI rate in older vehicles is 4.3% and 3.5% in newer vehicles, a reduction of 19%.

Modern car design appears to have had a positive effect on the likelihood of serious injury outcome for drivers in left side car to car impacts but the rate of slight injury has increased.
Female car drives are clearly more likely to be injured in a left side car to car impact than male drivers. The uninjured rate for female drivers is 34.2% in the older vehicles and 32.6% in the newer vehicles, representing a marginal increase in overall injury rate for females. The uninjured rate for male drivers is considerably higher at 55.8% in the older vehicles and 57.3% in the newer vehicles, representing a marginal decrease in the overall rate of injury for male drivers.

The KSI injury rate for male drivers in left side car to car impacts is 4.6% in the older vehicles and 3.6% in the newer vehicles, a reduction of 22%.

The KSI injury rate for female drivers is 4.5% in the older vehicles and 3.6% in the newer vehicles, a reduction of 20%.

Newer vehicle design appears to have had a benefit in reducing serious injury outcome for both male and female drivers in left side car to car impacts, the benefit being marginally greater for men than females. Female drivers remain considerably disadvantaged in terms of slight injury outcome compared to male drivers.

![Figure 12 Drivers by Age – car to car left side impacts](image)

Older drivers are more likely to be uninjured in left side car to car impact than younger drivers; this is the case for both old and new vehicles. The uninjured rate for younger drivers is 46.8% in older cars and 45.4% in newer cars representing a marginal increase in the
overall injury rate for younger drivers in newer vehicles. The uninjured rate for older drivers is 48.1% in old cars and 51.5% in new cars, representing a slight benefit in the overall injury outcome for older drivers in newer cars.

- The KSI rate for younger drivers is 4.4% in older vehicles and 3.4% in newer vehicles, a reduction of 23%.
- The KSI rate for older drivers is 5.5% in older vehicles and 4.2% in newer vehicles, a reduction of 24%.
- Although older drivers have a lower rate of overall injury outcome than younger drivers, and the reduction in the rate of KSI is similar for both driver age groups, the older drivers remain disadvantaged in terms of serious injury outcome.

Accidents other than car to car (injured occupant within car so excludes accidents where injury was only to pedestrian and cyclist/motorcyclist)

**Frontal Impacts**

Figures 13 – 15 compare the KSI outcome between old and new cars for drivers in car to non car frontal impacts.

![Figure 13 Drivers – car to non car frontal impacts](image)
• The KSI rate in frontal impacts for drivers of newer vehicles is 7.3% compared with 9.7% for drivers of older vehicles. This is a reduction of 25%.
• The proportion of uninjured drivers is marginally higher in the newer vehicles than in the older vehicles.
• Newer vehicles offer better protection for KSI injury outcome than older vehicles in non car to car frontal collisions.

![Bar chart showing drivers by gender and vehicle type for car to non car frontal impacts.](chart)

**Figure 14 Drivers by Gender – car to non car frontal impacts**

• It is clear that female drivers are more likely to be injured in a frontal impact than male drivers. The proportion of uninjured female drivers is 7% lower than male drivers for the older vehicles and 9% lower for the new vehicles.
• For both genders the proportion of uninjured drivers is slightly higher in the newer vehicles than the older vehicles.
• The KSI rate for male drivers is 10.9% in the older vehicles and 8% in the newer vehicles, a reduction of 27%.
• The KSI rate for female drivers is 8% in the older vehicles and 6.1% in the newer vehicles, a reduction of 24%.
• There has been a marginally greater benefit in the reduction of KSI injury outcome for male drivers when compared to female drivers in
frontal non car to car impacts, but the rate remains higher for men than for females.

![Frontal impacts chart]

**Figure 15 Drivers by Age – car to non car frontal impacts**

- Younger drivers have a higher injury rate than older drivers (>50) considering all levels of severity, both in the older cars and the newer cars. The uninjured rate for younger drivers is 42.8% in the older vehicles and 44.8% in the newer vehicles. The uninjured rate for older drivers is 48% in the older cars and 52.3% in the newer cars.
- The KSI rate for younger drivers is 10.4% in the older cars and 7.6% in the newer cars, a reduction of 27%.
- The KSI rate for older drivers is 10.3% in the older cars and 7.3% in the newer cars, a reduction of 29%.
- There are similar KSI rates for both age categories and across both vehicle age groups. The benefit in modern cars has been marginally greater for the older drivers compared to the younger drivers.

**Rear Impacts**

Figures 16 – 18 compare the KSI outcome between old and new cars for drivers in car to non car rear impacts.
The proportion of uninjured drivers in car to non car rear impacts has risen from 46.6% in older vehicles to 47.8% in newer vehicles.

The KSI rate in the older vehicle is 2.1% and this falls to 1.5% in the newer vehicles, a reduction of 29%.

Newer vehicle design appears to have had an effect upon reducing the likelihood of all injury severities in rear car to non car impacts.

Female drivers are clearly more likely to be injured in a rear car to non car impact than male drivers. This is largely accounted for by an
increase in slight injuries, most likely to be soft tissue neck injuries. The rate of uninjured drivers has risen in the newer cars for both genders, slightly more so for female drivers than male drivers.

- The KSI rate for female drivers is 2.4% in the older cars and 1.6% in the newer cars, a reduction of 33%.
- The KSI rate for male drivers is 2.1% in the older cars and 1.6% in the newer cars, a reduction of 24%.
- Female drivers have seen a greater reduction in KSI injury outcome in modern cars compared with the reduction for male drivers.

![Rear impacts chart](chart)

**Figure 18 Drivers by Age – car to non car rear impacts**

- Older drivers are less likely to be injured in a rear car to non car impact than younger drivers. The uninjured rate rises for both driver age groups in the newer cars compared with the older cars.
- The KSI rate for younger drivers is 2.1% in the older cars and 1.6% in the newer cars, a reduction of 24%.
- The KSI rate for older drivers is 2.7% in the older cars and 1.4% in the newer cars, a reduction of 48%.
- It appears that modern vehicle design has been beneficial for both younger and older drivers and the benefit has been greater for the older drivers than the younger drivers.
**Right Side Impacts - Struck Side**

Figures 19 – 21 compare the KSI outcome between old and new cars for drivers in car to non car right side impacts.

- The rate of uninjured drivers in right side car to non car impacts is a little higher (59.3%) in newer vehicles than in older vehicles (55.4%).
- The KSI rate in older cars is 7% compared with 4.8% in the newer cars, a reduction of 31%.
- Newer vehicles appear to offer better protection for drivers in right side car to non car impacts.

![Figure 19 Drivers – car to non car right side impacts](image)

![Figure 20 Drivers by Gender – car to non car right side impacts](image)
• Female drivers are clearly more likely to receive an injury in a right side car to non car impact than male drivers. The uninjured rate for female drivers is 46.6% in the older vehicles and 51.9% in the newer vehicles, representing an overall reduction in injuries for females in the newer cars. Similarly the proportion of uninjured male drivers rises from 57% in the older cars to 62.6% in the newer cars. The uninjured rate for male drivers remains consistently a little over 10% higher than for female drivers irrespective of vehicle age.

• The KSI rate for male drivers is 8.2% in the older cars and 5.6% in the newer cars, a reduction of 32%.

• The KSI rate for female drivers is 5.3% in the older cars and 3.7% in the newer cars, a reduction of 30%.

• Whilst female drivers are considerably more vulnerable to slight injury than male drivers and remain so in the newer vehicles, male drivers have a higher KSI rate in both the newer and older cars. The benefit in the reduction of the KSI rate for both males and females is similar.

![Bar chart showing percentages of drivers by age and vehicle type for right side car to non car impacts.](image)

**Figure 21 Drivers by Age – car to non car right side impacts**

• For car to non car right side impacts, older drivers have a higher uninjured rate than younger drivers in both old and new vehicles, though the discrepancy between the older and younger drivers reduces in the newer cars.
• The KSI rate for younger drivers is 7.7% in the older cars and 5% in the newer cars, a reduction of 35%.
• The KSI rate for older drivers is 6% in the older cars and 4.6% in the newer cars, a reduction of 23%.
• Modern vehicle design has benefited both younger and older drivers in right side non car to car impacts, but the benefit appears to be greater for the younger drivers.

Left Side Impacts – Non Struck Side
Figures 22 – 24 compare the KSI outcome between old and new cars for drivers in car to non car left side impacts.

![](chart)

Figure 22 Drivers – car to non car left side impacts

• The rate of uninjured drivers in left side car to non car impacts is similar for both the older vehicles (57.9%) and the newer vehicles (57.2%).
• The KSI rate is 6.3% in the older cars and 4.4% in the newer cars, a reduction of 30%.
• Modern car design appears to have had a positive effect on reducing the likelihood of KSI injury outcome for drivers in left side car to non car impacts.
Female drivers are more likely to be injured in a left side car to non car impact than male drivers. The uninjured rate for female drivers is 50.5% in the older vehicles and 48.6 in the newer vehicles, representing a marginal increase in overall injury rate for females. The uninjured rate for male drivers is higher at 58.7% in the older cars and 61.2% in the newer cars, representing a marginal decrease in the overall injury rate for men.

The KSI injury rate for male drivers is 7.8% in the older cars and 4.8% in the newer cars, a reduction of 38%.

The KSI injury rate for female drivers is 3.8% in the older cars and 3.9% in the newer cars, a slight increase of 3%.

New vehicle design appears to have had a considerable benefit in reducing the likelihood of KSI injury outcome for male drivers but has had no benefit, in fact a marginal disbenefit, for the injury outcome for female drivers in left side car to non car impacts.

**Figure 23 Drivers by Gender – car to non car left side impacts**
Figure 24 Drivers by Age – car to non car left side impacts

- Older drivers are more likely to be uninjured in a left side car to non car impact than younger drivers; this is the case for both old and new vehicles. The uninjured rate for younger drivers is 52.8% in the older cars and 53.9% in the newer cars, representing a marginal decrease in the overall injury rate for younger drivers in newer vehicles. The uninjured rate for older drivers is 65.4% in the older cars and 61.4% in the newer cars, representing an increase in the overall rate of injury for older drivers in left side car to non car impacts.
- The KSI rate for younger drivers is 7.4% in the older cars and 4.8% in the newer vehicles, a reduction of 35%.
- The KSI rate for older drivers is 4.1% in the older cars and 3.6% in the newer cars, a reduction of 12%.
- Modern vehicle design appears to have benefited younger driver both in terms of their overall injury rate and their KSI injury rate. For older drivers there has been an increase in overall injury rate in the newer cars and the reduction in the KSI rate, though 12%, is considerably lower than the reduction experienced by the younger drivers (35%).

Car passengers – front seat and rear seat

Since the data does not contain information relating to uninjured car passengers, a different approach has been used to compare the injury
outcomes from passengers in newer and older vehicles. The Odds Ratio method had been used and is calculated as the ratio of the KSI rate for a given subset in the older vehicles and the KSI rate for the same subset in the newer vehicles. An Odds Ratio equal to 1 (normalised to 0) indicates no change in the KSI rate. The Odds Ratios were calculated for both Front Seat Passengers (FSP) and Rear Seat Passengers (RSP) for each impact type, front, rear, right and left, and by each of the categories all occupants, male, female, young and old.

**Car to Car Impacts**
The results of the Odds Ratios for car to car impacts are summarised in table 1. Each scenario is commented in detail in figures 25 to 32.

**Table 1: Odds Ratios for car to car impacts by seating position and impact type**

<table>
<thead>
<tr>
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<th>Fronts</th>
<th>Rear</th>
<th>Right</th>
<th>Left</th>
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</thead>
<tbody>
<tr>
<td>All FSP</td>
<td>0.07</td>
<td>0.47</td>
<td>0.16</td>
<td>0.69</td>
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<tr>
<td>Male FSP</td>
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<td>0.56</td>
<td>0.5</td>
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<td>Female FSP</td>
<td>-0.03</td>
<td>0.53</td>
<td>0.01</td>
<td>0.46</td>
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<tr>
<td>Young FSP</td>
<td>0.04</td>
<td>0.6</td>
<td>0.49</td>
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</tr>
<tr>
<td>Old FSP</td>
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<tr>
<td>All RSP</td>
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<td>-0.04</td>
<td>0.1</td>
<td>0.01</td>
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<tr>
<td>Male RSP</td>
<td>-0.13</td>
<td>0.39</td>
<td>0.06</td>
<td>-0.1</td>
</tr>
<tr>
<td>Female RSP</td>
<td>-0.1</td>
<td>-0.48</td>
<td>0.11</td>
<td>0.1</td>
</tr>
<tr>
<td>Young RSP</td>
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<td>0</td>
<td>0.13</td>
<td>0.05</td>
</tr>
<tr>
<td>Old RSP</td>
<td>-0.03</td>
<td>-0.65</td>
<td>-0.08</td>
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</table>
In car to car frontal impacts KSI injury rate benefits are seen in the newer cars for all front seat passengers except for the younger female passengers. This disbenefit is marginal.

The greatest benefits are evident for male front seat passengers and the older front seat passengers.

For rear seat passengers in frontal impacts disbenefits for the KSI injury outcome are seen across the entire diversity of occupants.

The greatest disbenefits are observed for the male RSPs and the younger RSPs, those occupants who are inherently more resilient to injury.
In car to car rear impacts benefits are apparent in the newer vehicles for all front seat occupants.

The KSI rate in rear impacts has improved for male rear seat passengers and younger RSPs, but the rate has increased for female and older RSPs.
Right side impacts represent non struck side impacts for FSPs. Newer car design has benefited the KSI rate for all FSPs in right side impacts except for the older FSPs.

For rear seat passengers it is not possible to say whether a right side impact represents a struck side or a non struck side impact since exact location in the rear of the car is not recorded in the data set. On the whole benefits are observed for rear seat passengers in right side impacts, however when the data are categorised by RSP age, older RSPs appear disadvantaged in the newer cars.
• Left side impacts represent struck side impacts for front seat passengers. There is a clear improvement in the KSI rate for front seat passengers in the newer cars compared to the older cars.

• For rear seat passengers in left side impacts, small benefits are seen in the newer cars for female and younger occupants, whilst male occupants appear disadvantaged and older RSPs exhibit the greatest increase in KSI rate in the newer cars compared to the older cars.
Accidents other than car to car (injured occupant within car so excludes accidents where injury was only to pedestrian and cyclist/motorcyclist)

The results of the Odds Ratios for car to non car impacts are summarised in table 2. Each scenario is commented in detail in figures 33 to 40.

Table 2: Odds Ratios for car to non car impacts by seating position and impact type

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<tbody>
<tr>
<td>All FSP</td>
<td>0.33</td>
<td>0.31</td>
<td>0.35</td>
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<tr>
<td>Male FSP</td>
<td>0.46</td>
<td>1.79</td>
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<tr>
<td>Female FSP</td>
<td>0.12</td>
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<td>Young FSP</td>
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<td>All RSP</td>
<td>0.35</td>
<td>0.88</td>
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<td>Male RSP</td>
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<td>Female RSP</td>
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<td>1.09</td>
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<tr>
<td>Young RSP</td>
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<td>1.42</td>
<td>0.35</td>
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<tr>
<td>Old RSP</td>
<td>-0.02</td>
<td>-0.04</td>
<td>2.07</td>
<td>-1.47</td>
</tr>
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Figure 33 Front seat passengers – car to non car frontal impacts
Figure 34 Rear seat passengers – car to non car frontal impacts

- For car to non car frontal impacts, improvements in the rate of KSI injury outcome are seen for almost exclusively all the car passenger population.
- The only marginal increase in KSI rate is observed for older rear seat occupants.

Figure 35 Front seat passengers – car to non car rear impacts
In rear car to non car impacts, as with frontal impacts, reductions in the KSI rate are seen in the newer cars across most of the passenger population.

The only increases in KSI rate are seen in the female FSP group and the older RSP group.

In rear car to non car impacts, as with frontal impacts, reductions in the KSI rate are seen in the newer cars across most of the passenger population.

The only increases in KSI rate are seen in the female FSP group and the older RSP group.
In right side car to non car impacts (non struck impacts for FSPs), both front seat and rear seat passengers in their entirety have benefited with newer car design in terms of KSI injury outcome.
A similar observation to right side impacts is apparent for car to non car left side impacts, the exception being for the older RSPs.

The older RSPs appear to have a substantial increased rate of KSI injury outcome in the newer cars than the older cars. It should be pointed out that at this point in the analysis, the number of cases dropped quite substantially which can cloud the results since a single event can dramatically change the interpretation.

**CCIS Data Analysis**

**Frontal Impacts**

**Car to All Objects**

**Driver**

Table 3 shows the sample size for drivers in frontal impact irrespective of object hit and the Odds Ratios outcomes are illustrated in figures 41 to 45.
Table 3: Sample size – drivers, all frontal impacts

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<th>Drivers</th>
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<td>All</td>
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<td>Male</td>
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<td>638</td>
<td>1224</td>
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<tr>
<td>Young</td>
<td>1586</td>
<td>2485</td>
</tr>
<tr>
<td>Old</td>
<td>468</td>
<td>848</td>
</tr>
</tbody>
</table>

Figure 41 Drivers – all impact objects, frontal impacts

- Benefits are seen in newer cars for drivers in frontal impacts in all body regions apart from the neck and the abdomen.
- The result indicating a reduction in serious (AIS3+) facial injuries is susceptible to the low incidence of such injuries.
Male Belted Drivers - Frontal Impacts - All objects hit

- Cranium
- Face
- Neck
- Chest
- Abdomen
- Pelvis
- Knee
- Thigh
- Lower Leg
- Foot/Ankle

Figure 42 Male drivers – all impact objects, frontal impacts

- Male drivers benefit in terms of serious injury outcome in newer vehicles for frontal impacts across all body regions except the neck and the abdomen.
- The results for the neck and the abdomen are susceptible to the low occurrence of serious injury in these body regions.

Female Belted Drivers - Frontal Impacts - All objects hit

- Cranium
- Face
- Neck
- Chest
- Abdomen
- Pelvis
- Knee
- Thigh
- Lower Leg
- Foot/Ankle

Figure 43 Female drivers – all impact objects, frontal impacts

- The only apparent disbenefit for female drivers in frontal impacts relates to knee fractures. This is a marginal disbenefit.
- Results for the abdomen and pelvis should be treated with caution.
Younger Belted Drivers - Frontal Impacts - All objects hit

- Cranium
- Face
- Neck
- Chest
- Abdomen
- Thigh
- Knee
- Lower Leg
- Foot/Ankle

Old Belted Drivers - Frontal Impacts - All objects hit

- Cranium
- Face
- Neck
- Chest
- Abdomen
- Thigh
- Knee
- Lower Leg
- Foot/Ankle

**Figure 44 Younger Drivers – all impact objects, frontal impacts**

- Younger belted drivers benefit in the new cars and in frontal impacts across all body regions except for the neck and the abdomen.
- The AIS 3+ injury rates for the abdomen are identical in the new and old car samples.
- The disbenefit observed for neck injury outcome should be treated with caution.

**Figure 45 Older drivers – all impact objects, frontal impacts**
• Reductions in the rates of serious injury are observed in new cars across all body regions except the abdomen and the face for older drivers in frontal impacts.
• The result for the face is not applicable.
• The results for the abdomen and the lower leg need to be treated with caution.

It should be noted that although the number of serious abdominal injuries for male drivers was low in the old car sample and hence the result considered cautionary, there was a significant increase in the number seen in the new car sample. Similarly there are large but cautionary decreases in female pelvic injury and older occupant lower leg injury in the new cars compared with the old cars.

**Front Seat Passengers**
Table 4 shows the sample size for front seat passengers in frontal impacts irrespective of object hit and the Odds Ratios outcomes are illustrated in figures 46 to 50.

Table 4: Sample size – front seat passengers, all frontal impacts

<table>
<thead>
<tr>
<th>FSP</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>671</td>
<td>1018</td>
</tr>
<tr>
<td>Male</td>
<td>288</td>
<td>392</td>
</tr>
<tr>
<td>Female</td>
<td>365</td>
<td>601</td>
</tr>
<tr>
<td>Young</td>
<td>410</td>
<td>600</td>
</tr>
<tr>
<td>Male</td>
<td>138</td>
<td>222</td>
</tr>
</tbody>
</table>
Belted front seat passengers have benefited in new cars in terms of neck, lower leg and foot/ankle injury.

There are increases in the serious injury rate for the cranium and the knee.

Abdominal and thigh injury rates are unchanged between the two car samples.

It is not possible to calculate the Odds Ratio for face of pelvic injuries.

The results for the cranium, neck, abdomen and knee need to be treated with caution.
• Considering male front seat passengers in frontal impacts (all impact objects), new car design has benefited the serious injury rate for the chest, thigh and lower leg.
• There is no change in the rate of AIS 3+ cranium injury between the two car groups.
• It was not possible to calculate Odds Ratios for the face, neck, abdomen, pelvis or knee.
• All of the results for male FSPs need to be treated with caution.

Figure 48 Female front seat passengers – all impact objects, frontal impacts

• Female front seat passenger in frontal impacts see benefits in serious chest, abdomen, lower leg and foot/ankle injury rates on the new cars compared to the old cars.
• Substantial disbenefits are seen for the cranium and the neck. Disbenefits are also observed for the thigh.
• It is not possible to calculate Odds Ratios for the face, pelvis or knee.
• Results for the cranium, neck, abdomen and thigh need to be treated with caution.
Younger front seat passengers have benefited in newer cars in terms of serious chest and lower leg injury.

Disbenefits are seen for the cranium and the abdomen.

No change is observed for the neck, thigh and foot/ankle.

It was not possible to calculate Odds Ratios for the face, pelvis or knee.

The results for the cranium, neck, abdomen, thigh and lower leg should all be treated with caution.
• Older front seat passengers in frontal impacts (all impact objects) have benefited in terms of serious neck, chest, abdominal, lower leg and foot/ankle injury.
• Disbenefits are observed for the thigh and the knee.
• It was not possible to calculate Odds Ratios for the cranium, face or pelvis.

Though the number of AIS 3+ cranium injuries was low (all FSP) in the old car sample and so the result should be treated with caution, there was a substantial increase in the number of these injuries in the new car sample. Similarly a large but cautionary decrease in foot/ankle injury for older front seat occupants was observed.

Car to Car Impacts

Drivers
Table 5 shows the sample sizes for drivers in car to car frontal impacts and figures 51 – 55 illustrate the Odds Ratios outcomes.

Table 5: Sample size – drivers, car to car frontal impacts

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1711</td>
<td>2104</td>
</tr>
<tr>
<td>Male</td>
<td>1194</td>
<td>1319</td>
</tr>
<tr>
<td>Female</td>
<td>494</td>
<td>762</td>
</tr>
<tr>
<td>Young</td>
<td>1253</td>
<td>1460</td>
</tr>
<tr>
<td>Old</td>
<td>357</td>
<td>576</td>
</tr>
</tbody>
</table>
For car to car impacts, drivers in frontal impacts benefit in newer cars in terms of serious cranium, chest, pelvis, thigh and lower leg injury.
Disbenefits are seen for the neck, abdomen and knee.
There is no change in the serious injury rate for the foot/ankle.
It was not possible to calculate an Odds Ratio for the face.
The result for the abdomen needs to be treated with caution.
Male drivers in car to car frontal impacts have benefited in new cars in terms of serious cranium, face, chest, thigh, knee, lower leg and foot/ankle injury.

Disbenefits are seen for the neck, abdomen and pelvis.

The results for the face, neck and abdomen need to be treated with caution.

Female drivers in car to car frontal impacts have seen improvements in the serious injury rate for the cranium, face, chest, abdomen, thigh and lower leg in new cars.

Disbenefits have been observed for the knee and the foot/ankle.

There has been no change in the rate of AIS 2+ neck injury.

It was not possible to calculate an Odds Ratio for the pelvis.

The results for the cranium, face, neck, abdomen and lower leg need to be treated with caution.
Younger belted drivers in car to car frontal impacts have seen a reduction in the rate of serious injury in new cars for the cranium, face, chest, pelvis, thigh and lower leg.

Increases in serious injury rates are observed for the neck, knee and foot/ankle.

There has been no change in the rate of abdominal injury.

The results for face, neck and abdomen need to be treated with caution.
- Older belted drivers in car to car frontal impacts have seen a decrease in the rate of serious cranium, neck, chest, thigh, lower leg and foot/ankle injury in new cars compared with old cars.
- An increase in the serious injury rate is seen for the pelvis.
- There has been no change in the rate of AIS 2+ knee injury.
- It was not possible to calculate an Odds Ratio for facial or abdominal injuries.
- The results for the neck, pelvis, lower leg and foot/ankle need to be treated with caution.

**Front Seat Passengers**

Table 6 shows the sample sizes for front seat passengers in car to car frontal impacts and figures 56 – 60 illustrate the Odds Ratios outcomes.

**Table 6: Sample size – front seat passengers, car to car frontal impacts**

<table>
<thead>
<tr>
<th>FSP</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>516</td>
<td>686</td>
</tr>
<tr>
<td>Male</td>
<td>230</td>
<td>232</td>
</tr>
<tr>
<td>Female</td>
<td>269</td>
<td>432</td>
</tr>
<tr>
<td>Young</td>
<td>310</td>
<td>401</td>
</tr>
<tr>
<td>Old</td>
<td>105</td>
<td>154</td>
</tr>
</tbody>
</table>

**Figure 56 Front seat passengers – car to car frontal impacts**
• Belted front seat passengers in car to car frontal impacts have benefited in the rate of serious neck, chest, pelvis, thigh lower leg and foot/ankle injury in the new cars compared to the old cars.
• Disbenefits have been seen for the cranium and the abdomen.
• It was not possible to calculate Odds Ratios for the face, pelvis or knee.
• The results for the cranium, neck, abdomen, thigh and lower leg should be treated with caution.

Figure 57 Male front seat passengers – car to car frontal impacts

• Male front seat passengers have seen a decrease in the rate of serious injury in the newer cars for the cranium, thigh and foot/ankle in car to car frontal impacts.
• It was not possible to calculate Odds Ratios for any of the other body regions.
• All the results need to be treated with caution.
Female front seat passengers in car to car frontal impacts have benefited in newer cars for serious neck, chest, thigh, lower leg and foot/ankle injury.

A disbenefit has been seen for AIS 3+ abdominal injury.

Odds Ratios could not be calculated for the cranium, face, pelvis and knee.

The results for the neck, abdomen, thigh and lower leg should be treated with caution.
• Younger FSPs have benefited in newer car design in car to car frontal impacts in terms of serious cranium, chest, thigh and foot/ankle injury.
• Odds Ratios could not be calculated for any of the other body regions.
• The results for the cranium, chest and thigh need to be treated with caution.

Figure 60 Older front seat passengers – car to car frontal impacts

• Improvements in the rate of serious injury are seen for older FSPs in car to car frontal impacts for the neck, chest and thigh.
• It was not possible to calculate and Odds Ratio for any other body region.
• Results for the neck and thigh need to be treated with caution.
Car to Non Car Impacts

Drivers

Table 7 gives the sample sizes for drivers in car to non car frontal impacts whilst figures 61 – 65 show the Odds Ratio outcomes.

Table 7: Sample size – drivers, car to non car frontal impacts

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>494</td>
<td>1358</td>
</tr>
<tr>
<td>Male</td>
<td>348</td>
<td>881</td>
</tr>
<tr>
<td>Female</td>
<td>143</td>
<td>462</td>
</tr>
<tr>
<td>Young</td>
<td>332</td>
<td>1357</td>
</tr>
<tr>
<td>Old</td>
<td>110</td>
<td>271</td>
</tr>
</tbody>
</table>

Figure 61 Drivers – car to non car frontal impacts

- Improvements in the rate of serious injury are evident in new cars for all body regions except for the face when drivers in car to non car frontal impacts are considered.
- It was not possible to calculate an Odds Ratio for facial injury.
- The result for abdominal injuries should be treated with caution.
For male drivers in car to non car impacts, decreases in the serious injury rate are apparent for the cranium, chest, pelvis, knee, lower leg and the foot/ankle in new cars compared to old cars. Increases are evident for the abdomen and thigh. The AIS2+ neck injury rate was identical for the old and new cars. It was not possible to calculate an Odds Ratio for the face. The results for the neck, abdomen and pelvis should be treated with caution.
• For female drivers in car to non car frontal impacts, newer car design benefits serious injury outcome for all body regions except the face.
• It was not possible to calculate an Odds Ratio of the face.
• The results for the cranium, neck, abdomen, pelvis and lower leg should, however, be treated with caution.

![Bar chart showing injury severity for different body regions in young belted drivers in car to object impacts.](image)

**Figure 64 Younger drivers – car to car frontal impacts**

• Benefits in the new car sample are apparent for younger drivers in car to non car frontal impacts across all body regions.
• It was not possible to calculate an Odds Ratio for the face.
• The results for neck, abdomen and pelvis should be treated with caution.
For older drivers in car to non car frontal impacts benefits in the serious injury rates are seen for all body regions apart from the face and the chest.

The AIS 3+ chest injury rate is higher in the new cars than in the old cars.

It was not possible to calculate an Odds Ratio for the face.

All but the results for the foot and ankle should be treated with caution.

**Front Seat Passengers**

Table 8 shows the sample sizes for front seat passengers in car to non car frontal impacts whilst figures 66 – 70 illustrate the Odds Ratio outcomes.

**Table 8: Sample size – front seat passengers, car to non car frontal impacts**

<table>
<thead>
<tr>
<th>FSP</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>155</td>
<td>332</td>
</tr>
<tr>
<td>Male</td>
<td>58</td>
<td>159</td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
<td>169</td>
</tr>
<tr>
<td>Young</td>
<td>99</td>
<td>200</td>
</tr>
<tr>
<td>Old</td>
<td>33</td>
<td>67</td>
</tr>
</tbody>
</table>
Considering FSPs in car to non car impacts, the serious injury rates fall in the new cars for the neck, chest, abdomen and the foot/ankle.

The rates increase in the new cars for the cranium, the thigh and the lower leg.

It was not possible to calculate the Odds Ratios for the face, pelvis or knee.

All of the results apart from the chest should be treated with caution.
For male FSPs in car to non car frontal impacts it was only possible to calculate an Odds Ratio for the cranium. Here a disbenefit was seen in the new cars when compared to the old cars but this result should be treated with caution.

Figure 68 Female front seat passengers – car to non car frontal impacts

- Decreases in the serious injury rates are seen in the new cars for the neck, chest and abdomen when female FSPs in car to non car impacts are considered.
- Increases are apparent for the cranium, thigh, lower leg and foot/ankle.
- It was not possible to calculate an Odds Ratio for the face, pelvis or knee.
- Apart from the chest, all of the results should be treated with caution.
When younger FSPs in car to non car frontal impacts are considered, benefits in the new car sample are apparent for serious chest and lower leg injury outcome.

Disbenefits are seen for the cranium and the thigh.

It was not possible to calculate the Odds Ratios for the remaining body regions.

All of the results however need to be treated with caution.
• In the case of older FSPs in car to non car frontal impacts, it was only possible to calculate Odds Ratios for the chest and the foot/ankle.
• Minor benefits are seen in the new cars for serious chest injury outcome; more substantial benefits are seen for AIS 2+ foot/ankle injury outcome.
• Both results however should be treated with caution.
Struck Side Impacts

Car to All Objects

Table 9 shows the sample sizes for front seat occupants in struck side impacts, irrespective of impact object, whilst figures 71 – 75 illustrate the Odds Ratio outcomes.

**Table 9: Sample size – front seat occupants, all struck side impacts**

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>2028</td>
<td>1856</td>
</tr>
<tr>
<td>Male</td>
<td>1137</td>
<td>1106</td>
</tr>
<tr>
<td>Female</td>
<td>874</td>
<td>738</td>
</tr>
<tr>
<td>Young</td>
<td>1413</td>
<td>1327</td>
</tr>
<tr>
<td>Old</td>
<td>458</td>
<td>443</td>
</tr>
</tbody>
</table>

**Figure 71 Front seat occupants – all impact objects, struck side impacts**

- In struck side impacts, irrespective of impact objects, decreases in the rate of serious injury are seen for the chest pelvis and thigh in the new cars.
- Increases in serious injury rates are seen in the new cars for the cranium, neck, knee and foot/ankle.
- The facial, abdominal and lower leg injury outcome is identical in the old and new cars.
Figure 72 Male front seat occupants – all impact objects, 
stuck side impacts

- For males in stuck side impacts (all bullet objects), benefits for serious injury outcome in new car design are apparent for the chest, abdomen, pelvis, and thigh.
- Disbenefits are apparent for the cranium, neck, lower leg and foot/ankle.
- The serious injury rates for the face and the knee are identical.
- The results for the face and the knee need to be treated with caution.

Figure 73 Female front seat occupants – all impact objects, 
struck side impacts
• When female front seat occupants in struck side crashes are considered, decreases in the rate of serious injury are seen in the new cars for the chest, lower leg and the foot/ankle. Increases are seen for the cranium, neck, abdomen, pelvis, thigh and knee.

• It was not possible to calculate an Odds Ratio for the face.

• The results for the knee and the foot/ankle should be treated with caution.

![Figure 74 Younger front seat occupants – all impact objects, struck side impacts](image)

• Younger front occupants in struck side impacts have improvements in the serious injury rates to the chest, pelvis and thigh in the new cars compared to the old cars.

• Disbenefits are seen for the cranium, neck, abdomen, lower leg and foot/ankle.

• The rates for the face and the knee are identical in the new and old car samples.

• The result for the face should be treated with caution.
Older front seat occupants have lower serious injury rates in new cars struck side impacts compared to old cars for the cranium, chest, pelvis, thigh and lower leg.

A higher rate is seen in the new cars for serious neck injury.

The injury outcome is identical in the sample for the face, abdomen and foot/ankle.

It was not possible to calculate an Odds Ratio for the knee.

The results for the face, neck, abdomen, pelvis and foot/ankle should be treated with caution.

**Car to car**

Table 10 shows the samples sizes for front occupants in car to car struck side impacts; figures 76 – 80 illustrate the Odds Ratio outcomes.

**Table 10: Sample size – front seat occupants, car to car struck side impacts**

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>Old cars</th>
<th>new cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1301</td>
<td>962</td>
</tr>
<tr>
<td>Male</td>
<td>684</td>
<td>568</td>
</tr>
<tr>
<td>Female</td>
<td>600</td>
<td>386</td>
</tr>
<tr>
<td>Young</td>
<td>867</td>
<td>613</td>
</tr>
<tr>
<td>Old</td>
<td>330</td>
<td>298</td>
</tr>
</tbody>
</table>
In car to car struck side impacts, benefits in new cars are seen in the serious injury outcome for front seat occupant across all body regions other than the face and the knee.

There is an increase in the rate of AIS 3+ facial injury in the new cars compared with the old cars.

It was not possible to calculate an Odds Ratio for the knee.
• Considering male front seat occupants in struck side crashes, decreases in the rate of serious injury are observed in the new cars for all body regions other than the face, neck and the knee.
• The rate of AIS 2+ neck injury has increased in the new cars.
• It was not possible to calculate Odds Ratios for the face or the knee.
• The results for the abdomen, pelvis, thigh and foot/ankle need to be treated with caution.

**Figure 78 Female front seat occupants – car to car struck side impacts**

• Female front occupants in struck side crashes have benefited in the new cars in terms of serious injury outcome for the cranium, face, neck, chest, lower leg and foot/ankle.
• Disbenefits are seen for the abdomen, pelvis and thigh.
• It was not possible to calculate an Odds Ratio for the knee.
• The results for the face, neck, pelvis and foot/ankle need to be treated with caution.
Younger front occupants have seen benefits for serious injury outcome in the new car sample across all body regions other than the face, the neck and the knee.

A disbenefit is apparent for AIS 3+ facial injury.

The rate of AIS 2+ neck injury was identical in both car samples.

It was not possible to calculate the Odds Ratio for knee injury outcome.

The results for the pelvis, lower leg and foot/ankle need to be treated with caution.

Figure 80 Older front seat occupants – car to car struck side impacts

PPAD 9/033/128, S0221/VF
• Older car occupants have a lower rate of serious injury in new cars in struck side impacts for the cranium, chest, pelvis, thigh and lower leg.
• There is an increase in the rate of serious injury for the neck, abdomen and the foot/ankle.
• It was not possible to calculate Odds Ratios for the face or the neck.
• The results for the neck, abdomen, pelvis, thigh and foot/ankle need to be treated with caution.

It should be noted that though the number of serious pelvic and lower leg injuries for male drivers was low in the new car sample and hence the result considered cautionary, there was a significant decrease over the number seen in the old car sample. Similarly there are large but cautionary decreases in pelvic, lower leg and foot/ankle injury for younger occupants in the new cars compared with the old cars.

Car to Non Car

Table 11 gives the sample sizes for front seat occupants in car to non car struck side impacts whilst figures 81 – 85 illustrate the Odds Ratio outcomes.

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>726</td>
<td>857</td>
</tr>
<tr>
<td>Male</td>
<td>395</td>
<td>457</td>
</tr>
<tr>
<td>Female</td>
<td>274</td>
<td>337</td>
</tr>
<tr>
<td>Young</td>
<td>546</td>
<td>688</td>
</tr>
<tr>
<td>Old</td>
<td>128</td>
<td>134</td>
</tr>
</tbody>
</table>
Figure 81 Front seat occupants – car to non car struck side impacts

- In car to non car struck side impacts, decreases in the rate of serious injury occur in the new cars compared to the old cars for the thigh and the knee only.
- Increases are observed in all other body regions except for the face.
- The rate of AIS3+ facial injury is identical in the new and old cars.
- The results for the face, knee and foot/ankle need to be treated with caution.

Figure 82 Male front seat occupants – car to non car struck side impacts
• For male front occupants in car to non car impacts, benefits in the new cars are only seen for serious injury outcome in the abdomen and thigh.
• Disbenefits are evident for the cranium, neck, chest, pelvis, lower leg and foot/ankle.
• The serious injury rates for the face and neck are identical in the new and old cars.
• The results for the face, knee and foot/ankle need to be treated with caution.

![Female front occupants - Struck Side - Car to Object](image)

**Figure 83 Female front seat occupants – car to non car struck side impacts**

• Female front occupants in struck side impacts see a decrease in the rate of serious injury outcome in new cars for the knee and the lower leg.
• Increases are apparent for the cranium, chest, pelvis and thigh.
• It was not possible to calculate Odds Ratios for the face, neck, abdomen, or foot/ankle.
• The results for the cranium, pelvis, thigh, knee and the lower leg should be treated with caution.
Considering younger front seat occupants in struck side crashes, there is a decrease in the serious injury rate in the new cars for the face, thigh and knee. Increases are apparent for all other body regions. The results for the face, pelvis, knee and the foot/ankle need to be treated with caution.
• Older front seat occupants in struck side crashes benefit in the new cars in terms of serious injury outcome for the cranium, abdomen, pelvis and lower leg.
• A disbenefit is seen for the chest.
• It is not possible to calculate and Odds Ratio for the face, neck, thigh, knee, or foot/ankle.

Non Struck Side Impacts

Car to All Objects

Table 12 shows the sample sizes for front seat occupant in non struck side impacts, irrespective of object hit; figures 86 – 90 illustrate the Odds Ratio outcomes.

Table 12: Sample size – front seat occupants, all impact objects, non struck side impacts

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>old cars</th>
<th>new cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1707</td>
<td>1661</td>
</tr>
<tr>
<td>Male</td>
<td>970</td>
<td>948</td>
</tr>
<tr>
<td>Female</td>
<td>705</td>
<td>686</td>
</tr>
<tr>
<td>Young</td>
<td>1086</td>
<td>1134</td>
</tr>
<tr>
<td>Old</td>
<td>403</td>
<td>382</td>
</tr>
</tbody>
</table>

Figure 86 Front seat occupants – all impact objects, non struck side crashes
• In non struck side impacts, irrespective of impact object, front seat occupants have lower rates of serious injury in the new cars for the cranium, neck, abdomen, pelvis and the foot/ankle.
• The serious injury rate is higher in the new cars for the chest, knee and lower leg.
• The AIS 2+ thigh injury rate is identical for the old and new cars.
• It was not possible to calculate an Odds Ratio for facial injury.
• The results for the abdomen, pelvis, knee and the foot/ankle need to be treated with caution.

![Figure 87 Male front seat occupants – all impact objects, non struck side impacts](image)

• For male front occupants in non struck side crashes (all objects hit), benefits are seen in the new cars for the cranium, neck, abdomen, and the foot/ankle.
• Disbenefits are apparent for the chest, thigh and lower leg.
• It was not possible to calculate an Odds Ratio for the face, pelvis or knee.
• The results for the neck, abdomen, thigh, lower leg and the foot/ankle need to be treated with caution.
Considering female front occupants in non-stuck side crashes, irrespective of impact object, benefits in the rate of serious injury are seen in the new cars for the pelvis, thigh and foot/ankle.

Disbenefits are seen for the cranium, neck, chest, knee and lower leg.

It was not possible to calculate Odds Ratios for the face or the abdomen.

The results for the pelvis and all lower limb regions should be treated with caution.
• Younger occupants in non stuck side impact (all impact objects) have a lower rate of serious injury in new cars compared with old cars for the cranium, neck, abdomen and pelvis.
• The serious injury rate is higher in the new cars for the chest, knee and lower leg.
• The AIS2+ injury rates are identical for the thigh and the foot/ankle in the new and old car samples.
• It was not possible to calculate and Odds Ratio for the face.
• The results for the abdomen, pelvis, knee, lower leg and the foot/ankle should be treated with caution.

**Figure 90 Older front seat occupants – all impact objects, non struck side impacts**

• Considering older occupants in non struck side crashes (all impact objects) benefit are seen in the new cars for serious injury outcome to the cranium and the foot/ankle.
• Disbenefits are apparent for the neck, chest and the thigh.
• It was not possible to calculate Odds Ratios for the remaining boy regions (change chart)
• The results for the cranium, neck, thigh and foot/ankle should be treated with caution.
It should be noted that although the number of serious pelvic injuries for all front occupants was low in the new car sample and hence the result considered cautionary, there was a significant decrease over the number seen in the old car sample. Similarly there are large but cautionary decreases for neck injury in the male occupant sample and for cranium injury in the older occupant sample in the new cars compared with the old cars. A large increase in knee injury for all occupants was observed in the new cars compared with the old cars.

**Car to Car**

Table 13 gives the sample sizes for front seat occupants in car to car non struck side crashes whilst figures 91 – 95 show the Odds Ratio outcomes.

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>old cars</th>
<th>new cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1106</td>
<td>867</td>
</tr>
<tr>
<td>Male</td>
<td>618</td>
<td>421</td>
</tr>
<tr>
<td>Female</td>
<td>462</td>
<td>429</td>
</tr>
<tr>
<td>Young</td>
<td>677</td>
<td>571</td>
</tr>
<tr>
<td>Old</td>
<td>282</td>
<td>225</td>
</tr>
</tbody>
</table>

**Figure 91 Front seat occupants – car to car non struck side impacts**
- In car to car non struck side impacts, benefits are seen for front seat occupants in new cars compared to old cars for the cranium, neck, chest, abdomen, thigh and foot/ankle.
- Disbenefits are apparent for the knee and the lower leg.
- It was not possible to calculate Odds Ratios for the face or the pelvis.
- The results for the abdomen and all the results for the lower extremities should be treated with caution.

![Male front occupants - Non Struck Side - Car to Car](image)

**Figure 92 Male front seat occupants – car to car non struck side impacts**

- Male front seat occupants in car to car non struck side impacts have a lower rate of serious injury in the new cars for the cranium, neck, chest, thigh and the foot/ankle.
- The abdominal serious injury rate is identical in the new and old cars.
- It was not possible to calculate Odds Ratios for the face, pelvis knee or lower leg.
- The results for the neck, abdomen, thigh and foot/ankle need to be treated with caution.
Considering female front occupants in car to car non struck side impacts, benefits are seen in the new cars for serious cranium, chest and lower leg injuries.

A disbenefit is apparent for AIS 2+ neck injury.

The rate of AIS 2+ knee injury is identical for the two car samples.

It was not possible to calculate Odds Ratios for the remaining body regions.

The results for the cranium, knee and lower leg should be treated with caution.
Younger front occupants in car to car non-stuck side impacts have a lower rate of serious cranium, neck, chest, abdominal and thigh injuries in new cars compared to old cars.

The rate is higher in the new cars for serious knee and lower leg injury.

It was not possible to calculate an Odds Ratio for the face, pelvis or foot/ankle.

The results for the chest, abdomen, thigh, knee and lower leg should all be treated with caution.
• For older front occupants in car to car non struck side impacts, the only benefit in the new cars compared to the old is for the foot/ankle.
• Disbenefits are seen for the neck and the chest.
• It was not possible to calculate an Odds Ratio for the remaining body regions.
• The results for the neck and the foot/ankle should be treated with caution.

It should be noted that although the number of serious thigh and ankle injuries for all front occupants was low in the new car sample and hence the result considered cautionary, there was a significant decrease over the number seen in the old car sample. Similarly, there are large but cautionary decreases for neck injury in the male occupant sample and for pelvis and thigh injury in the female occupant sample, in the new cars compared with the old cars.

Car to Non Car

Table 14 shows the sample sizes for front seat occupants in car to non car non struck side impacts. Figures 96-100 illustrate the Odds Ratio outcomes.

Table 14: Sample size – front seat occupants, car to non car non struck side impacts

<table>
<thead>
<tr>
<th>Front seat occupants</th>
<th>Old cars</th>
<th>New cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>600</td>
<td>758</td>
</tr>
<tr>
<td>Male</td>
<td>350</td>
<td>502</td>
</tr>
<tr>
<td>Female</td>
<td>242</td>
<td>244</td>
</tr>
<tr>
<td>Young</td>
<td>405</td>
<td>541</td>
</tr>
<tr>
<td>Old</td>
<td>121</td>
<td>153</td>
</tr>
</tbody>
</table>
In car to non car stuck side impacts benefits are seen for front occupants in new cars compared to old cars for serious cranium, neck, and abdominal injury.

Disbenefits are apparent for the chest, thigh and lower leg.

It was not possible to calculate Odds Ratios for the remaining body regions.

The results for the neck, abdomen, thigh and lower leg should be treated with caution.
• Male front occupants in car to non car impacts have a lower rate of serious injury in new cars compared to old cars for the cranium, neck, abdomen, pelvis and lower leg.

• A higher rate of serious injury in the new cars is apparent for the chest and the thigh.

• It was not possible to calculate Odds Ratios for the remaining body regions.

• The results for the neck, abdomen, pelvis, thigh and lower leg need to be treated with caution.

---

![Figure 98 Female front seat occupants – car to non car non stuck side impacts](image)

---

• For female front occupants in car to non car non struck side impacts, the only benefit in the new cars compared to the old is for serious neck injury.

• Disbenefits are apparent for the cranium, chest and thigh.

• It was not possible to calculate Odds Ratios for the remaining body regions.

• The results for the cranium, neck and thigh need to be treated with caution.
Younger front occupants in car to non car, non struck side impacts, have a lower rate of serious injury in new cars compared to old cars for the cranium, neck, abdomen and lower leg.

They have a higher rate of serious injury in new cars for the chest and the thigh.

It was not possible to calculate Odds Ratios for the remaining body regions.

The results for the neck, abdomen, thigh and lower leg need to be treated with caution.

Figure 99 Younger front seat occupants – car to non car non struck side impacts
Older front seat occupants in car to non car, non struck side impacts, benefit in terms of serious injury outcome in the new car sample for the cranium and the chest.

It was not possible to calculate the Odds Ratios for the remaining body regions.

All of the results need to be treated with caution.
Appendix 2: Time Line
# Frontal and Side Impact Protection Policy Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958</td>
<td>The 1958 UN agreement supervised by WP 29, the Inland Transport Committee’s Working Party on the Construction of Vehicles</td>
</tr>
<tr>
<td>1960s</td>
<td>Infamous design fault in the Chevrolet Corsair was the start of public demand for improvements in vehicle safety and the first vehicle safety legislative development (US) in 1967. Mackay (1988) later described this first generation of standards on which subsequent European standards were based as arbitrary design rules which lacked comprehensive justification</td>
</tr>
<tr>
<td>1970</td>
<td>The EEVC was founded in 1970 in response to the US Department of Transportation’s initiative for an international programme on experimental safety vehicles. EC Directive 70/156/EEC sets out EU-wide requirements for the type approval of vehicles</td>
</tr>
<tr>
<td>1972</td>
<td>Ralph Nader awakened consumer and media interest in unsafe vehicle design and car industry action to avoid or water down legislation in Unsafe at any speed</td>
</tr>
<tr>
<td>1975</td>
<td>HYBRIDIII dummy available. UN ECE Regulation 33 on structural frontal impact protection, July 1975. US IIHS publish crash data from insurance claims</td>
</tr>
<tr>
<td>1978</td>
<td>1978-81 EC Side impact project, ARU Birmingham University /TRL. First frontal crash tests in US – 100% full width frontal barrier test US FMVSS 208 (48km/h). Start of US NCAP using US FMVSS 208 at 56 km/h</td>
</tr>
<tr>
<td>Year</td>
<td>Event/Development</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>1980</td>
<td>Start of whole vehicle testing for research and development and consumer testing, but regulations only require component testing. Each country pursuing its own research themes with some co-ordination at EEVC</td>
</tr>
<tr>
<td>1982</td>
<td>EEVC proposes a standardised test procedure for cars using movable deformable barrier in a full scale test using EuroSID dummy</td>
</tr>
<tr>
<td>1983</td>
<td>CCIS began</td>
</tr>
<tr>
<td>1984</td>
<td>Development of deformable barrier – TRRL funded by DfT</td>
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<tr>
<td>1985</td>
<td>ERGA Passive Safety group set up by EC and Member States in July 1985 to study possibilities for adapting existing EEC Directives to adapt to technical progress</td>
</tr>
<tr>
<td>1986</td>
<td>European Road Safety Year</td>
</tr>
<tr>
<td>1987</td>
<td>First UK casualty reduction targets: Road safety: the next steps</td>
</tr>
<tr>
<td>Year</td>
<td>Research and development/ promotion of test procedures and technical basis etc.</td>
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<td>------</td>
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</tbody>
</table>
| 1989 | UK and Australian research confirm that the involvement of the full frontal structure is the exception to the rule  
Hobbs 1992\(^{20}\)  
Filides et al 1991\(^{26}\)  
UK DfT, casualty savings for next 10-15 years highlights importance of veh measures  
Frustration from DfT and UK researchers about standards negotiated internationally and influenced by purely industrial view  
Increased role of real world accident data in research programmes  
EEVC Working Group 9 presents final recommendations from to side impact test procedures to 12 ESV Conf in Melbourne  
ERGA safety group reports on its work to the European Commission. One recommendations is the take up of EEVC side impact test recommendations  
European car industry puts forward proposal for Composite Test Procedure for side impact | Package of proposed legislative road safety measures put forward in 1989 by the European Commission (e.g. harmonised blood alcohol and speed limits) | | |
<p>| 1990 | Political Agenda develops– mainly research up till now | | | |</p>
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>Creation of EEVC WG11 on frontal impact protection. Polarisation between industry views and UK research led view UK raises public awareness with TV programme</td>
<td>The American side impact test procedure is adopted in US in FMVSS 214 with different barrier to European barrier</td>
</tr>
<tr>
<td></td>
<td>Side impact test procedure (90 degree impact with moving barrier with ground clearance height of 300mm) developed by EEVC EEVC Working Group 9 - Specification of the EEVC Side Impact Dummy EuroSID-1. April 1990</td>
<td>Political need for new frontal impact test acknowledged and 3 proposals under consideration: 1) angled barrier test 2) draft EEVC proposal 3) proposal based on FMVSS 208 but discussions stalled until 1993</td>
</tr>
<tr>
<td>Year</td>
<td>Event/Comment</td>
<td>UN ECE legislation/other national legislation</td>
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<td>------</td>
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<tr>
<td>1992</td>
<td>A UK study estimates that better frontal impact test procedure could lead to a saving of 65,000 deaths and serious injuries in EU countries. Also that better side impact test procedure could lead to a saving of 25,000 deaths and serious injuries in EU countries. These statistics later used by NGOs and the European Commission. WALL J.G., Vehicle safety-what are the needs? Transport Research Laboratory, Proceedings of the XXIV FISITA Congress, June 1992, IMechE, UK, 1992.</td>
<td>The 92/53 EEC Directive established European Community Whole Vehicle Type Approval (ECWVTA) for cars</td>
</tr>
<tr>
<td>1993</td>
<td>EEVC Working Group 9 - Side Impact Test Procedures - Final Report. In view of concern about absence of evidence-based road safety policymaking in Brussels, European Transport Safety Council established by PACTS and German, Dutch orgs. with publication of comprehensive report on vehicle safety distributed to policymakers in EU institutions and nationally. Reducing traffic injuries through vehicle safety improvements: the role of car design. Final report and technical annexes, ETSC, 1993 looked critically at the options for a new European frontal impact test, highlighting the superiority of the EEVC ODB test and how UN ECE had dragged its feet generally on updating vehicle safety standards – legislative standards 20 years behind the needs identified by crash research. ETSC joins forces with the European consumer organisation, BEUC, to put the case to the EU institutions and Member States for improvements in vehicle crash protection standards.</td>
<td>UN ECE side impact regulation agreed with barrier height of 260mm</td>
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<tr>
<td>Year</td>
<td>Event</td>
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<tr>
<td>1994</td>
<td>Policy Bifurcation point – less UK resources into regulation and large investment into developing consumer rating NCAP – research feeds both</td>
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<td></td>
<td>Research and development/ promotion of test procedures and technical basis etc.</td>
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<td></td>
<td>UN ECE legislation/other national legislation</td>
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<tr>
<td></td>
<td>EC legislation</td>
<td></td>
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<tr>
<td></td>
<td>Consumer information</td>
<td></td>
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<tr>
<td>1994</td>
<td>EEVC completing validation results on frontal ODB test to ensure repeatability</td>
<td></td>
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<tr>
<td></td>
<td>EEVC WG 11 presents new frontal impact test procedure to 14th ESV Paper No 96-S3-O-28</td>
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<td></td>
<td>ARU, Loughborough conducts measurements of front stiff structure heights and concludes that 260m barrier clearance is far too low</td>
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<td></td>
<td>ETSC symposium in European Parliament – UK TRL presents evidence to show that Stage 1 of frontal impact proposal barely justifiable on safety grounds.</td>
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<tr>
<td></td>
<td>Also evidence to show that reducing the barrier height to 260mm and excluding viscous criteria will reduce potential protection to car occupants</td>
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<td></td>
<td>Experts and MEPs argue for removal of Stage 1 of both legislative proposals and immediate adoption of Stage 2.</td>
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<td></td>
<td>One manufacturer, Fiat had demonstrated on road feasibility of side impact barrier height.</td>
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<td></td>
<td>EC issues a 2 stage proposal for legislation for frontal impact protection on 13.12.94 (COM(94)520 final comprising a Stage 1 30 degree rigid barrier test and anti-slide device for new car types (1.10.95) and Stage 2 and ODB test by (1.10.98), though the detail of Stage 2 is not included in the proposal for a Directive</td>
<td></td>
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<tr>
<td></td>
<td>The UK Department of Transport assists in establishing a legislative amendment (EEVC ODB test procedures and requirements) to the EC proposal tabled (and later accepted) by the European Parliament</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC issues a 2 stage proposal for legislation for side impact protection (COM(94)519 final, based on the UN ECE Regulation comprising a Stage 1 test for a 260mm barrier for new car types (1.10.95) and Stage 2 with a barrier height of 300mm by ODB test by (1.10.2001)</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Research and development/ promotion of test procedures and technical basis etc.</td>
<td>UN ECE legislation/other national legislation</td>
</tr>
<tr>
<td>------</td>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td>1995</td>
<td>1st edition of ETSC’s CRASH newsletter on vehicle crash protection</td>
<td>Cross party European Parliamentary resolution tabled on 7.2.94 expressing concern that new EC proposals do not reflect best practice</td>
</tr>
<tr>
<td></td>
<td>FIA joins the ETSC/BEUC NGO campaign for research-based improvements to the crash test proposals</td>
<td>Given Parliament’s of co-decision for Single Market legislation, the Commission’s proposals discussed formally by European Parliamentary Committees. The lead Committee was Economic and monetary Affairs – rapporteur UK MEP</td>
</tr>
<tr>
<td></td>
<td>ETSC develops and shows video for policymakers ‘Legislating for Safety’ to explain why changes are needed to Commission’s front and side impact proposals.</td>
<td>Stage 1 frontal impact proposal unanimously rejected in favour of going straight to Stage 2 with a review, Strasbourg plenary in July 1995</td>
</tr>
<tr>
<td></td>
<td>Pete Thomas and John Charles paper to Washington Dec 1995 to conclude that driver risk of AIS 2+ lower limb injury was 52% greater than passenger risk – down to presence of pedals and other structures</td>
<td>The Stage 1 of side impact proposal also unanimously rejected in favour of going straight to Stage 2 (300 m barrier height) to be met by new types from 1.10.1998 in Strasbourg plenary, July 1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DfT attends key meeting in Brussels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commission amended front impact proposal published 27.11.95 (COM(95) 510 final</td>
</tr>
<tr>
<td>Year</td>
<td>Research and development/promotion of test procedures and technical basis etc.</td>
<td>UN ECE legislation/other national legislation</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>1996</td>
<td>An analysis of car to car accidents in Sweden between 1994 and 1996 showed a decrease of 35% in the relative risk of fatal and severe injury associated with 'new' car designs compared with 'old' designs</td>
<td>EC Whole Vehicle Type Approval for cars is in force from 7th January 1996</td>
</tr>
<tr>
<td></td>
<td>EEVC WG11 propose tibia and foot certification tests</td>
<td>EC Council of Ministers agree new frontal impact Directive, 28.05.96 accepted by the Commission on 13.06.96.</td>
</tr>
<tr>
<td></td>
<td>Frontal and side impact Directives require 2 year review</td>
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<tr>
<td>1997</td>
<td>DfT produces projections of potential savings from vehicle safety measures to meet national target</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VSRC, UK, showed that front impact test speed is too slow</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Research and development/ promotion of test procedures and technical basis etc.</td>
<td>UN ECE legislation/other national legislation</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>1998</td>
<td>UN ECE Agreement on Global Technical Regulations&lt;br&gt;Implementation date of 1.10.98 for new EC frontal and side impact test legislation&lt;br&gt;Discussion in background in Europe about whether to increase the frontal impact Directive speed since manufacturers are designing for higher speed with EuroNCAP</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>EEVC presents further recommendations to EC DG Enterprise for further revision of front and side impact Directives (<a href="http://www.eevc.org">www.eevc.org</a> - visited 16.6.04)</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
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</tbody>
</table>
Appendix 3: Topic Guides
Vehicle Safety Standards – Improving Car Crashworthiness
Policy Evaluation Programme

**Topic Guide for Industry**

The purpose of this interview is to establish industry’s views about the introduction and influence of the front and side impact Regulations and EuroNCAP.

START: 1) Introduce yourself and explain the purpose of the interview. 2) ask the interviewee to introduce themselves briefly, by giving their name, current role, how long they have been with the company and whether they were directly involved with the introduction of the Regulations and EuroNCAP and if so, in what capacity.

**THE REGULATIONS**

Impact

1. How have the regulations influenced design in your company?

2. Have the levels of protection afforded to an occupant in an accident improved since the introduction of front and side impact Regulations?

3. If so, are these improvements the result of the Regulations or other factors?

PROBE

- Would your vehicles have the same safety design features without the regulatory requirement?

- Would you have implemented the same level of protection to reduce injury risk without the front and side impact Regulations? If yes, why and over what timescale?

4. What are the additional benefits / disbenefits of whole vehicle testing versus component testing?

5. Have the Regulations promoted a process of continuous improvement in crashworthiness performance?
6. Do you feel that either the front or side impact Regulations have led you to optimise systems for specific impact scenarios?

7. Has this optimisation disadvantaged any particular vehicle user group? (Women, children, elderly, people with disability)

**PROBE**

- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in vehicles that are less safe than they might otherwise be in other crash scenarios?

- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in additional problems of compatibility?

8. Have vehicle modifications designed to improve performance under the Regulations resulted in vehicles that are less / more pedestrian friendly?

**Investment decisions and cost (Ensure costs only apply to meeting the regulations)**

9. What is the timescale for investment decisions on improving the crashworthiness of cars?

10. At what stage in the formulation/implementation of the Regulations did you start to take account of them in design and investment decisions? (We should anticipate different answers for front and side impact)

11. What has been the burden to the industry in terms of modifications required for meeting the Regulations?

12. What has been the cost for each production vehicle? Identify direct and indirect costs.

13. Does the company separately identify the cost of meeting the Regulations? When considering new investment is the cost of meeting the Regulations considered?

**Process**

14. What were the driving forces behind the introduction of the side and front impact Regulations?

15. Why were the Regulations proposed at the time they were?

16. Why were regulations introduced later in Europe than the USA?

17. Were you, from the outset, supportive of front and side impact Regulations? If so why; if not, why not?
PROBE

- Check difference in responses to side and front regulations
  - Did you want a lower barrier height in the side impact test? If so, why?
  - Why was there such a debate on the impact speed, angle and overlap for the front impact Regulation?
  - Was there any merit in delaying the introduction of the Regulations?
  - Could the introduction of the Regulations have been managed/delivered differently?

18. Through which channels did you make your views known?

PROBE details of lobbying of:

- Government
- European Commission (which DG?)
- European Parliament
- Trade associations
- Other manufacturers
- Media
- Other
- Did manufacturers coordinate their response?
- Were the Regulations modified to take account of the views of the car industry?

PROBE

- Were you able to change the original proposal? If yes, how?
- What support did you receive?
- Was your position supported by your government? Why?/why not? If yes, in what way did they support you?
- What positions were taken by the different governments and car manufacturers?

19. Now that the regulations are established, how supportive are you of the regulations?

20. Do you think, given the current performance of cars in the consumer test, that it would be appropriate to raise the speed of the front impact Regulations tests in line with EuroNCAP?

EuroNCAP

Impact

21. How has EuroNCAP influenced design

22. Have the levels of protection afforded to an occupant in an accident improved since the introduction of EuroNCAP?
23. If so, are these improvements the result of EuroNCAP or other factors?

PROBE

- Would your vehicles have the same safety design features without EuroNCAP.
- Would you have implemented the same level of protection to reduce injury risk without EuroNCAP. If yes, why?

24. Has EuroNCAP promoted a process of continuous improvement in crashworthiness performance?

25. Do you feel that EuroNCAP has led you to optimise systems for specific impact scenarios?

26. Has this optimisation disadvantaged any particular vehicle user group? (Women, children, elderly, people with disability)

PROBE

- Have vehicle modifications designed to meet the requirements of EuroNCAP resulted in vehicles that are less safe than they might otherwise be in other crash scenarios?
- Have vehicle modifications, designed to meet the requirements of EuroNCAP, resulted in additional problems of compatibility?

27. Have vehicle modifications designed to improve performance under EuroNCAP resulted in vehicles that are less / more pedestrian friendly?

28. Has EuroNCAP modified consumer attitudes towards purchasing cars?

29. How do you see the future of EuroNCAP as an approach for further improvements in car crashworthiness?

Investment decisions and cost

30. At what stage in the formulation/implementation of EuroNCAP did the company start to take account of it in design and investment decisions?

31. What has been the burden in order to achieve good ratings in the EuroNCAP programme?

32. Does the company separately identify the cost of meeting the requirements of EuroNCAP? When considering new investment is the cost of meeting EuroNCAP considered?
33. What has been the average cost to each typical production vehicle? (They may not breakdown costs to this level)

**Process**

34. What were the driving forces behind the introduction of EuroNCAP?

35. Why was EuroNCAP proposed at the time it was?

36. Were you opposed to EuroNCAP when it was first introduced? If so, why?

37. Through which channels did you make your views known? To whom and when?

**PROBE** details of lobbying of:

- Government
- European Commission (which DG?).
- European Parliament
- Trade associations
- Other manufacturers
- Media
- Other
- Did manufacturers coordinate their response? If so, how?
- Was EuroNCAP modified to take account of the views of the car industry?

**PROBE**

- Were you able to change the original proposal? If yes, how?
- What support did you receive?
- Was your position supported by your Government? Why?/why not? If yes, in what way did they support you?
- What positions were taken by the different Governments and car manufacturers?

38. Now that EuroNCAP is established, how supportive are you of the Programme? (probe turning point if appropriate)

39. What was your reaction to the publication of named individual vehicle test results?

40. Did you feel any pressure to perform well in the early EuroNCAP tests (over and above other consumer tests such as ADAC, AU)?

41. Do you use the EuroNCAP results in marketing? Do you feel that a higher score is an advantage even if not directly used in marketing and why?

42. Could the development/introduction of EuroNCAP have been managed/delivered differently?
43. How comfortable do you now feel with the way the EuroNCAP development process works?

REGULATIONS VERSUS CONSUMER TESTING

44. What is the driving force in car crashworthiness performance?

45. Which approach (Regulation/EuroNCAP) has been the more effective?

46. If EuroNCAP has been most effective, is there still a role for regulation and vice versa.

47. What is your view of publications that rate one make and model against another using insurance and accident data?

48. Do you feel that such rankings influence your investment into car crashworthiness?

49. Do you get a more efficient and widespread deployment of safety benefit through regulation or consumer testing?

UK INPUT

50. Were there any governments in particular that took the lead in promoting the Regulations?

51. Are there any governments in particular that take the lead in promoting EuroNCAP?

52. What has been the role of the European Commission/European Parliament in promoting car crashworthiness/the Regulations/ EuroNCAP?

53. How would you rate the UK DfT initiatives as being the driving force behind the development and implementation of the front and side impact Regulations when compared to (your own and) other European governments?

54. How would you rate the UK DfT initiatives as being the driving force behind the development and implementation of the EuroNCAP programme when compared to (your own and) other European governments?

55. In your opinion what has been the overall impact of the regulations and EuroNCAP programme? - Successes and Failures?

Probe future and diversity of crash testing versus virtual testing if not already covered
The purpose of this interview is to establish the views of research groups about the introduction and influence of the front and side impact Regulations and EuroNCAP.

START: 1) Introduce yourself and explain the purpose of the interview. 2) ask the interviewee to introduce themselves briefly, by giving their name, current role, how long they have been with the organisation and whether they were directly involved with the introduction of the Regulations and EuroNCAP and if so, in what capacity.

THE REGULATIONS - Include questions referring to Any Standards and Regulations

Impact

1. Did the levels of protection afforded to an occupant in an accident improve as a result of the introduction of front and side impact Regulations?

2. If so, are these improvements the result of the Regulations or other factors?

PROBE

o In your opinion would vehicles have had the same safety design features without the regulatory requirement?

o In your opinion would Manufacturers have implemented the same level of protection to reduce injury risk without the front and side impact Regulations? If yes, why?

3. What are the additional benefits / disbenefits of whole vehicle testing versus component testing?

4. Have the Regulations promoted a process of continuous improvement (?) in crashworthiness performance?

5. Do you feel that either the front or side impact Regulations have led to optimisation of systems for specific impact scenarios?
6. Has this optimisation disadvantaged any particular vehicle user group? (Women, children, elderly, people with disability) Were they more (or less) disadvantaged than they would have been without the regulations?

**PROBE**

- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in vehicles that are less safe than they might otherwise be in other crash scenarios?
- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in additional issues of compatibility?

7. Have vehicle modifications designed to improve performance under the Regulations resulted in vehicles that are less/ more pedestrian friendly?

8. Do you think, given the current performance of cars in the consumer test, that it would be appropriate to raise the speed of the front impact Regulation in line with EuroNCAP?

**Investment decisions and cost**

9. What was the anticipated burden to the industry in terms of modifications required for meeting the Regulations?

10. Was industry’s timescale for investment decisions on improving the crashworthiness of cars taken into account when the Regulations were introduced?

11. What was the envisaged average cost to the industry for each typical production vehicle?

12. What was the research programme budget? Whose budget?

**PROBE**

- If, how and why it changed over time.

**Process**

13. What were the driving forces behind the introduction of the side and front impact Regulations?

14. Why were the Regulations proposed at the time they were?

15. Why were regulations introduced in the US before Europe?

16. Was there opposition from the industry to the front and side impact Regulations? If so, to what and why?
PROBE

- Why did industry want a lower barrier height in the side impact test?
- Why was there such a debate on the impact speed, angle and overlap for the front Regulation?
- Was there any merit in delaying the introduction of the Regulations?
- Could the introduction of the Regulations have been managed/delivered differently?

17. How strong was the industry view / opposition?

18. Through which channels did the car industry make its views known?

19. Were the Regulations modified to take account of the views of industry?

PROBE

- How was industry able to change the original proposal?
- What support did industry receive from their national governments?
- What positions were taken by the different governments and car manufacturers?
- In your view did the modifications made strengthen or weaken the level of protection given to occupants in an accident?

EURONCAP

Impact

20. Have the levels of protection afforded to an occupant in an accident improved since the introduction of EuroNCAP?

21. If so, are these improvements the result of EuroNCAP or other factors?

PROBE

- In your opinion would manufacturers have implemented the same level of protection to reduce injury risk without EuroNCAP? If yes, why? – not a research group question - delete

- To what extent has EuroNCAP promoted a process of continuous improvement in crashworthiness performance?

22. Do you feel that EuroNCAP has led industry to optimise systems for specific impact scenarios?
PROBE

- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in vehicles that are less safe or safer than they might otherwise be in other crash scenarios?

- Have vehicle modifications, designed to meet the requirements of the Regulations, resulted in additional problems of compatibility?

23. Have vehicle modifications designed to improve performance under the Regulations resulted in vehicles that are less / more pedestrian friendly?

24. Has EuroNCAP modified consumer attitudes towards purchasing cars?

25. Do you feel that such rankings influence the industry’s attitude towards car safety? (Probe into possible crossover into primary safety)

26. Do you feel that such rankings influence the industry’s investment in design?

27. How do you see the future of EuroNCAP as an approach for further improvements in car crashworthiness?

28. Do you see a benefit in publications such as DfT’s ‘Choosing safety’?

29. What is your view of publications that rate one make and model against another using insurance and accident data? (Is this what you mean by the above question?)

Costs

30. What has been the burden for industry to achieve good ratings in the EuroNCAP programme?

Process

31. What were the driving forces behind the introduction of EuroNCAP?

32. Why was EuroNCAP proposed at the time it was?

33. Why was EuroNCAP introduced later than its US counterpart?

34. Was there opposition from the industry to EuroNCAP? If so, what strength of opposition and why?

35. What positions were taken by the different governments and car manufacturers?
36. Through which channels did industry make its views known? To whom and when?

37. Was EuroNCAP modified to meet industry’s concerns? If so how?

38. In your view, did the modifications strengthen or weaken the protection given to occupants in an accident?

39. What was industry’s reaction to the publication of named individual vehicle test results?

40. Did you think that industry was put under pressure to perform well in the early EuroNCAP tests (over and above other consumer tests such as ADAC, AuS)?

41. Could the development/introduction of EuroNCAP have been managed/delivered differently?

REGULATIONS VERSUS CONSUMER TESTING

42. What is the driving force in car crashworthiness performance?

43. Which approach (Regulation/EuroNCAP) has been the more effective?

44. In your opinion if EuroNCAP has been most effective, is there still a role for regulation and vice versa? What should the future role be? Are they complimentary?

45. Do you get a more efficient and widespread deployment of safety benefit through regulation or consumer testing?

UK INPUT

46. Were there any governments in particular that took the lead in promoting the Regulations?

47. Are there any governments in particular that take the lead in promoting EuroNCAP?

48. What has been the role of the European Commission/European Parliament in promoting car crashworthiness/the Regulations/ EuroNCAP?

49. How would you rate the UK DfT initiatives / efforts as being the driving force behind the development and implementation of the front and side impact Regulations when compared to (your own and) other European Governments?
50. How would you rate the UK DfT initiatives as being the driving force behind the development and implementation of the EuroNCAP programme when compared to (your own and) other European Governments?

51. In your opinion what has been the overall impact of the regulations and EuroNCAP programme? - Successes and Failures?