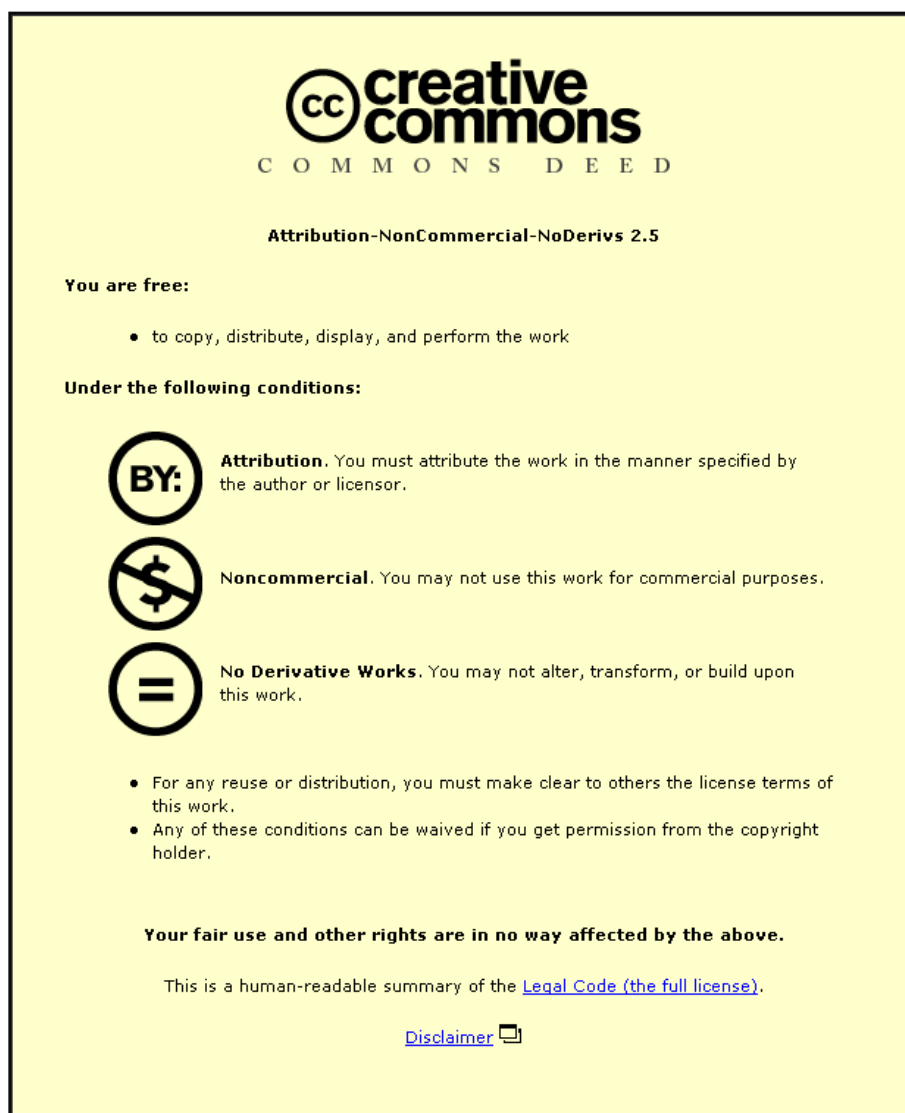




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THE METHODOLOGY OF ON THE SPOT ACCIDENT INVESTIGATIONS IN THE UK

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ABSTRACT

A new 'On-The-Spot' (OTS) accident research project is now underway in the UK. This project enables expert investigators to attend the scene of an accident within 15 minutes of the incident occurring, which allows the collection of accident data that would otherwise be quickly lost. This paper considers previous studies and the justification for a new research approach before describing methodology used on the spot and during subsequent follow-up research. Investigations focus on all types of vehicles (including damage, failures, features fitted and their contribution); the highway (including design, features, maintenance and condition); the human factors (including drivers, riders, passengers and pedestrians); and the injuries sustained. Five hundred crashes will be studied in depth each year. The project objectives include establishing an in-depth database that will permit analyses to better understand the causes of crashes and injuries, and assist in the development of solutions.

INTRODUCTION

In order to develop effective strategies to reduce road crashes and injuries, national administrations and the motor industry have long recognised the need to determine what is happening in the real world. This is best achieved through carrying out in-depth crash investigations.

The UK was home to some of the earliest rigorous and scientific on-the-spot crash research carried out at the scene of road traffic crashes. Such in-depth investigations were begun in the UK by Starks and Miller at the Road Research Laboratory (DSIR, 1963). Mackay subsequently founded the Accident Research Unit at the University of Birmingham (Mackay, 1969) and put a multidisciplinary team in place to research the causes of crashes, the causes of injuries and vehicle crashworthiness. This work was expanded by Ashton et al. (1977) to include on-the-spot pedestrian crash research yielding results relating vehicle design, velocity and injury patterns. A further team at the TRRL also conducted on-the-spot accident investigations (Sabey et al., 1975) assessing factors that included the causes of crashes.

Sabey et al. went on to quantify the role in road accidents of environment, vehicle and human factors.

Current On-The-Spot Studies

There are a number of on-the-spot accident investigation studies active across Europe today. These include the in-depth database maintained by the team at MUH (Otte, 1997), and the work of INRETS (Girard, 1993) currently examining crash causation in Salon de Provence and pedestrian injuries in Lyon. The European Accident Causation Study (EACS, 1998) is jointly funded by the European car constructors (ACEA) and the European Commission to study vehicle, road, traffic and human behaviour, together with some attention to the causes of injuries. EACS functions in addition to a number of independent studies conducted by several of the motor manufacturers.

Despite the considerable value of on-the-spot accident research, it has possibly not made the greatest contribution to in-car safety over the past twenty years. This is because a number of real world, retrospective studies have operated over this time and have played a much more important role in providing detailed in-depth crash injury data. One of the best-respected studies is the UK Co-operative Crash Injury Study (CCIS, 2001) which has been running since 1983. Similar studies are operated by NASS in the United States.

Mackay et al. (1985) described the retrospective approach and the benefits found in comparison to on-the-spot methods. Retrospective studies, such as the CCIS, are inherently more cost effective because resources are focused on crashworthiness and injury investigations without additional costs associated with maintaining personnel on standby for long periods. Investigators examine cars at recovery yards, often several days post-impact. Thus the CCIS has been able to build a large, detailed crash-injury database that continues to provide valuable inputs to the regulatory and vehicle design processes. Carsten et al. (1989) also demonstrated the value of such retrospective investigations in studying the causes of urban crashes.

However, the retrospective approach can not be used to obtain perishable (volatile) accident data such as

trace marks on the highway, pedestrian contact marks on vehicles, the final resting position of the vehicles involved and weather, visibility and traffic conditions. Such information is lost during the clearing of the accident scene and it is only by prompt attendance at the scene of the crash that such information can be reliably obtained. Indeed, a review of retrospective studies will show that the breadth of good quality data obtained is not generally as extensive as the results obtained by on-the-spot studies. It is possible, for example, to obtain accurate measurements of the positions of debris and of the vehicles themselves after the impact, instead of having to rely on sketches from drivers or police officers. Furthermore, interviews with those directly or indirectly involved in the crash may be attempted. Here there is the further advantage that the interviewee will have a recent memory of events and will not have had time for memory to be modified or for details to be forgotten.

Concern is now increasing for pedestrians and other vulnerable road users. Governments and vehicle manufacturers are recognising that all road users need to be protected, and as such are interested in not only the consequences of road crashes, but also in crash causation, road user behaviour and the effects of road engineering. Much of the information that is necessary to understand these complex issues is found at the scene of the crash and is lost once the accident scene is cleared. Current and accurate real world data is needed and, as noted by Mackay et al. (1985), retrospective methods are not adequate for investigating pedestrian impacts.

The New OTS Project

OTS is a new on-the-spot accident investigation method developed to overcome a number of limitations previously encountered. The new UK teams work closely alongside local police. This link is strengthened by the inclusion of a serving police officer on each team, which ensures a secure, direct and reliable link with the local police command and control system which provides immediate crash notifications. Response vehicles are used, driven by the OTS police officers, to give brisk journey times to the scene. In this way, it is possible to cover larger catchment areas than has previously been possible. It is a combination of the relatively large areas and increased traffic densities on modern roads that result in larger crash sample sizes than were attained in some earlier studies.

OTS is the result of over two years of preparation in the UK. The full project protocol was assembled by

Morris et al. (1999c) based on modules developed using a range of expertise from the VSRC (Morris et al., 1999a), TRL (Turner et al., 1999) and BARC (Hill et al., 1999 a & b). The method was tested and further developed using pilot studies in Nottinghamshire and the West Midlands over 1998 and 1999 (Morris et al., 1999b).

The data gathered by the project focuses on:

- All types of vehicles (including damage, failures, features fitted and their contribution).
- The highway (including design, features, maintenance and condition).
- The human factors (including drivers, riders, passengers and pedestrians and, where possible, data on the training, experience and other road user aspects that might have influenced the cause of the crash).
- The injuries sustained.

Protocols have been developed in line with recent international activities. These include the EC proposals for the development of a Pan-European Accident Database based on recommendations from the STAIRS project (STAIRS, 1998 and Ross et al., 1998). Similarly, the OECD RS9 Committee's Common International Methodology for In-depth [motorcycle] Accident Investigations (OECD, 1999) were considered when developing the protocols for motorcycle accident investigation. This has resulted in the UK OTS protocols being developed in line with the procedures set out in both STAIRS and the OECD RS9 methodology in order to make crash research data compatible across international projects.

OBJECTIVES

On The Spot (OTS) Accident Data Collection has been established with the following objectives;

1. To establish an in-depth research database of a representative sample of road accidents in the United Kingdom.
2. To better understand the causes of crashes and injuries.
3. To assist in the development of solutions.

The remainder of this paper describes the organisation and methodology in place for OTS in the UK.

PROJECT ORGANISATION

The UK Department of the Environment, Transport and the Regions (DETR) and the Highways Agency (HA), which is an Executive Agency of the DETR, have both provided funding the two teams who are undertaking OTS investigations in England. The locations of the two studies are shown in Figure 1.

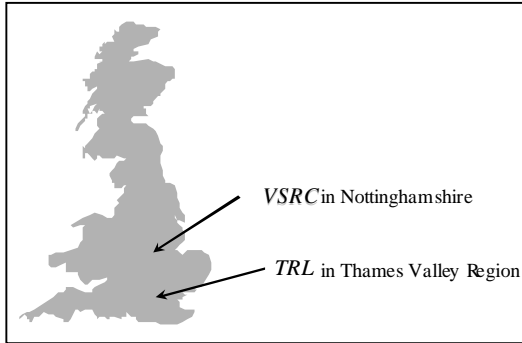


Figure 1. Locations of OTS Investigation Teams.

The Vehicle Safety Research Centre (VSRC) at Loughborough University cover the South Nottinghamshire area in the East Midlands.



Figure 2. The VSRC Investigation Team in action

The Transport Research Laboratory (TRL) are covering the Thames Valley region in the South East.



Figure 3. The TRL Investigation Team in action

A holistic approach is taken to each OTS investigation. This is made possible because funding originates from Vehicle Standards and Engineering, Road Safety Division at the DETR and the Highways Agency. Consequently vehicle safety, human factors and highway engineering are all investigated together.

Data collection commenced towards the end of 2000 and will, in the first instance, continue until June 2003, resulting in a database consisting of at least 1,500 detailed crash reports.

Selection of Study Areas

Sample areas were examined and designed to ensure that the severities of road accidents occurring within the sample areas were representative of the severity of accidents occurring nationally. The results of this investigation are shown in Tables 1 & 2:

Accident Injury Severity	TRL Study Region		GB National Statistics	
	N	%	N	%
Killed	32	0.8%	3,137	1.3%
Serious	373	9.8%	34,633	14.5%
Slight	3,392	89.3%	201,153	84.2%
Total	3,797	100.0%	238,923	100.0%

Table 1. Numbers and percentages of road accidents for 1998, classified by injury severity: TRL Study Region and GB National statistics.

Accident Injury Severity	VSRC Study Region		GB National Statistics	
	N	%	N	%
Killed	41	1.6%	3,137	1.3%
Serious	514	20.3%	34,633	14.5%
Slight	1979	78.1%	201,153	84.2%
Total	2,534	100.0%	238,923	100.0%

Table 2. Numbers and percentages of road accidents for 1998, classified by injury severity: VSRC Study Region and GB National statistics.

Accident severities within the two sampling areas approximate well to the national distribution of accident numbers, with a slight over-emphasis on serious accidents in the VSRC region which is balanced by a slight under-emphasis on serious accidents in the TRL region.

The sampling areas were also chosen to ensure a representative sample of accidents involving different road users was examined, as shown in Tables 3 and 4:

Type of Casualty	TRL Study Region		GB National Statistics	
	No.	%	No.	%
Pedestrian	518	10.2	44,886	13.8
Pedal Cyclists	459	9.0	22,923	7.0
TWMV ¹ rider	439	8.7	24,610	7.6
Car/taxi occupant	3,425	67.5	208,693	64.2
Goods vehicle occupant	132	2.6	11,116	3.4
Bus and minibus occupant	81	1.6	11,382	3.5
Other vehicle occupant	20	0.4	1,602	0.5
Total	5,074	100	325,212	100

Table 3. Numbers and percentages of road accident casualties (1998), classified by road user type: TRL Study Region & GB National statistics.

Type of Casualty	VSRC Study Region		GB National Statistics	
	No.	%	No.	%
Pedestrian	596	17.2	44,886	13.8
Pedal Cyclists	283	8.2	22,923	7.0
TWMV ¹ rider	238	6.9	24,610	7.6
Car/taxi occupant	2,078	60.0	208,693	64.2
Goods vehicle occupant	106	3.1	11,116	3.4
Bus and minibus occupant	150	4.3	11,382	3.5
Other vehicle occupant	13	0.4	1,602	0.5
Total	3,464	100.0	325,212	100.0

Table 4. Numbers and percentages of road accident casualties (1998), classified by road user type: VSRC Study Region & GB National statistics.

[Note that in Tables 3 & 4 "TWMV rider" refers to a two-wheeled motor vehicle user.]

Examining the accidents by road user type also shows that the sampling areas chosen are reasonably representative, with perhaps a slight over-sample of car occupant injury accidents in the TRL study region. The VSRC study region shows a slight over-sample of pedestrian accidents.

Areas chosen for the study were also made coincident with catchment areas for hospitals that were prepared to co-operate with the studies.

Ease of access to all areas of the study region was also important. Previous trials (Morris et al., 1999b) using blue light methods of reaching crash scenes have shown that all parts of each sample region must be reached within 15 minutes or else essential information will be lost. This has to be possible when maximum traffic congestion occurs as well as in quite traffic conditions at night.

OTS crash investigations must relate to national data. The results of the STAIRS project, with which OTS is intended to be compatible, demonstrated the need to have a specified area that can be related to the national database for all reported injury crashes. All of the areas covered by OTS are completely identifiable from details within a unique police reference number, so a clear statistical link will be possible.

The OTS Teams

Each OTS team is made up of some six investigators including a Team Manager, Senior Officer and a serving Police Officer. The project provides funding for both team police officers on a full-time basis. They are highly skilled advanced police drivers with crash investigation training and experience. VSRC and TRL also have personnel employed to provide follow-up support to the investigation team, including a medical specialist, police liaison officer and clerical officer. Both centres are further supported by local experts in human, vehicle and highway safety factors.

Typically, teams remain on standby for an eight hour shift period and are ready to respond immediately to an accident notification from the local police control centre. The team travel to the crash scene in a specially marked high conspicuity vehicle which is driven by the skilled police driver. The response team attending the accident consists of at least three investigators, including the police officer.

The two OTS teams use a rotating system of shifts which has been specially devised to ensure that each part of the day and night is equally covered by the shift periods. The plan also ensures that the days covered change so that, at the end of the year, the total cases will be statistically weighted to provide frequency estimates that are representative of the complete year.

The VSRC team office is located at the Nottinghamshire Police Traffic Wing in the centre of Nottingham. It lies at the centre of the radial network of trunk roads so that most points on the perimeter of the area can be reached very quickly.

The TRL team office is located at the TRL site in Crowthorne, Berkshire. The study region around TRL is traversed in the north by the M4 and in the south by the M3 and contains both junctions 11 and 12 of the M25. The location of any accident within the catchment area can be reached extremely rapidly, despite the often significant levels of traffic present on the roads in the region.

Both team regions contain a good mix of A and B roads, rural, urban and motorway environments.

On-the-spot Procedure

Once the investigation team arrives at the scene of an accident, the safety of the investigation team, emergency services personnel and the general public is the first priority. All team members are qualified in first-aid, but to date this training has thankfully been unnecessary as ambulance personnel are usually present at the scene before the OTS team arrive.

The serving police officer on the OTS team has a very important role on arrival at the accident scene. It is his job to make contact with the police officer in charge of the accident scene and brief him as to the intended activities of the investigators. After safety and protocol issues are addressed, the team can then make contact with the various elements and people involved in the crash in the least invasive fashion possible.

A library of some 200 OTS forms has been prepared that cover all accident eventualities and possible vehicle, casualty and highway environments which may be encountered. A key objective is to capture within minutes of the crash the “volatile” data which is present at the scene post-impact. The forms are therefore structured into Priority Levels such that the investigators begin with the most volatile information and progressively obtain as much additional

information as possible, often obtaining some Level Two and Level Three information during follow-up activities on another day.

On-the-spot Priority Levels

Level 1: “volatile” – the data is only available for a few minutes after the crash. Examples include vehicle rest positions, debris locations and road surface and weather conditions.

Level 2: available for 2-3 days – the data can be reliably collected several days after the crash. For example tyre tread depth, and locations of roadside objects and traffic signs.

Level 3: available semi-permanently – the data can be satisfactorily collected weeks or months after the crash. Examples include injury details and road dimensions.

INVESTIGATIVE PROCEDURES

As the investigation proceeds, the team collects the information required by the investigative protocols and make video and photographic recordings of the accident scene. The vulnerable road users are considered first, followed by “volatile” evidence on the highway such as contact marks, trace marks and damage to road features. Vehicles are investigated with the smaller and more mobile vehicles being examined before the heavier vehicles. Detailed measurements are taken of the highway environment and all relevant information is recorded on a scene plan. Finally all other information of interest is captured, time and scene conditions permitting.

Casualties (including Pedestrians)

For all casualties, their post-impact positions, evidence of injuries and interaction with vehicles or other highway features are noted wherever possible. For pedestrians and cyclists, details of clothing (material properties, body regions covered and conspicuity) are also recorded.

Vehicle Investigations

All vehicles encountered are examined regardless of type, age or the crash/occupant injury severity. Both primary and secondary safety features on the vehicle are considered, including:

- Collision avoidance systems including ABS and speed limiters.
- Controls and lights: usage and condition on all vehicle types, including pedal cycles.
- Defects: tyres, brakes, steering, suspension.

- Crashworthiness: structures, bumpers, under-run guards (specification and fixings).
- Damage assessment: full description, documentation and crash-energy calculations.
- Restraint systems: seatbelt usage, airbag effectiveness, pretensioner present, child restraint types, mounting and overall effectiveness.
- Occupants: injury causation (contacts), ejection/trapping.
- Loads: restraint and movement.

Highway Investigation

Details of highway layout are noted with special emphasis on safety features. Specific factors are assessed, as listed below:

- Highway layout and design.
- Traffic density.
- Road surface: texture, temperature, friction, contamination.
- Views and sight-lines.
- Signing including visibility and positioning.
- Meteorological conditions: precipitation, light levels, cloud cover, visibility, wind speed, temperature.

The local meteorological conditions are recorded in conjunction with road surface drainage and temperature measures. Based on the information collected, the investigator will seek evidence of crash causation and will assess any contributory factors on approach routes taken by each crash participant.

The trained investigation teams are always alert to possible visual illusion effects, environmental conditions, structural peculiarities, road structures and traffic control measures at the scene of an accident. Any existing safety scheme will also be appraised, where appropriate.

Finally, video recordings are made, at eye level, for the approach routes taken by each accident participant including pedestrians and cyclists.

Witness Interviews

Witnesses are identified, when possible, at the scene of the accident. If they give their consent, brief interviews are conducted immediately. Key witnesses details are then recorded permitting more extensive interviews during follow-up investigations. Much consideration has been given to the style and labelling of the high conspicuity clothing worn by

both teams in an attempt to differentiate the research staff from the police attending the accident scene. The choice of clothing different from that of the police emphasises the neutral and independent stance of the investigators, as uniformed police officers do not interview crash participants for research purposes. In this way it is hoped that the researchers can gain the confidence of the interviewees and so obtain unbiased responses to research questions.

Follow-up Investigations

A number of follow-up investigations take place in the days after the first scene visit. The highway may be further examined during a follow-up visit, when specialist expertise may also be available. Skidding coefficient measurements may be taken by a SCRIM machine to determine whether road surface friction was a contributory factor. For motorcycle crashes, traffic flow exposure data are recorded under similar traffic conditions one week later, as required by the OECD methodology described earlier. Highway data held by local authority engineers may also be consulted in order to assess any previous history of crashes at the site.

Physical data recorded at the scene, including trace marks and debris locations, are used to calculate approach speeds and trajectories. Vehicle damage assessments also facilitate the determination of speed change at impact (ΔV). Finally, the analysis of velocity will attempt to calculate avoidance speeds to show the maximum travel speed at which the crash could have been avoided.

Injury data are obtained from hospitals and coroners by medical officers on each team. Strict data confidentiality procedures are rigorously observed, and permission has been granted by ethical committees at all participating hospitals.

Details coded for casualties include:

- Characteristics: age, gender, mass, stature, predisposing medical conditions.
- Selected treatment details.
- Injury details: nature, extent, location and severity according to the Abbreviated Injury Scale (AAAM, 1990).
- Anthropometric data suitable for reconstruction of pedestrian kinematics and possible mathematical modelling of interactions between pedestrians and vehicles.
- General clothing, including motorcycle clothing.

- Motor and pedal cycle helmet specifications and damage.

A postal questionnaire is sent to selected crash participants requesting further details concerning driving experience, familiarity with routes taken, vehicle details, injuries and other details. Previous experience with similar procedures at VSRC and TRL has consistently given a questionnaire return rate in excess of 60%.

For those crashes where human factors are implicated as a cause, an investigation is made to identify the role of sensory, perceptual, cognitive and personal psychological factors. Investigators identify factors that appear to have a human factors component. The data are then reviewed by the human factors specialists on each team to determine key issues. In this way it is possible to attempt to state for each crash whether the key issues are:

- Vehicle design, e.g. lighting, mirrors, A-pillar obscuration.
- Road design, e.g. sight lines, lighting.
- Driver experience / skill / judgement / impairment, e.g. training implications, alcohol.

A structured expert case review process is used to guide and advise the interpretation of all factors in each case. Reviews are held internally by each team, but also investigators are brought together at regular intervals with experts from VSRC, TRL, and other participating agencies, to assess and draw conclusions in the following areas:

- Contributory crash factors.
- Crash prevention and remedial measures (in place or recommended, including new/future technologies).
- Relevance to current research and/or regulatory issues.
- Feedback to investigators concerning methodology and improved practices.
- Quality control.

Contributory factors are classified using methodology developed by Broughton et al. (1998). Causes of crashes are broken down into precipitating factors (e.g. "Driver failed to avoid pedestrian") and contributory factors (e.g. "view obscured by glare from sun"), each coded as "definite", "probable" or "possible".

Case Report Concluding Remarks

Where possible, each case report concludes by listing contributory factors and possible counter measures under the following headings:

- Impacts to vehicles: Precipitating factors,
 Causation factors,
 Possible counter-measures.
- Injuries to casualties: Causation factors,
 Possible counter-measures.

DATA MANAGEMENT

A database has been designed using MS Access to hold all of the data collected during an investigation. This contains in excess of 3,000 fields that describe highways, cars, goods vehicles, buses, pedestrians, pedal cycles and motor cycles. Drivers, riders, passengers and their injuries may also be described in detail.

All information recorded will be completely anonymous and will not include personal details or other information that could identify individuals or their vehicles

Data Analysis and Research

Data analyses will be possible using a variety of software packages. The database will hold over 500 cases by the end of 2001, building to at least 1500 by mid-2003. Statistical interrogations will be done using SPSS procedures. The case files will also be rich in video and photographic material that may be searched electronically and analysed on a case by case basis where required.

With regard to Vehicle Safety, OTS will facilitate research into both primary and secondary aspects. It will be possible to study potential benefits from pre-crash sensing and collision avoidance technologies given environment, human and vehicle factors identified in current crashes. Alternatively, the causes of injuries and the crash performance of key secondary safety technologies will also be investigated using skills and experience gained by both teams on the UK CCIS.

THE BENEFITS OF OTS RESEARCH

The following are some examples of research into the enhanced safety of vehicles that it is anticipated will be possible using OTS data:

- Protection for a wider range of vulnerable road users: the elderly, cyclists and motorcyclists.
- Attempt to build on current pedestrian protection procedures by refining car-pedestrian impact velocity distributions, and by analysing interactions with many types of vehicle, and a range of vehicle contact locations.
- Car to car crash compatibility in new and old vehicles.
- Safety of luggage and loads on cars and trucks, including injuries caused by occupant loading.
- Rollover initiation.
- Lights showing on stationary or parked vehicles when impacted from the rear.
- Evaluation of test parameters used in the Euro-NCAP, including striking object, impact velocity and injury outcome.
- Truck impacts with cars and vulnerable road users assessing the design and feasibility of fitting under-run guards to specific truck types observed.
- In-vehicle information and communications equipment as an aid or distraction to drivers, relative to road conditions.
- Representatives of DETR at Vehicle Standards and Engineering, the Road Safety Division and the Highways Agency for their continued help and guidance.
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- Ford & Jaguar for their financial support and advice during early pilot studies and protocol development at VSRC.

It is expected that the results from the OTS Accident Investigation project will make a significant contribution to road safety, vehicle crashworthiness and occupant protection. The safety improvements which will undoubtedly arise from this work will be seen not only in the UK but also in many other countries who will be able to benefit from the high-quality research currently being carried out by VSRC and TRL.

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