

Road Safety Research Report No. 73

**The UK On The Spot Accident
Data Collection Study –
Phase II Report**

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EXECUTIVE SUMMARY

In 1999, the UK's Department for Transport and Highways Agency (HA) commissioned Phase I of the 'On the Spot' (OTS 1) accident research project to collect information at the scene of all types of road accidents. In-depth accident investigations were carried out to study the influence on crash causation and injury mechanisms of human involvement, highway design and vehicle design. This ambitious work was undertaken to allow research to be conducted that will investigate the causes of crashes, their subsequent injuries and the associated societal costs. It was recognised that only through a detailed knowledge of these complex causal factors will effective countermeasures be developed and, ultimately, successfully applied to improve road transport safety.

Phase I of OTS started in June 2000, ran for three years and three months, and produced a database of over 1,500 accidents from two distinct geographical regions covering all road users and injury severities. Phase II followed on directly with the same investigation teams, regions and infrastructure, and was completed in September 2006. A further 1,500 accident cases have been investigated and information added to the project database.

Phases I and II of the study were undertaken by two investigation teams, from the Vehicle Safety Research Centre (VSRC) at Loughborough University and the Transport Research Laboratory (TRL) Limited, working in close co-operation to produce a joint dataset. The teams worked in the Nottinghamshire and Thames Valley Police Force areas respectively, and each investigated 750 crashes per phase of the study.

Throughout the project, VSRC and TRL have developed the methodology and database, improving both the qualitative and quantitative nature of the study. The process of continual enhancement and development of the original integrated protocols (December 1999) has been undertaken with care to ensure there is consistency and compatibility over time, allowing meaningful analysis to be undertaken of all 3,000 OTS investigated crashes, from June 2000 to June 2006.

A comprehensive description of methodology and investigations achieved during Phase I was published in November 2005. The executive summary from that report has been included in Appendix 2.

A brief outline of the number and type of accidents investigated in Phase II by each research centre can be found in Appendix 1, and further details may be viewed on the project website (www.ukots.org).

In 2005, Britain's police forces started to use a new coding system to describe the factors that contribute to the causes of injury crashes. This so called Contributory

Factors (2005) coding system is routinely completed for each injury crash reported to the police through the STATS19 recording protocols. The OTS investigation methodology was enhanced to incorporate the 2005 Contributory Factors system, and all OTS cases (2000 to 2006) were analysed and the new causation measures applied. Significant proportions of the cases were completed at this time and required a retrospective review of all the investigation notes in order to evaluate all the pertinent details. The Phase I database is fully compatible with the OTS browser designed for Phase II and now also incorporates photographs, scene plans and path videos.

1 INTRODUCTION

The aims and objectives of the On the Spot (OTS) Phase II project are summarised below.

- The aim of the OTS Accident Data Collection Study is to provide a uniquely valuable information resource concerning real-world road accidents. The OTS Accident Data Collection Study provides the data to enable the development of evidence-led innovative policy and countermeasures to reduce road traffic casualties.
- The objective of the project was to investigate 1,500 road traffic accidents in the OTS-defined Nottinghamshire and Thames Valley Police areas in order to collect high-quality crash data to improve the understanding of human involvement, vehicle design and highway design in accident causation and injury mechanisms.

This was achieved by experienced researchers attending the scenes of a known sample of road traffic accidents notified to the emergency services. It is necessary to attend the scene of the road traffic accident while the vehicles, and possibly victims, are still in place to enable the capture of ‘perishable’ information that is only available for a very short time.

Capture of the ‘perishable’ or ‘volatile’ information provides a more complete picture of the accident, potentially allowing for a greater understanding. Further data required to provide a complete understanding of the accident are collected later, through follow-up visits and other information collection procedures.

During Phases I and II of the OTS project, the Transport Research Laboratory (TRL) and the Vehicle Safety Research Centre (VSRC) at Loughborough University attended and investigated over 3,000 accidents within the Nottinghamshire and Thames Valley regions.

1.1 Requirement of the OTS Accident Data Collection Study

The OTS Accident Data Collection Study was commissioned by the Department for Transport and the Highways Agency (HA) to enhance road safety and to reduce road casualties through improved accident research.

Approximately 3,500 people are killed and 40,000 seriously injured every year in the UK as a result of road traffic crashes. The Department for Transport has targeted a substantial reduction in the injuries and loss of life that results from road crashes by the year 2010²², compared with the average for 1994–1998, involving:

- a 40% reduction in the number of people killed or seriously injured in road accidents;

- a 50% reduction in the number of children killed or seriously injured; and
- a 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 vehicle kilometres.

This is echoed in the HA's aim to deliver a high-quality service to all its customers by improving road safety.

The VSRC and TRL were awarded joint contracts to develop common protocols and the infrastructure to support the investigation of 1,500 accidents over two separate geographical locations during a three-year period commencing in the summer of 2003.

This report describes the research design and methodology development of a collaborative approach to enable expert crash investigators to attend the scene of accidents within 15 minutes of the incident occurring, thus allowing the collection of accident data that would otherwise be quickly lost.

1.2 Research background

The Department for Transport has long recognised the vital part that real-world accident data play in the development of safer road transport. The UK was home to some of the earliest rigorous and scientific OTS crash research carried out at the scene of road traffic crashes. Such in-depth investigations were begun in the UK in the early 1960s by the then Road Research Laboratory²³. In the mid-1970s further TRL OTS crash investigations assessed factors that included the causes of crashes and quantified the role of the environment, vehicle and human factors⁵⁰. Around the same time, the Accident Research Unit at the University of Birmingham expanded its crash investigation activities to include OTS pedestrian crash research, yielding results relating to vehicle design, velocity and injury patterns².

Despite the considerable value of OTS accident research, the results have not been used extensively in research into in-car safety over the past 20 years. This is because a number of real-world, completely 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 most respected studies is the UK Co-operative Crash Injury Study (CCIS), which has been running since 1983^{5,41}. Such fully retrospective studies, in which investigators examine cars at recovery yards, often several days post-impact, are inherently more cost-effective because resources are focused on crashworthiness and injury investigations, without the additional costs associated with maintaining personnel on standby for long periods. However, this approach cannot be used to obtain perishable accident data, such as trace marks on the highway, pedestrian contact marks on vehicles, the final resting position of the vehicles involved, witness interviews, 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.

The increased safety of vehicle occupants through improvements in car safety has not been matched by improvements in the safety of pedestrians and other vulnerable road users. Governments and vehicle manufacturers recognise that all road users need to be protected, and, as such, are interested not only in 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 but is lost once the accident scene is cleared⁶. Current and accurate real-world data are needed, and research shows that fully retrospective methods are not adequate for investigating the in-depth causes of crashes and injuries to vulnerable road users.

There are a number of OTS accident investigation studies active across Europe today. These include the newly founded SafetyNet teams operating over six countries with European Commission funding, the German In-Depth Accident Study (GIDAS)⁴⁷ maintained by teams at the Medical University of Hanover and the Technical University of Dresden and the work of French Laboratory INRETS. The now completed European Accident Causation Study (EACS)⁴ was jointly funded by the European Automobile Manufacturers Association (ACEA) and the European Commission to study vehicle, road, traffic and human behaviour, together with some attention to the causes of injuries.

Phase I of the OTS Project has established the project as a powerful research tool with great potential for assisting safety professionals and government safety policy²¹. The body of experience is now considerable, both on scene and in the post-scene follow-up phases of vehicle examination, reconstruction of circumstances, and interpretation of evidence and assessment of injury. The key research data collected during Phase I of the project have been utilised by a number of studies, detailed later in this report.

1.3 Scope of work

This second phase of the OTS project was set up to achieve the following specific objectives:

- to conduct 1,500 in-depth accident investigations over three years using a systematic methodology;
- to gain a greater understanding of injury mechanism to road accident victims and injury outcome;
- to gain a greater understanding of the human contribution to accident causation and injury outcome;

- to gain a greater understanding of the contribution of highway design to accident causation and injury outcome;
- to provide support for legislation or other standards to reduce accidents and mitigate their effects through the provision of statistically valid data to focus future research on common injury and accident causation mechanisms; and
- to provide information or expert advice/experience to facilitate monitoring vehicle crash-worthiness, safety devices, highway design features, driver training and the condition of driver, vehicle and highway.

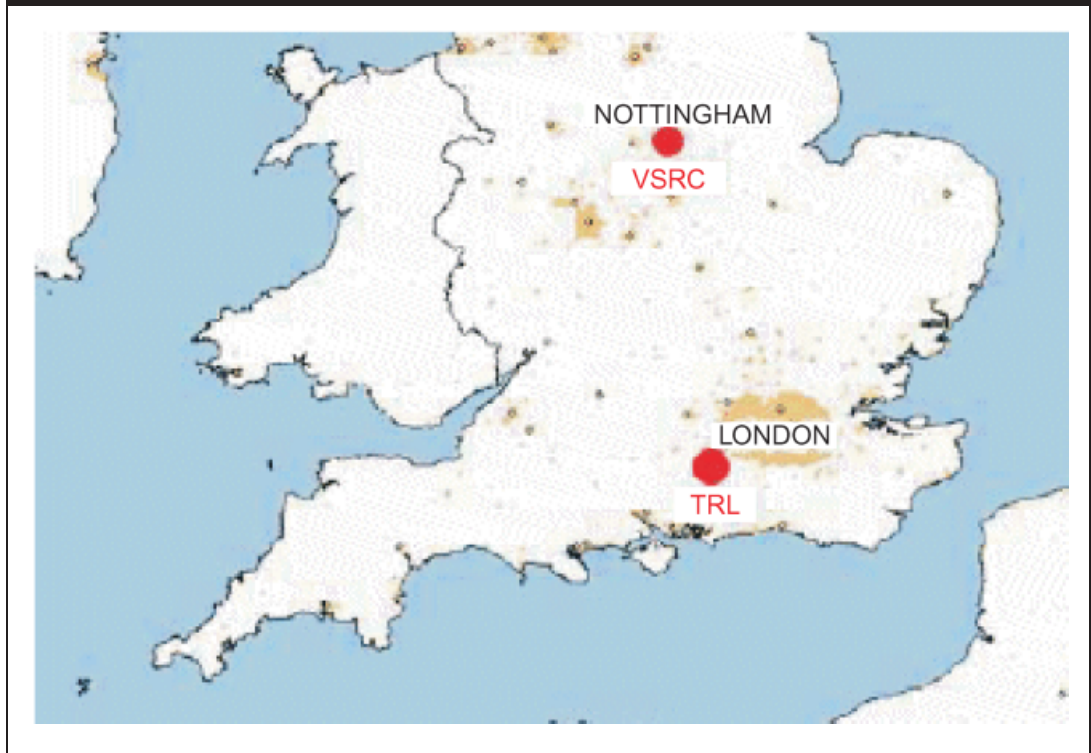
In addition to the above, the project will provide access to a baseline sample of accidents allowing further specialised studies to be separately contracted to collect additional data for more specific purposes.

2 PROJECT INFRASTRUCTURE

To ensure consistency between Phases I and II of the project, the location of the two teams and their sampling protocols have remained the same.

2.1 Location of the OTS teams

Figure 2.1: Geographical locations of the two OTS teams



The Vehicle Safety Research Centre (VSRC) covered the South Nottinghamshire area of the East Midlands. This included the city of Nottingham with an urban population of approximately 267,000 people. The VSRC team office was located at the Nottinghamshire Police Operational Support Division close to the centre of Nottingham. It lay at the centre of a radial network of trunk roads, so that most points on the perimeter of the area could be reached very quickly.

The Transport Research Laboratory (TRL) covered the Slough, Reading, Henley-on-Thames and High Wycombe areas in the South East of England. The TRL team office was located at the TRL site in Crowthorne, Berkshire, although a room was also made available by the police at Taplow Traffic Office, which provided a more central location for team members waiting for notification of crashes. The study area around TRL was traversed in the north by the M4 and in the south by the M3, and contained Junctions 11 and 12 of the M25. The location of any accident within the

investigation area could be reached rapidly, despite the often significant levels of traffic present on the roads in these regions.

Both areas contained a good mix of A, B, rural and urban roads and motorway environments. However, the areas were different in terms of road-user crash involvement and associated characteristics. The VSRC area was concentrated around a large conurbation, whereas the TRL area had a greater mixture of towns and rural environments. The difference in road types and socio-economic characteristics of the two areas ensured the teams jointly investigated a representative collection of crashes.

2.2 Sampling protocols

The two areas were selected to ensure that, after the data from both areas was combined, the severity distribution of road accidents was representative of the severity of accidents occurring nationally. As shown in Table 2.1, accident severities within the two study areas approximated well to the national distribution of accident numbers, with a slightly greater proportion of serious accidents in the VSRC area and a slightly lower proportion of such accidents in the TRL area. The study areas were also chosen to ensure a representative sample of accidents involving different road users – Table 2.2 shows that the two areas taken together were reasonably representative. There was a slightly higher proportion of pedestrian accidents in the VSRC area and a slightly higher proportion of car-occupant injury accidents in the TRL area, compared with the national average.

Table 2.1: Distribution of road accidents (2003), classified by accident severity

Accident severity	VSRC area		TRL area		OTS total area		All Stats19 areas	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Fatal	39	1.8%	44	1.4%	83	1.6%	3,247	1.5%
Serious	391	17.9%	358	11.4%	749	14.0%	28,913	13.5%
Slight	1,756	80.3%	2,742	87.2%	4,498	84.4%	181,870	85.0%
Total	2,186	100.0%	3,144	100.0%	5330	100.0%	214,030	100.0%

Table 2.2: Casualties in road accidents (2003), classified by road user type

Casualty type	VSRC area		TRL area		OTS total area		All Stats19 areas	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Pedestrian	381	12.8%	408	9.9%	789	11.1%	36,405	12.5%
Pedal cyclist	195	6.6%	283	6.8%	478	6.7%	17,033	5.9%
TWMV	311	10.5%	411	9.9%	722	10.2%	28,411	9.8%
Car/taxi	1,853	62.5%	2,887	69.9%	4,740	66.8%	187,242	64.4%
Goods vehicle	108	3.6%	101	2.4%	209	2.9%	9,958	3.4%
Bus/minibus	106	3.6%	34	0.8%	140	2.0%	10,168	3.5%
Others	13	0.4%	9	0.3%	22	0.3%	1,390	0.5%
Total	2,967	100.0%	4,133	100.0%	7,100	100.0%	290,607	100.0%

As well as choosing geographical areas which were broadly representative of national statistics with respect to the two variables considered in Tables 2.1 and 2.2, the Standardisation of Accident and Injury Registration Systems (STAIRS) project,⁴⁹ with which OTS has been designed to be compatible, demonstrated the need to sample from a rigorously defined area. This was so that the sampled accidents can be directly compared to the subset of nationally-recorded accidents in that area. This enabled a sample of crashes to be investigated from within known populations, and it allows for a more reliable scaling of findings from the study to the national situation. The OTS investigation areas had fixed geographical boundaries, which were coincident with the areas covered by the local hospitals that co-operated with the study. The areas covered by the teams were completely identifiable by details from local police injury accident reports, so clear statistical links were possible (Figures 2.2 and 2.3).

**Figure 2.2: VSRC investigation area. Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office
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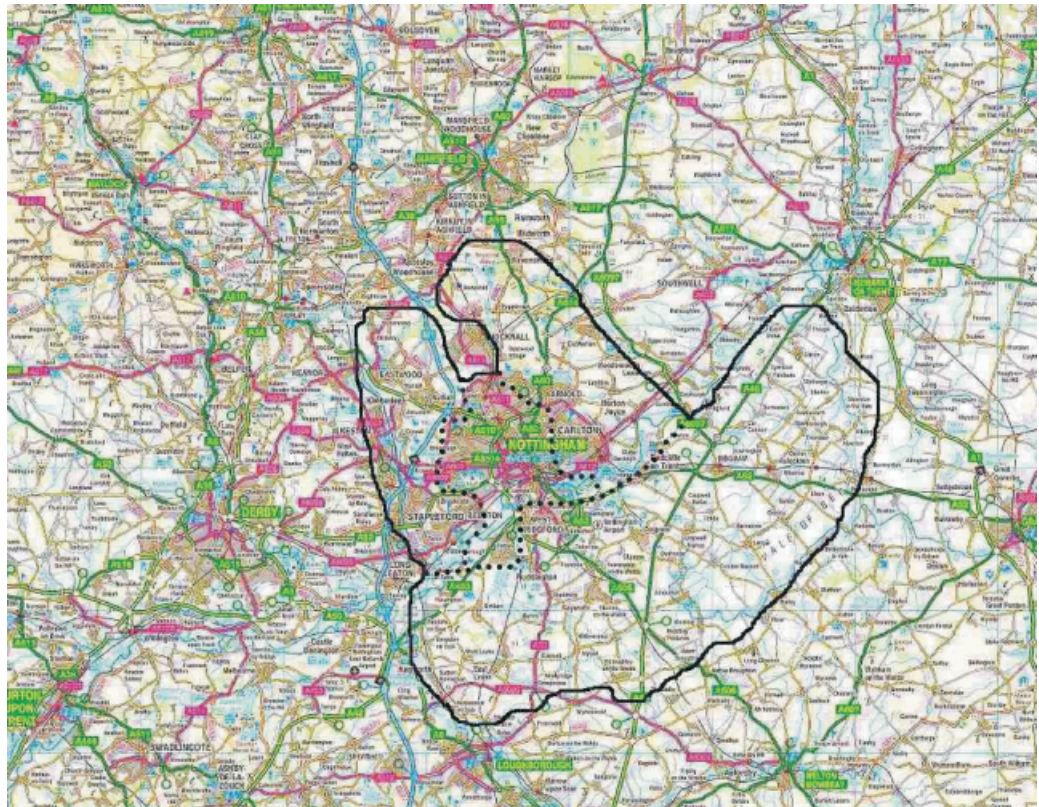


Figure 2.3: TRL investigation area. Reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office
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2.2.1 Standardisation of Accident and Injury Registration Systems

The OTS study also conformed to the STAIRS European accident investigation protocols. The aim of the STAIRS project was to try to develop a harmonised procedure for the in-depth investigation of crashes for the purposes of improving crashworthiness and safety regulations. The European Commission recognised the need for detailed crash injury data to support its decision-making. This data needed to be sufficiently detailed to relate to current regulations and be capable of being analysed to reflect crashes across Europe. Three main countries were involved in this research: the UK, France and Germany. The key areas addressed included a core

dataset, national crash population, data quality, data processing and exchange, and statistical methods for data analysis, terminology and ethical considerations.

2.3 External co-operation and support

The continued success of the OTS study would not have been possible without significant support and assistance from the following local organisations, in particular Nottinghamshire and Thames Valley police forces.

2.3.1 *Police liaison*

The project continued, as it had done in Phase I, to enjoy the full support of both Nottinghamshire and Thames Valley police.

The Nottinghamshire Chief Constable continued to support the project by seconding a fully-qualified police response driver to the VSRC OTS team. The seconded police officer formed part of the VSRC's investigation team, and brought with him considerable knowledge of road accidents and the essential aspects of evidence found at the scene. The officer also provided essential links to Nottinghamshire Police's control room systems to provide accident notifications. This arrangement is described later in this report.

Nottinghamshire Police also provided a dedicated team office to house the three team members and equipment needed for on-call work.

Thames Valley police continued to provide TRL with notification of all road traffic accidents reported within the region and, in addition, allowed TRL to continue to use the Taplow traffic police station as a base for the OTS team.

2.3.2 *Hospital liaison*

The requirement for medical data to support the project was important for understanding the injury outcome of the accidents.

Queen's Medical Centre (QMC) continued, as in Phase I, to provide information relating to the injury outcome of casualties involved in OTS cases in the VSRC's area. In addition, QMC Accident and Emergency (A&E) staff, overseen by an A&E consultant, with the full approval from the QMC Ethics Committee, were able to provide valuable anthropometric data for vulnerable road users who were involved in OTS cases.

As in Phase I, TRL continued to have the full support of the following hospitals:

- Wexham Park Hospital, Slough;
- Wycombe General Hospital, High Wycombe;

- the Royal Berkshire Hospital, Reading; and
- Frimley Park Hospital, Frimley.

2.3.3 *HM Coroners*

Both research centres have long-established links with HM Coroner's offices locally. These links enable post-mortem reports to be obtained for the examination of injury details where necessary.

2.3.4 *Ambulance, fire and recovery operator co-operation*

As both investigation teams attended accident scenes in the role of observers, it was essential to maintain good relationships with all the emergency services. To ensure the continued co-operation of the emergency services, and thus the success of the project, each team met with the fire and rescue and ambulance services in their respective areas to explain the nature of the project. This again proved a valuable exercise, as an excellent level of co-operation was obtained from the ambulance and fire crews attending accident scenes, and this was maintained over the life of the project.

Royal Berkshire Ambulance Trust covered the entire TRL OTS investigation area, and with their co-operation TRL was able to establish a parallel accident notification system using their Royal Berkshire Ambulance Trust command and control centre (for further details see Section 3.3).

2.3.5 *Vehicle recovery operator*

Follow-up examination of the accident-damaged vehicles and investigation of the vehicles at the accident scene often required the co-operation of the recovery operators charged with removing the vehicles from the scene. Both teams continued to receive good co-operation from the vehicle recovery operators, as they had done in Phase I.

2.4 **Data confidentiality and ethical approval**

An important part of the work is to ensure the confidentiality of individuals involved in accidents. Accident files used in research often contain information that can be of a sensitive nature, and any accident data study involved in occupant injury research will require access to personal data. The OTS project has a duty to ensure that data are used sensitively and not misused. This issue is always of primary concern when establishing the infrastructure of such projects in order to gain the co-operation of necessary parties. Where required, the OTS project has sought and been granted formal ethical approval from the co-operating organisations.

TRL and VSRC have been at the forefront of accident research for over 25 years, and have considerable experience in matters of data protection and handling sensitive personal data.

The OTS data confidentiality code of practice protocol, developed by TRL and VSRC in Phase I of the project, continues to provide reassurance to co-operating organisations that information passed to the OTS teams will only be used for the purposes of accident research. No personal data are included in the project database or passed to any third parties.

3 PROJECT ORGANISATION

3.1 Team structure and response vehicles

Both teams were able to draw on the experience gained in Phase I of the project. As a result of this experience, TRL was able to operate successfully without a seconded police officer. However, to aid with communication, safety and transit to accident scenes in Nottinghamshire, the VSRC opted to continue to second a police officer for the duration of Phase II.

Both teams continued to use the response vehicles acquired in Phase I of the project.

3.2 *Shift system*

Typically, the two teams remained on standby for a nine-hour shift period ready to respond immediately to an accident notification. Both teams used a rotating system of shifts, which was specifically devised to ensure that the days covered changed, so that, at the end of the year, the assembled dataset could be statistically weighted to provide frequency estimates that were representative of the complete year.

Both TRL and VSRC operated closely matching shift patterns for OTS Phase II.

The OTS Phase II call-out shift pattern consisted of a ‘six days on and four days off’ rota, which operates in a 20-day cycle as shown for TRL in Table 3.1.

Day	Shift
1	6am to 3pm ('early')
2	6am to 3pm
3	3pm to 12am ('late')
4	3pm to 12am
5	Rest day
6	12am to 6am ('night'), followed by 10 hours rest, followed by 4pm to 12am
7	Rest day
8	Rest day
9	Rest day
10	Rest day
11	6am to 3pm
12	6am to 3pm
13	6am to 3pm
14	3pm to 12am
15	Rest day
16	12am to 6am, followed by 10 hours rest, followed by 4pm to 12am
17	Rest day
18	Rest day
19	Rest day
20	Rest day

3.3 Accident notification

The efficient and timely notification of crashes was essential for the study to work.

The police notification system established by the two centres in Phase I of the project continued to provide accident notifications to the teams. However, TRL was also able to establish a parallel notification system using Royal Berkshire Ambulance Trust (RBAT) pagers. Such a system was not found to be necessary in Nottinghamshire, as all notifications are relayed to the VSRC team via the police control room. That system at VSRC achieves the necessary number and type of accidents for investigation and allows the team sufficient time to respond.

All emergency calls regarding injury road traffic accidents are reported to both the ambulance service and the police, with the ambulance service tending to receive the report first. RBAT were able to modify their command and control system to page the location of all reported road traffic accidents to TRL automatically. Using this system, TRL's OTS team was able to reduce its response times.

4 OTS METHODOLOGY

The basic methodology developed for the OTS Phase I project was adopted in Phase II. That integrated methodology had been compiled for Phase I by the VSRC from separate component methodologies developed by the VSRC, TRL and the University of Birmingham during preliminary work and pilot studies carried out in preparation for Phase I.

The Phase II project investigated all road traffic accidents, with respect to the causes and consequences, focusing on the contribution of:

- vehicles (including design, failures and safety features fitted to the vehicles);
- highways (including their design, features, maintenance and condition);
- human factors (including drivers, riders, passengers and, where possible, data on the training, experience and other road user aspects that might have influenced the cause of the crash).

In addition, the project recorded information relating to the mechanisms and causes of road user injuries.

The overall methodology in Phase II was enhanced, specifically with the introduction of the vehicle phase data and the 2005 causation system. The on-scene procedures and protocols remained the same as those set out in the OTS Phase I report. The methods used for the collection of medical information, including the sending out of questionnaires, also remained the same. Case completion continued in the same fashion as in Phase I, but the process was aided by the introduction of the OTS Phase II data input system developed by TRL.

4.1 Phase II protocol updates

TRL and VSRC have successfully collected the data required by the protocols for the past six years and have been directly involved in the creation and development of the OTS data collection protocols.

In Phase II, with customers' approval, TRL and VSRC updated the OTS Phase I data protocols to enhance the quality and value of the OTS database. Specifically, TRL and VSRC improved the following areas:

- priority guidelines for investigations;
- enhanced highways information;
- enhanced vehicle reconstruction; and
- contributory factors.

whilst ensuring that the OTS Phases I and II datasets remained compatible.

4.2 Priority guidelines for investigation

In Phase II, TRL and VSRC restructured the priorities of data collection at the scene and introduced data collection guidelines to be used by both OTS contractors. The guidelines prioritised the nature and extent of the data collected at the scene to ensure that the most important data for the specific type of accident attended is sought and examined. This modular and focused approach was designed to capture as much relevant information as possible within the on-scene time constraints.

The guidelines were built around current research policies and were subject to regular reviews. The system enabled the focus of the investigators to be directed to the areas of specific interest and thus ensured the best use of the limited time available on-scene and for subsequent reconstructions.

The guidelines were provided for the following three sections:

- core dataset;
- priorities for investigations relating to accident causation and infrastructure; and
- priorities for investigation relating to passive-safety issues and injuries.

These guidelines were successfully implemented and followed by both the TRL and VSRC data collection teams.

4.3 Enhanced highway information – road environment prior to, and beyond, the locus of accident

A system of recording information relating to the road environment prior to, and beyond, the locus of the accident was created. The system allowed investigators to record information relating to changes in the speed limit of the road, road friction, road layout and changes in road alignment, as well as other physical road parameters. This unique information will enable analysis to be undertaken into the effect of changes in the road parameters on the causes and consequences of road traffic accidents.

4.4 Enhanced velocity and reconstructions – phase data

In Phase II, TRL introduced a new system for recording reconstruction information, which enabled both investigating teams to record estimates of the speed of a vehicle at different stages in the accident.

The system provided investigators with a method of recording:

- the distance the vehicles travelled, pre-, during and post-crash;
- the velocity changes they experienced; and

- the accident reconstruction techniques used to calculate the speed of the vehicles at different stages of the accident.

For instance, the system enabled an investigator to record that:

‘a vehicle was travelling at a constant speed of 40 mph, before the driver applied his brakes and steered to the left; this resulted in the car skidding for 10 m before it collided with a tree at 30 mph (the vehicle experienced a 15 mph change in velocity during the impact); the car then spun for a further 4 m before coming to rest.’

At each stage the investigator can record, in the OTS database, the speed at the start of the phase, for example the car speed at the start of the skid and at the end of the skid, the distance the vehicle skidded, and the direction the vehicle was travelling in at the start and at the end of the skid.

This information provides OTS data users with a unique understanding of the dynamics of a vehicle during an accident. This system enables the effectiveness and benefits of new primary safety systems to be estimated based on the OTS accident sample. For instance, it is possible to assess what the benefits would have been, in terms of reduced impact speed, if the braking systems of vehicles in the OTS sample had been improved.

The system will also allow the behavioural factors to be quantified in terms of the speed and pre-impact driving actions. The system also provides an evidence-based description of why the driver failed to negotiate a particular highways feature.

4.5 Contributory factors

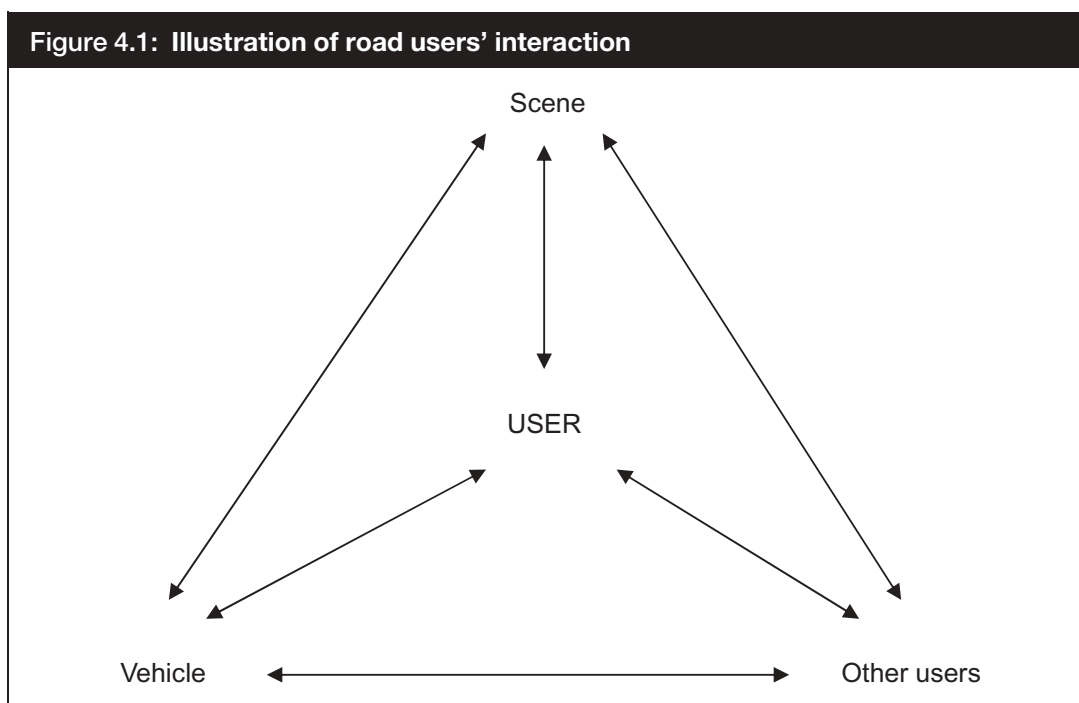
In Phase II the project continued to use the contributory factors codes³ defined in the Phase I protocols.

In 2005, Britain’s police forces started to use a new coding system to describe the factors that contribute to the causes of injury crashes. This so called Contributory Factors (2005) coding system is routinely completed for each injury crash reported to the police through the STATS19 recording protocols. The OTS investigation methodology was enhanced to incorporate the 2005 Contributory Factors system, and all OTS cases (2000 to 2006) were analysed and the new causation measures applied. Significant proportions of the cases were completed at this time and required a retrospective review of all the investigation notes in order to evaluate all the pertinent details. The Phase I database is fully compatible with the OTS browser designed for Phase II and now also incorporates photographs, scene plans and path videos.

4.6 OTS hierarchical database structure

The OTS study provides a unique opportunity to research accidents on the UK road network. Therefore, it is very important that the OTS data are recorded in a database that will allow effective analysis of the information and interpretation of the evidence recorded. The database structure is tailored to assist in achieving the research objectives of the study.

The greatest analytical benefit can be gained by recording each accident in terms of the interactions between the road users and their environment. This enables analysts to interrogate the OTS database from the greatest number of starting points. It is possible to identify or seek cases that are ‘similar’ to each other in terms of the simple characteristics of a road user, his vehicle or the scene; or ‘similar’ in terms of the six interactions between these and any other road users present (Figure 4.1).

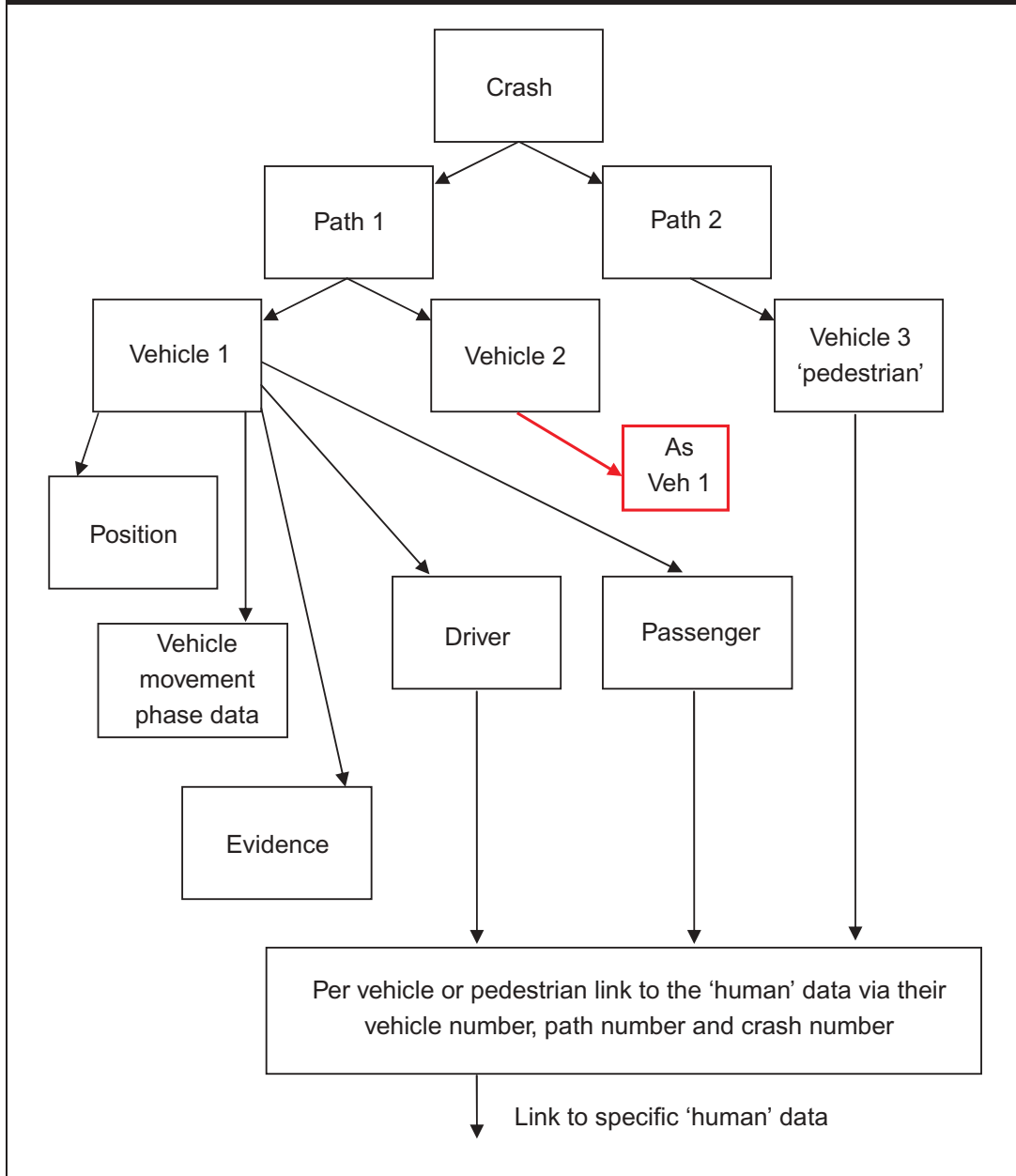


In Figure 4.1 the outer three interactions describe the circumstance, as presented to the user, while the inner three interactions describe how the user dealt with the developing circumstance.

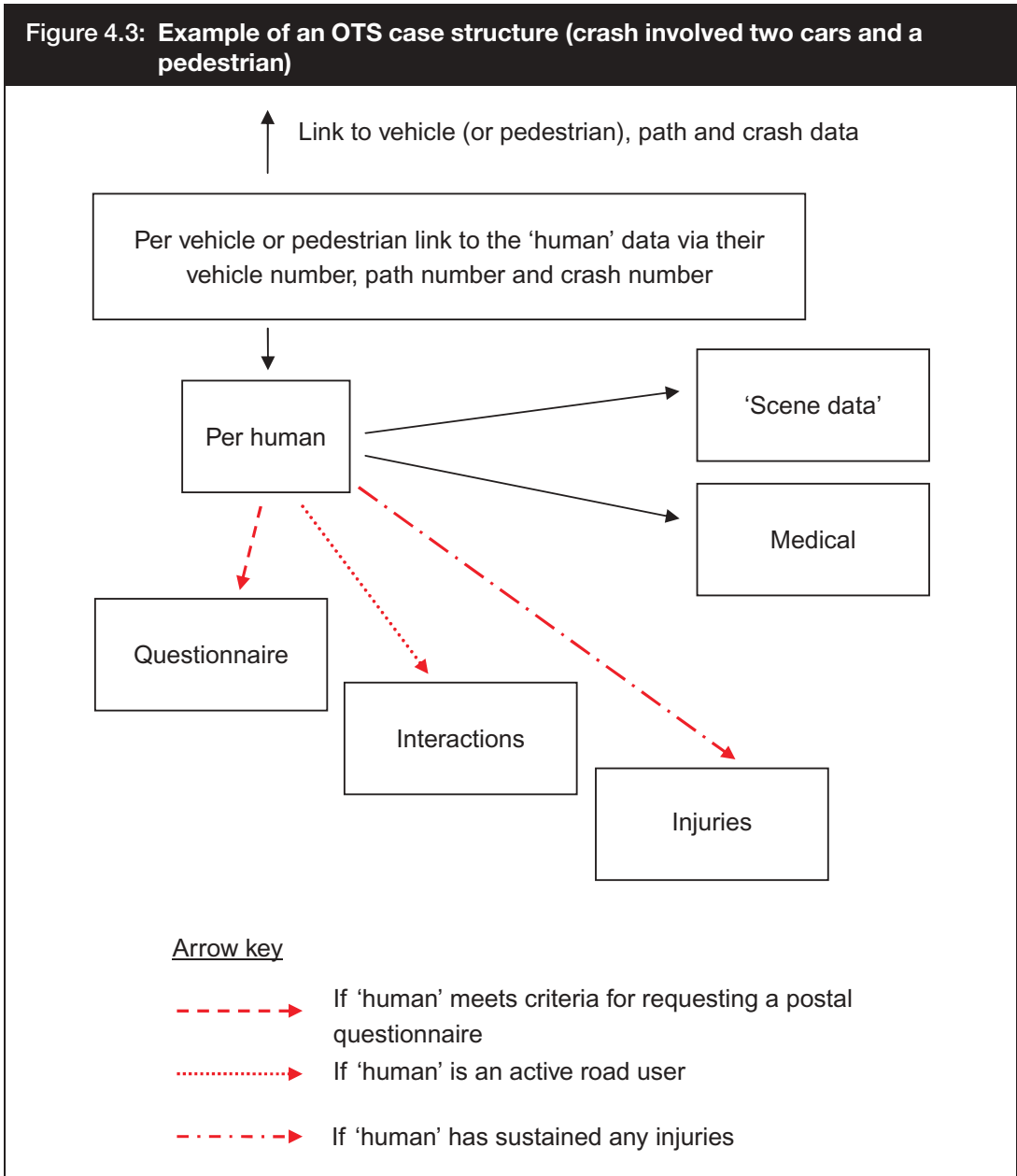
4.7 OTS case – ‘tree structure’

The data recorded for each OTS incident, both at the scene and subsequently through the follow-up activities and reconstruction work, are organised by the appropriate hierarchy within the ‘crash tree structure’. Figures 4.2 and 4.3 detail the ‘tree structure’ used per case, showing the associated different statistical levels that are used to organise and group the data for each accident.

Figure 4.2: Example of an OTS case structure (crash involved two cars and a pedestrian)



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



evidence is recorded for each OTS case and stored electronically with the OTS browser.

4.8 Database structure and definitions

The data from the study are collated in an extensive database, with each case having thousands of data points. In order to be able to make effective use of such a large dataset, the database is structured in a hierarchy of different levels (as detailed in Section 4.7).

Typically a simple accident database would have an accident level, each record of which may be linked to several vehicles. In turn, each vehicle record may then be linked to several casualties. Data are collected on injury crashes in Britain by the police, using this structure (STATS19). For the OTS database, these levels are split further to enable more flexible use of the data. The main data levels are as follows:

- scene (crash or accident);
- path;
- vehicle:
 - vehicle movement details – phase data;
 - evidence or contact marks;
 - occupied seating position characteristics;
- human; and
- injury.

There are 11 distinct tables of information within the OTS database, which contain many thousands of variables.

The database can be analysed in many ways, ranging from simple frequency tables or charts at one statistical level – for example the number of crashes by police injury severity or the number of casualties by police injury severity – to more complex cross-tabulations comparing variables at the same or different hierarchical levels. Statistical or analytical models can also be built to investigate different hypothesis using the OTS database, searching for commonality or relationships when many factors or variables are all considered.

4.8.1 *Scene (crash) level definition*

There is some information that only occurs once per accident, such as the date and time of the incident. These data are recorded at the crash or ‘scene’ level.

The scene level is equivalent to the accident level in STATS19. There is one record per accident, and it contains all the data that relate to the whole accident and to the whole collision scene. Example data fields at this level are the date on which the accident occurred and whether the scene was in daylight or darkness.

4.8.2 *Path (approach) level definition*

Each road user involved in the accident will have travelled (or approached) along a particular ‘path’. The path refers to the road or footway used by the vehicle or pedestrian. Specific information relating to the path is recorded, such as the presence of street lighting or the nature and type of the road, as well as characteristics such as

the speed limit. For single-vehicle collisions or shunt-type accidents, there will only be one path.

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

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

4.8.3 TAR code definition

4.8.3.1 Highways description of the path or approach to the accident locus (TAR codes)

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

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

- feature:
 - shape;
 - control;
- geometry:
 - horizontal;
 - vertical;
 - camber;
- status:
 - class;
 - speed limit;
 - width.

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

The ‘geometry’ section describes the physical characteristics of the highway surface – whether a (horizontal) bend, a gradient and a camber are present – together with a simple assessment of their direction and relative magnitude.

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

This meets the aims of being a highly-concise, generic and comparative encoding system (see Table 4.1). To fulfil the need for a very valuable analysis-focused methodology, the basic structure of these TAR codes has been applied in sequence for every path through an accident scene. For every active road user (whatever their mode of travel) we have documented their chosen path at the point of the accident locus, but also just prior to, and just beyond, the locus. For analysis, this generates a data matrix describing not only the highway features, but also the ‘gradient’ of these features through the locus.

For example, a single TAR code may describe a path as involving a locus on a right-hand bend going up a slight incline, but adding TAR codes for the highway before and beyond the locus allows the investigators to record that the bend was becoming tighter or that the incline was before a hill crest.

The TAR codes describe the environment that is presented to each road user, irrespective of their traditionally assigned ‘road user group’. The codes may be used to identify simply the presence of a particular feature at an accident locus, or they may be interrogated more fully to classify accidents due to the environmental changes with which those road users had to deal.

This is a new concept to describe highway layout for the purpose of accident investigation. To illustrate the breadth of possibilities, the following list gives examples of situations that one could use TAR codes to locate in the database. Clearly these are just examples to highlight what becomes possible using this methodology:

- junction layout – for example, roundabouts, staggered crossings, etc.;
- combinations of proximate features – for example, uncontrolled crossroads just before a traffic-light controlled junction;
- speed limit change in conjunction with physical carriageway changes;
- tightening or reverse-curving bends;
- camber changes on otherwise constant bends;

Table 4.1: Example sections from the TAR coding scheme									
Feature				Geometry					
Shape		Control		Horizontal		Vertical		Camber	
N	No Junction Present	A	Absence of (active) signals	3	Left sharp	3	Up steep		
A	Road continues straight on with an additional (minor) road joining from the right (T-Junction)	T	Traffic Light Control (inc Pelican)	2	Left	2	Up		
B	Road terminates with a (major) road passing across the vehicles path (T-Junction)	Z	Zebra Crossing	1	Left slight	1	Up slight	1	Positive
C	Road continues straight on with an additional (minor) road joining from the left (T-Junction)	L	Level Crossing	0	Straight	0	Level	0	None
D	Road continues straight on with an additional (minor) road joining from the left and right (Crossroad)			-1	Right slight	-1	Down slight	-1	Negative
E	Road is temporally broken by a (major) road passing across the vehicles path (Crossroad)			-2	Right	-2	Down		
M	Junction with more than four approaches (not a roundabout)			-3	Right sharp	-3	Down steep		
3	3 Arm Roundabout								
4	4 Arm Roundabout								
5	5 Arm Roundabout								
6	etc								
X	Crossing (pedestrian /train etc)								

- reductions in the number of lanes beyond roundabouts; and
- paths where one road user has been travelling without a designated lane.

Considering multiple approaches to a locus, one could seek:

- various types of crossroads between a major and a minor road;
- imbalances in the designed space for travel in different directions; and
- control of traffic at features where different types of carriageway intersect.

The TAR codes are nested within the path level data.

4.8.4 *Vehicle level definition*

The next level is the vehicle level. Each vehicle is given a unique identification within those sharing the same path. At this point in the database structure the data can describe explicitly how a vehicle on the first path collided head-on with a vehicle on the second path, or how one vehicle ‘shunted’ another one on the same path.

Unlike the STATS19 database, in which pedestrians are associated with the vehicle that impacted them, OTS also records pedestrians as active road users in their own right and describes their direction of movement and actions.

4.8.5 *Phase data definition*

The structure is not entirely linear, and has several points at which it branches from the main levels. For example, each vehicle may have many dynamic phases (be they skidding, impacts or rollovers) as well as having many occupants. For each dynamic phase, the velocity and direction prior to the start of the phase and at the end of the phase are recorded. This system ensures that valuable data regarding the movements of a vehicle prior to, at and post-collision are recorded in a systematic and routine way.

4.8.6 *Position level definition*

The position tables contain information relating to occupied vehicle seating positions. This includes reference to seat-belt and airbag types and status, seat and head restraint positions, and so on. The position table is strongly linked to the vehicle and human table.

4.8.7 Evidence level definition

The contact or impact evidence caused by humans striking vehicle interior or exterior structures, the ground or other objects, is detailed. For example, Figure 4.4 shows a pedestrian head strike to a car's windscreen. Each contact identified is linked to the vehicle (if appropriate) and the specific human that caused the damage (evidence) found.

Figure 4.4: Example of evidence (pedestrian head contact damage to windscreen)



4.8.8 Human level definition

This nesting of data levels continues, with many humans linked to their vehicle and many injuries linked to each person.

Specific data are collected for the humans involved in crashes, be they drivers, passengers, pedestrians or riders. The information obtained for humans is gathered from three different sources and is divided accordingly within the database. These sources are:

- the on-scene investigation team;
- questionnaires sent to humans who meet the selection criteria; and
- information obtained from medical sources (ambulance, hospital and coroners' reports).

There are three tables within the database that reflect the sources detailed above: human, questionnaire and medical, respectively.

4.8.9 *Interaction level definition*

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

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

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

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

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

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

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

The concept of blameworthiness has intentionally been almost entirely removed from the interactions section of the database. We still can and do record violations of traffic law within the system, but this is not the main focus, since those aspects of

the crashes are well documented elsewhere in the structure of the database (the contributory factors system).

The interactions fall into seven categories:

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

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

The descriptions for individual interactions are structured into levels of increasing detail. This structure is reflected in the code numbers chosen, with a digit for the category, another for the subsection and a third for the detail (Table 4.2).

It is clear from Table 4.2 that no individual line is likely to suffice in providing an adequate description of the reasons for a crash. The Interaction Coding system is designed to allow a record of as many as are necessary to describe **why** the crash happened. From descriptions written from each road user’s perspective in turn, the salient conclusions may be extracted and coded.

4.8.9.1 Interaction Coding to record primary safety conclusions – case example

To clarify the purpose and meaning of these interaction codes, the following are the descriptions, categories and codes for an example case, in which a car and pedal cycle have collided at night.

Driver’s perspective

The car driver was driving along a straight road in darkness, with poor street lighting. He collided with the rear of a cyclist who was travelling in the same direction, but not displaying lights. The driver did not stop at the scene and was arrested the next morning after failing a breath test.

Table 4.2: Example category from the Interaction Coding scheme		
Category	Code	Description
Perception expecting, looking, planning	299	Perceived incorrectly a likely event NFS
	219	Did not look for
	229	Looked but did not see NFS
	221	Looked but did not notice item in plain view
	222	Looked but did not discern (eg lights against similar background)
	223	Looked but did not see, due to physical obstruction on carriageway
	224	Looked but did not see, due to physical obstruction off carriageway
	225	Looked but did not see, due to carriageway geometry (eg bend/crest)
	226	Looked but did not see, due to vehicle geometry (eg blind spot; windows obscured)
	239	
	249	Saw, but did not perceive a hazard from (or in, or on)
	259	Anticipated incorrectly the likely (motion NFS) of
	251	Anticipated incorrectly the likely position of
252	Anticipated incorrectly the likely path of	
253	Anticipated incorrectly the likely speed of	
254	Anticipated incorrectly the likely acceleration of	
255	Anticipated incorrectly the likely deceleration of	
269		
279	Perceived incorrectly the road layout (NFS) on	
271	Perceived incorrectly the road layout (visual through effect) on	
289		

- Failed to avoid another road user (599)
... because he ...
- Looked but did not discern (e.g. lights against similar background) (222)
... because he ...
- Suffered impairment due to alcohol (731)
... and ...
- Was legally unfit to drive due to alcohol (131).

Cyclist's perspective

The cyclist was travelling along a straight road and was hit from behind by a car. The rider was drunk and not displaying lights at night.

- Omitted to give useful information or signal to another road user (566)
... because he ...

- Misjudged his own conspicuity to another road user (379)
... and ...
- Was legally unfit to drive due to alcohol (131).

The actual interaction codes and the categories they represent are independent of road user type, and can therefore allow comparison of accident causation in the analysis of multimodal studies. To identify crashes in which one road user did not discern the presence of another, who had judged that he was conspicuous to the first, one could look for the codes 222 and 379 in the interactions of pairs of road users and find the case example above as just one case where this type of interaction occurred.

4.8.10 Injury level definition

If a human involved in an OTS case is injured, every effort is made to ascertain the exact description of each injury sustained. This is either done through interviewing the casualty at the scene, sending a postal questionnaire or, in the more serious cases, assessing their diagnostic and treatment hospital records. In the rare events that fatal casualties are investigated by the study, co-operation is sought from the coroner and the pathologist, and a copy of the post-mortem report is obtained.

It was decided that less emphasis would be placed on injury details and injury-causing mechanisms for car occupants during Phase II. That was because the Co-operative Crash Injury Study (CCIS)⁵ existed specifically to investigate in-depth the injuries to car occupants, alongside OTS. That decision allowed the teams to maximise their efforts regarding accident causation and injuries to other road users who are not investigated elsewhere.

The injuries sustained are all coded using the Abbreviated Injury Scale¹. The AIS was originally developed for impact injury assessment. The AIS is a classification system that denotes the type and severity of given injuries.

Where possible, every injury sustained is correlated to its cause. The evidence level of the database is often the source of scene-identified information that allows specific injury causation mechanisms to be understood and documented. Therefore, each injury is related to the human who sustained the trauma, the nature of the component or vehicle feature or object that was impacted and linked to the evidence number correlated to the vehicle or object.

5 DATA INPUT AND BROWSER SYSTEMS

To aid in both the presentation and entry of OTS data, two new computer systems were designed and created by TRL. These were the OTS browser and OTS data input system. This software combined forms and protocols already developed by TRL and VSRC into a single, effective database system allowing detailed accident data to be both compiled and subsequently explored by a variety of end users.

5.1 OTS browser system

The browser system provides a front end to the database, presenting decoded data in an easy-to-read and structured format. The system also provides a platform to view images and movies of the scene, paths and vehicles involved in the accident. The browser also enables users to run simple analysis queries on the OTS database. For instance, users can choose to view only motorcycle loss-of-control accidents.

Figure 5.1: The OTS browser

The screenshot displays the OTS browser software interface. The window title is "OTS Phase 2 Browser [D:\My Archive\OTS\Data\OTS phase 1d\OTS Phase 1 release.d.mdb]". The interface includes a menu bar (File, Edit, Data, View, Tools, Window, Help) and a toolbar. On the left, there is a sidebar with a "Scene: Scene Metadata" section and buttons for "Case Summary...", "OTS Data Matrix", "Scene", "Path", "Vehicle", "Position", "Human", "Evidence", and "Phase". The main area features a form with several sections: "Scene: 1", "Path:", "Vehicles:", "Position:", "Human:", "Evidence:", "Phase:", "Accident:", "Injury:", "Instruction:", "Cause/Contrib:", "Scene Core", "Accident Causation", "Scene Metadata", "Layout", "Conditions", "Control And Facilities", "Comments", "Contributory Factors 2005", "Scene Plan", and "Scene Photo". The "Scene Metadata" section is active, showing a list of fields: "Scene, Scene Metadata: 21", "\$_0002 [1] - Police County", "\$_0002 [1] - OTS Police Officer (name & no.)", "\$_0003 [1] - Officer-in-Charge (name & no.)", "\$_0004 [1] - Officer-in-Charge (Division)", "\$_0008 [2] - Day of week", "\$_0009 [2] - OTS Team Attended", and "\$_0016 [1] - CAR... Crash Participants (how many vehicles involved, what type, how many pedestrians, how many cycles etc)". The "Day of week" field has radio buttons for Monday [1], Tuesday [2] (selected), Wednesday [3], Thursday [4], Friday [5], Saturday [6], and Sunday [7]. The "OTR Team Attended" field has radio buttons for TRL [1] (selected) and VSRC [2]. The "CAR..." field has a dropdown menu with "2 CARS AND 1 MOV WITH DRIVERS". At the bottom, there are navigation buttons: "First", "Previous", "Next", "Last", "To Case", "Query...", "Print...", and "Lock". The status bar shows "Record 1 of 1513".

Figure 5.1 shows the browser system. The different levels of the database are displayed in the right-hand column, allowing users to select the level they wish to view. The buttons along the top of the data form relate to the type of data contained on the form – for instance in Figure 5.1 the user has selected to view Scene Metadata, such as the day of the week and the police force area.

5.2 OTS data input system

The data input system (DIS) enables multiple users to enter data directly into the database at the same time. The DIS provides a system for managing the processing of cases, with different types of users having different permissions to edit the data. The system also manages the storage and referencing of images relating to the OTS cases. Images are referenced in the OTS database to enable the browser system to display images of the case to the user when viewing cases.

6 PROJECT MANAGEMENT

6.1 Training

During Phase II of the project, both TRL and VSRC introduced new members to their teams, all of whom received full training, including health and safety and first aid. In addition, both centres actively partook in team exchanges to ensure that a common data collection methodology was adopted.

6.1.1 *Collision reconstruction*

While both teams routinely carry out training in a variety of aspects of accident investigations for new and existing team members, the topic of collision reconstruction received special attention during Phase II. A number of complementary activities were carried out at both centres, and some joint training activities were undertaken.

VSRC organised a week-long training course on collision reconstruction for the investigators from both VSRC and TRL, utilising the skills of a very experienced police accident investigator. At the VSRC, a University Certificate in Continuing Professional Development in Forensic Road Collision Investigation is now standard training practice for all members of the VSRC team. This is a course approved by the Institute of Traffic Accident Investigators (ITAI) and by the Association of Chief Police Officers (ACPO) for UK police.

The approach at TRL has been to initiate a six-day course based on the material used in the above course to cover the basic and intermediary principles of accident investigation techniques. In addition, the TRL team have attended a Society of Automotive Engineers (SAE) advanced accident investigation course covering the advanced physics of crash reconstruction and the associated forensic evidence interpretation following traffic accidents. This included a review of the uncertainty in the standard measurements and calculations regularly used and taught to collision investigators. The course worked through the concepts of vehicle behaviour from first principles and thus provided the investigators with an in-depth understanding of how and when to apply (and, perhaps equally importantly, when not to apply) various reconstruction techniques.

6.2 Health and safety

In Phase II, as in Phase I, both centres continued regularly to review the risk associated with the OTS study and regularly updated procedures and protocols to minimise and, where possible, mitigate these risks. In addition, all necessary steps were taken to ensure compliance with the Health and Safety at Work Act 1974.

The procedures and protocols adhered to by both teams ensured that the following key processes were observed:

- ensuring the team had the relevant safety equipment, including clothing, footwear and scene protection equipment;
- undertaking a detailed risk assessment of the operational risks and the correct course of action to minimise these risks;
- training all call-out team members in how to minimise risk when at accident scenes;
- providing crash investigators with access to the appropriate inoculations, such as hepatitis B and tetanus;
- briefings for any new team members before their involvement at live accident sites; and
- the provision of first aid training for all accident investigators.

These processes were supported by an ongoing approach to risk awareness within the whole team, combined with the process of risk management.

Safety training was provided for all members of the call-out teams, along with further training in working on-site where required. TRL and VSRC have considerable experience of working on-site in hazardous conditions, motorways and the wider highways network. Training from experienced site operatives was made available for all staff.

VSRC continued to operate under a localised health and safety policy, in addition to the broader policy of its parent organisation, Loughborough University.

Both centres provided support for the mental wellbeing of their teams, through access to de-briefing sessions and counselling services provided by either Nottinghamshire Police counselling services or TRL's qualified welfare officer.

In addition to the OTS accident investigators, other personnel occasionally visited accident scenes with the team. This benefited the study in terms of the application of specialist knowledge, training, harmonising data collection and promoting the Government's research work towards the 2010 casualty reduction targets. Procedures were introduced to ensure the safety of these additional visiting personnel.

6.3 VSRC and TRL team collaboration

Phase II of the OTS project continued with the mutual support and collaborative practices developed during Phase I, providing the funding group with maximum data quality. Informal workshops and group meetings were held at regular intervals.

Based on the experiences of Phase I, the areas of most benefit were those involving technical collaboration and are listed below:

- maintenance of common sampling plans;
- maintenance of priority guidelines for investigation;
- development and enhancement of common methodologies for new and ongoing investigation procedures;
- the co-ordination of database activities; and
- catalysing joint analytical views of the data.

During Phase II, in-depth accident case reviews continued, and systems for training, support and staff exchanges were built upon and increased. Staff exchange visits between the teams and a week-long joint training course were a success, providing another mechanism for pooling experience and skills across the research centres, thus helping to improve the consistency, quality and insight of the data collected and analysed.

7 DISSEMINATION OF INFORMATION

7.1 Project website

Following on from the publication of the OTS brochure and development of the project website by the VSRC during Phase 1 of OTS, the VSRC have now enhanced the website to provide a highly effective means of disseminating information about the project and the key findings to date. The website is available at www.ukots.org and provides information and key data to the public and research professionals, along with a secure ‘members only’ area for effective communication within the project. The members’ area is currently used for the sharing of protocols, training materials and meeting minutes, and it contains details of the Special Investigation cases. The website is updated on a regular basis, and the secure data users’ area can be used for the dissemination of data to authorised users.

7.2 Publications and presentations

Information about the OTS study has been disseminated in the publications and presentations detailed below.

7.2.1 *Phase I (projects completed, June 2000 to September 2003)*

Some 23 papers were presented at international conferences and workshops throughout the period, describing OTS methodologies, early data overviews and case examples. A full bibliographic listing has been provided below.

7.2.2 *Phase II (projects completed, September 2003 to September 2006)*

Further presentations and publications were made to include advances in methodology, as listed in Section 11, References. In addition, there were three international conference presentations, as described below. Further, there were many presentations and information exchanges with the sponsors of the project and the wider road transport safety community.

In December 2005, Richard Cuerden gave a presentation to the Road Haulage Association Forum meeting, chaired by Dr Stephen Ladyman, entitled *Crash Investigation Studies (OTS): Evidence-based Traffic Safety Countermeasures*.

7.2.3 *Dissemination venues 2001–06*

Project information has been disseminated at a variety of venues as summarised in Table 7.1, and as fully detailed in the References section.

Table 7.1: Table detailing conferences and meetings where OTS data were disseminated

Forum	Venue	Date	Ref.
Parliamentary Advisory Council for Transport Safety (PACTS)	London	January 2001	28
Nottinghamshire Casualty Reduction Partnership	Nottingham	January 2001	29
Association of Chief Police Officers (ACPO)	Cumbria	May 2001	30
International Technical Conference on the Enhanced Safety of Vehicles (ESV)	Amsterdam	June 2001	31
International Conference on Accident Investigation, Reconstruction, Interpretation and the Law (AIRIL)	Vancouver	August 2001	25
Traffic Safety on Three Continents, Conference	Moscow	September 2001	32
Institute of Traffic Accident Investigators' Conference (ITAI)	York	November 2001	26
Cooperative Crash Injury Study (CCIS) Symposium	Birmingham	December 2001	33
Behavioural Research in Road Safety, Eleventh Seminar	Manchester	February 2002	34
European Vehicle Passive Safety Network, Pedestrian Safety Workshop	Cranfield	September 2002	45
British Trauma Society – Annual Scientific Conference	Leeds	October 2002	7
European Commission Road Infrastructure Safety Workshop	Brussels	November 2002	35
Parliamentary Advisory Council for Transport Safety (PACTS)	London	January 2003	8
Pedestrian Protection Workshop at Autoliv	Havant	March 2003	9
Foresight Vehicle Committee Meeting	Crowthorne (TRL)	March 2003	10
Society of Motor Manufacturers	London	April 2003	11
International Technical Conference on the Enhanced Safety of Vehicles (ESV)	Nagoya, Japan	May 2003	12 and 51
British Trauma Society – Trauma Nursing Course	London	September 2003	14
British Trauma Society – Annual Scientific Conference	London	September 2003	15
European Vehicle Passive Safety Network, Vehicle-Infrastructure Crashworthiness Workshop	Rhode, Germany	October 2003	36
Expert Symposium on Accident Research Hannover Medical School (ESAR)	Hannover	September 2004	38

Table 7.1: (continued)			
Forum	Venue	Date	Ref.
Roads 2004 Trunk Road Management Conference (Highways Agency Conference)	Manchester	September 2004	16
VDI Internationaler Kongress	Braunschweig, Germany	November 2005	39
Road Haulage Association Forum meeting	London	December 2005	17
Parliamentary Advisory Council for Transport Safety (PACTS)	London	January 2006	18
Road Safety Conference, National Roads Authority, Ireland	Dublin	March 2006	-
SafetyNet Project Meeting	Delft	March 2006	-
East Midlands Intermediate Care Scheme (EMICS)	Nottingham	April 2006	-
Parliamentary Advisory Council for Transport Safety (PACTS)	London	May 2006	19
TRACE Project Meeting	Ismaning, Germany	May 2006	-
SafetyNet Project Meeting	Hannover, Germany	June 2006	-

7.2.4 Key publications and presentations in Phase II (2003 to 2006)

7.2.4.1 Interaction of road environment, vehicle and human factors in the causation of pedestrian accidents

This project culminated in a paper presented by Lenard and Hill³⁸ from VSRC at the International Expert Symposium on Accident Research (ESAR), Hannover, 3–4 September 2004. The purpose of this paper was to present various OTS methodologies for describing accident causation and the interaction of road, vehicle and human factors by reference to pedestrian accidents. Analyses were intended to provide an insight into how and why pedestrian accidents occur, in order to assist the development of effective road, vehicle and behavioural countermeasures.

7.2.4.2 Drivers' perception of accident circumstances and opportunities for crash avoidance through technological intervention

This project resulted in a paper presented at the VDI International Conference: Driver in the 21st Century – Humans as drivers and their interaction with vehicles, Braunschweig 22–23 November 2005. The paper was written by Lenard, Dodson and Hill³⁹ from VSRC. Questionnaire data from 953 drivers, motorcyclists, pedal cyclists and pedestrians involved in accidents were presented with a focus on the causes of accidents and the perception of safety. Their responses indicated that other

road users, the weather and the condition of the road surface are important factors, in their view, in why the accidents occurred. A closer examination of cases where the behaviour of the other road user was nominated as a factor revealed an element of agreement with the independent views of the OTS investigators at a general level, but many disparities at a detailed level.

7.2.4.3 Motorcycle and pedal cycle crash characteristics in the UK

Fails, Cuerden and Lunt²⁴ from TRL presented a paper entitled 'Motorcycle and pedal cycle crash characteristics in the UK' at the Vehicle Safety 2004 Conference, IMechE, December 2004. This paper presents information on 215 accidents that have been investigated to date that involved two-wheel vehicle (TWV) accidents. The rider and TWV characteristics are considered for motorcycles and pedal cycles separately, and single- and multi-vehicle collisions are presented. The paper then presents a new and innovative primary safety coding system (Interaction Codes) used to document the conclusions reached following in-depth accident investigations.

The rates of fatal or serious motorcycle and pedal cycle rider casualties per unit distance travelled are 30 and 12 times greater (respectively) than for all drivers and riders. Two hundred and fifteen cases from the OTS accident investigation project were studied, and in 41% of the single-vehicle accidents a casualty was killed or seriously injured (KSI).

Multiple-vehicle accidents at junctions were frequent in the sample and had almost as high a proportion of KSI outcome as single-vehicle TWV accidents. Examining these, it was found that another vehicle crossing the path of a TWV at a free-flowing junction showed both frequent incidence and high severity, marking this as the most important multi-vehicle impact configuration for addressing serious accidents.

7.2.4.4 Development and implementation of the UK OTS Accident Data Collection study. Phase 1

In November 2005, the final report on the Development and Implementation of the UK OTS Accident Data Collection Study²¹ was published by the Department for Transport (Hill and Cuerden, 2005).

7.3 Visits

Representatives from the Czech Republic Department of Transport spent a week with the team at VSRC, learning about the project and the data collection methodology.

7.4 National and international links

The OTS project is highly regarded across the European research community, where the database is seen to be a unique source of high-quality in-depth data from the UK, especially concerning the causes of road accidents and associated factors. The Department for Transport have granted permission for the database to be shared with a number of European research projects, as outlined below.

7.4.1 *SafetyNet – www.erso.eu*

SafetyNet is an integrated project working to build a ‘Road Safety Observatory’ for the European Union (EU), including data resources for policy support and other tools to monitor progress towards targets, identify best practise, and ensure that new regulatory and other safety actions will result in maximum casualty reductions.

A key component will be a new in-depth accident causation database containing 1,000 investigations with data from six EU Member States, including UK accidents originating from the OTS database. This new resource will be a major advance in knowledge about accidents and injuries at the EU level. There will be applications in the areas of new technology development, active safety systems, infrastructure and road safety. All the findings assembled or gathered within the project will be available over the web to the road safety community. A full description of the SafetyNet project is available at the website for the new EU Observatory at www.erso.eu.

More specifically, the VSRC team are providing 250 enhanced OTS cases for this European in-depth accident causation database. This database will also include cases from the Netherlands, Sweden, Germany, Finland and Italy. Where possible, all cases incorporate interview data, and they are analysed using a new accident causation methodology developed in Sweden.

7.4.2 *Traffic Accident Causation in Europe – www.trace-project.org*

Together with partners across eight European countries, and Australia, the VSRC are bringing OTS data to the analysis of Traffic Accident Causation in Europe (TRACE), which is a research project funded by the European Commission under the Sixth Framework programme. The general objective of the TRACE project is to provide the scientific community, stakeholders, suppliers and the vehicle industry with a global overview of road accident causation issues in Europe and overseas. The objective is to identify, characterise and quantify the nature of risk factors, groups at risk, specific conflict driving situations and accident situations; and to estimate the safety benefits of a selection of technology-based safety functions. Reports will be available at project completion in December 2007. A full project description can be found on the project website.

The VSRC team are preparing aggregated OTS data for this comprehensive European study, analysing accident causation and evaluating the safety benefits of vehicle technologies. This work is in partnership with centres from Germany, Spain, Greece, the Netherlands, Italy, France and the Czech Republic.

7.4.3 *Advanced Protection Systems – www.aprosys.com*

The Integrated Project on Advanced Protection Systems (APROSYS) aims to help make significant further reductions in fatalities and injury numbers by deploying appropriate passive (or crash) safety strategies. With funding from the EC Sixth Framework programme, APROSYS is developing critical technologies that improve passive safety for all European road users for priority accident types and levels of crash severity.

OTS case studies and statistical data made an important contribution to the analysis of pedestrian accidents, including accident/injury mechanisms, and subsequent recommendations. Further, TRL undertook analysis of OTS data for other work packages aimed at improving vehicle occupant protection and mitigating crashes.

7.4.4 *New Programme for the Assessment of Child-restraint Systems – www.npacs.com*

The New Programme for the Assessment of Child-restraint Systems (NPACS) aims to establish scientifically based, EU-wide, harmonised test and rating protocols that will provide consumers with clear and understandable information about dynamic performance and the usability of child-restraint systems. The current research phase of NPACS is funded by the governments of the UK, the Netherlands, Germany and Catalunya, and also by ICRT (Consumer Organisations), FIA automobile clubs (ÖAMTC, ADAC), GDV (German Insurance Association), DG TREN (Transport and Energy) of the European Commission and the FIA Foundation for the Automobile and Society. OTS case examples made a useful contribution to the overall analysis, assisting with the understanding of the effectiveness of child restraints and misuse issues, where restraints had not been fitted correctly into vehicles.

7.4.5 *IMPROVER*

During the IMPROVER (Impact Assessment of Road Safety Measures for Vehicles and Road Equipment) project, work was undertaken to examine the national accident data of participant countries, with respect to the safety implications of SUVs (sports utility vehicles) and MPVs (multi-purpose vehicles) as part of the vehicle fleet. As well as the statistical analysis, two countries were in a position to undertake detailed accident analysis – Germany, via the GIDAS (German In-Depth Accident Study) and the UK, through the OTS study. This detailed case-by-case analysis undertaken by the TRL team provided direct insight into the interactions

encountered during a collision with an SUV, and was a valuable addition to the work.

7.4.6 *Powered Two-Wheeler Integrated Safety*

The main aim of the Powered Two-Wheeler Integrated Safety (PISa) project is to develop and implement ‘reliable and fail-safe’ integrated safety systems for a range of powered two-wheelers (PTWs), which will greatly improve their performance and primary safety (handling and stability) and can link to secondary safety devices. The project involves 11 partners from research and industry, including VSRC and TRL, and is funded by the European Commission. Important aspects of the project are to identify user needs and requirements, as well as the accident scenarios in which such safety systems will make the most beneficial contribution to accident or injury reduction. OTS is one of the existing data sources of motorcycle data that are being made available to PISa. The OTS data will be reviewed and cases selected for detailed analysis. A small number of cases will be used as the basis for development and evaluation of the developed systems.

8 SUPPLEMENTARY ACTIVITIES

A wide variety of supplementary activities have been initiated in parallel with the main data collection activity. These additional activities have ensured that OTS findings and expertise have been effectively utilised for data analyses, data sharing with other safety-orientated projects, and/or as a platform for ad hoc on-scene investigation activities.

8.1 Data analyses

The Department for Transport and HA make use of the OTS database when assessing a variety of ad hoc road safety queries and current issues of concern that may be raised by Ministers, department officials, other safety professionals or the general public. Recent examples where the VSRC or TRL have provided such ad hoc database query reports include the following:

- accidents occurring at road works;
- accidents involving vehicle malfunctions;
- accident case examples involving inappropriate speed;
- abnormal loads carried by vehicles in accidents;
- accidents involving left-hand drive heavy goods vehicles;
- motorcycle accidents and effectiveness of braking;
- accidents involving tinted car windows; and
- accident characteristics of crashes involving ‘white vans’.

The HA has issued the OTS database and software for use by their contractors. Additionally, in-depth OTS analyses have been encouraged at the outset for a number of the projects.

8.1.1 *OTS data analysis project*

This extensive analysis of the current OTS database is currently under way by the QinetiQ Centre for Human Sciences. QinetiQ is conducting analyses to:

- highlight areas which are important for policy development;
- provide recommendations for countermeasures by specific accident types; and
- identify possible improvements to the research protocol.

8.1.2 Pedestrian crash analysis

The VSRC and TRL are making a joint analysis of the pedestrian accident data. The aim of this work is to investigate the current relationship between speed, survivability and life-altering injuries in pedestrian accidents. This work is intended to support road safety policy and education programmes.

8.1.3 Analysis of OTS data to supplement the MAIDS motorcycle study

TRL is undertaking this project, aiming to supplement the recently published European Motorcycle Accident In-Depth Study (MAIDS) report^{46,42} with comparable in-depth data from OTS. This will widen the MAIDS report's perspective to include the UK situation and explore the relevance of findings in the UK context.

A detailed investigation of each of the UK OTS motorcycle accidents is to be conducted based on UK priority areas. MAIDS used information from five countries: France, Germany, Italy, the Netherlands and Spain (<http://maids.acembike.org>). The project will pay particular attention to the items of data that may be directly compared with MAIDS findings entailing careful comparisons of the data stored within the OTS (UK) and MAIDS databases.

The findings of the MAIDS study will be examined and compared with the data from the UK OTS database. In the case where motorcycle safety issues important to the UK cannot be investigated using the OTS data, an analysis of the MAIDS data on the subject of interest may be carried out. It is proposed to carry out an analysis on the MAIDS data to provide a larger dataset for analysis and for comparison with the OTS data.

The output from this project may result in future changes or additions to OTS data collection and will inform on the UK scenario with relevance to the MAIDS study.

8.1.4 Conspicuity of recovery vehicles

This project has recently being started by TRL to investigate accidents that involve emergency service and recovery vehicles. There is a need to understand more about vehicle conspicuity, and this work will use several data sources, including OTS, to investigate the nature and type of crashes where such vehicles are involved. Specific emphasis will be placed on what was, or was not, seen by the active road users involved in the collisions.

8.2 PhD programme

During Phase II of OTS there have been two PhD students at VSRC who are incorporating OTS data into their work:

- **Driver-Vehicle-Road Network Based Synthetic Traffic Simulation System** – the Synthetic Traffic Simulator (ST-SIM) has been developed as an agent-based micro-simulation software that gives equal emphasis to models of driver behaviour, vehicle dynamics and road network infrastructure. Work funded by the HA has allowed the student to focus on the estimation of driver decision-making prior to impact in accidents. This has involved reconstructing a number of OTS cases and highlighting the sensitivity of each to variations in estimated pre-crash driver decision-making.
- **New Automotive Active Safety Technologies and Casualty Reduction** – new predictive analysis methodologies are being used. These will relate the new active safety technologies with casualty reduction, based on real-world accident data, from on-scene crash investigations carried out by the OTS team.

8.3 Special investigations

In addition to routine on-scene investigations, the OTS teams make Special Accident Investigations where road traffic incidents are deemed to be of special interest for reasons relating to road safety issues, human factors, vehicle factors or highway-related issues.

Significant effort has been involved in identifying potential cases across the UK in media reports and police accident notifications, and also in following up potential cases with the Department for Transport, local police forces and local vehicle recovery firms. Twenty-nine accident reports have been produced to date.

8.4 Anthropometric study of vulnerable road users

Leading on from the Anthropometric Study of Injured Pedestrians undertaken by VSRC during Phase I of the project, the VSRC have successfully renewed its agreement with the Accident and Emergency Centre of Queen's Medical Centre, Nottingham (where the majority of casualties were taken from OTS accidents investigated by VSRC) to look at providing data from all vulnerable road users injured in crashes. This allows for anthropometric measurements to be taken, where consent is given by the casualty, along with information concerning the exact location of injuries and descriptions of clothing worn. This will provide valuable information for both the reconstruction of the causes of injuries and possible future mathematical modelling of vehicle and vulnerable road-user interactions and the causes of injuries.

8.5 Offence histories

The Vehicle Safety Research Centre (VSRC) undertook a pilot study on the feasibility to routinely collect data on offence histories of road users which may be correlated with accident involvement. This work was made possible through the

support and co-operation of Nottinghamshire Police. The work demonstrated the logistics required for gathering such data within tight ethical boundaries.

8.6 ‘A’ pillar obscuration

The scope of this study, developed at TRL⁴³, was to assess if there is a problem caused by car ‘A’ pillar obscuration in the real world and, if so, to start to quantify the size of that problem. This was achieved by using real-world crash data to construct three-dimensional visualisations that would provide a graphical illustration of the obscuration caused by the car ‘A’ pillar. The real-world crash data used in the study were obtained from the OTS crash study.

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

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

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

8.7 Errant vehicles

This project investigated OTS crashes where vehicles left the carriageway. Specifically, the work was undertaken to address recommendations from an HA working group to review the standard for the provision of nearside safety barriers on the trunk road network. OTS cases were used to describe how and where errant vehicles travel after leaving the nearside of the carriageway. The research focused on the factors that influence the travel of errant vehicles, the relative significance of these factors, and potential ways to address them. Data on errant vehicle travel are needed both in the context of the post-Selby action plan, and particularly to inform the risk assessment being developed for the revised standard for vehicle restraint systems⁴⁰.

8.8 The effectiveness of vehicle restraints

The aim of the project is to investigate the effectiveness related to the design and use of vehicle-restraint systems (safety barriers). Vehicle-restraint systems provide both protection to road users from errant vehicles and containment protection for vehicles that strike them. Current vehicle-restraint systems are designed for a number of different vehicle types and crash scenarios, but are not specifically designed to restrain or contain the larger category of passenger cars that has emerged in recent years.

These larger cars, referred to as ‘group vehicles’, include types such as multi-purpose vehicles (MPVs, also known as ‘people carriers’), off-road vehicles (4x4s), sports utility vehicles (SUVs) and motor-homes (also known as motor caravans or camper vans). They typically have a larger mass and higher centre of gravity than standard cars, and hence may behave in a different way from a ‘standard’ car when striking a vehicle restraint.

The project determines the nature of real-world crashes involving these larger group vehicles, highlights the differences that exist in the crash characteristics of these vehicles compared with standard cars when vehicle restraints are struck, and quantifies the size of the problem⁴⁴.

9 CONCLUSIONS AND RECOMMENDATIONS

The data collected by the OTS study have continued to provide valuable information regarding the causes and consequences of road traffic accidents. During OTS Phase II, these data have been used to support numerous Department for Transport and European accident research projects, and are widely regarded as a unique source of high-quality in-depth information concerning the causes of road accidents.

Most notably, the data collected in OTS Phases I and II have been, and continue to be, used to support the following projects:

- Department for Transport 'A' pillar obscuration project;
- Impact Assessment of Road Safety Measures for Vehicles and Road Equipment project (IMPROVER);
- Advanced Protections Systems (APROSYS);
- EU SafetyNet;
- New Programme for the Assessment of Child-restraint Systems (NPACS); and
- Department for Transport Analysis of OTS data to supplement MAIDS motorcycle Study.

The introduction of the crash reconstruction 'phase data' during Phase II has enabled the systematic recording of vehicle pre- and post-impact movements to be documented. This enhancement allows detailed analysis of the OTS database to be undertaken with regards to the potential influence of speed and primary safety systems on the causes of road traffic accidents. In addition, the potential benefits of current and future crash prevention or mitigation systems can be evaluated using real-world evidence to determine their effectiveness. This key information will also enable valuable knowledge to be generated about the causes of injuries to vulnerable road users.

In addition, the introduction of a new systematic system for recording the road environment prior to, at and beyond the locus of an accident in Phase II has provided a new tool for assessing the effects of highway design on accident causation.

During Phase II, the level of expertise the OTS teams' offer the project has significantly improved, increasing both the amount and quality of the data gathered. The OTS project continues to provide a valuable source of information to a variety of other research projects. In addition, the evidence-based approach is a fundamental factor that assists the Department for Transport in the development of policies aimed at reducing road traffic casualties.

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11 REFERENCES AND BIBLIOGRAPHY

1. Association for the Advancement of Automotive Medicine (AAAM). The Abbreviated Injury Scale 1990 Revision. Des Plaines, IL., USA, 1990
2. Ashton, S. J.; Pedder, J. B.; Mackay, G. M. Pedestrian Injuries and the Car Exterior. SAE Transactions, New York. Paper 770092, 1977
3. Broughton, J.; Markey, K. A.; Rowe, D. A New System for Recording Contributory Factors in Road Accidents. TRL Report 323, Prepared for the DETR, 1988
4. Chenisbest, B.; Jahn, N.; le Coz, J. European Accident Causation Survey (EACS) Methodology. 16th International Conference on the Enhanced Safety of Vehicles, Windsor, Ontario. Paper Number 98-S2-O-08, Volume 1, pp 414–421, 1998
5. Co-operative Crash Injury Study (CCIS), see <http://www.ukccis.com/>
6. Cuerden, R. Injury Patterns In Pedestrian Accidents And The Associated Methodology Of A Real World In-Depth Study. Automotive Environmental Impact and Safety IMechE Autotech 1997 Congress, Birmingham, UK. November 1997. ISBN 1860581161, Paper reference C524/155/97, pages 215–229.
7. Cuerden, R. Mechanism of Pedestrian Injury – OTS Case Reviews. Presentation to the British Trauma Society Annual Scientific Meeting, Leeds, October 2002.
8. Cuerden, R. OTS Crash Investigations – An update. Presentation made to the Vehicle Design Working Party of the Parliamentary Advisory Council for Transport Safety (PACTS), January 2003
9. Cuerden, R. Real World OTS Pedestrian Crashes and Vehicle Design. Presentation given at a Pedestrian Protection Workshop held at Autoliv, Havant, UK, March 2003.
10. Cuerden, R. OTS Crash Investigations – A Window on the Real World of Traffic Accidents. Presentation to Foresight Vehicle Committee at TRL, March 2003.
11. Cuerden, R. An Overview of the UK’s Real-World Crash Investigation Studies OTS and CCIS. Presentation to the Society of Motor Manufacturers and Traders (SMMT), London, UK, April 2003.
12. Cuerden, R., Lunt, H., Fails, A. and Hill, J.R. ‘On The Spot’ Crash Investigations in the UK: New Insights for Vehicle Safety Research, Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles , US Department of Transportation, National Highway Traffic Safety Administration, Nagoya, Japan, 12 pp , [CD-ROM]. 19–22 May, 2003

13. Cuerden, R., Hill, J. R. Work Specification for OTS Phase 2. Current OTS Practice, New Requirements and Additional Options. Draft document for use in support of DfT documentation relating to Phase 2 of the OTS Data Collection Project. TRL & VSRC, July 2003.
14. Cuerden, R. There is no such thing as an accident – The need for Injury Prevention. Presentation to the British Trauma Society Trauma Nursing Course, London, UK, September 2003.
15. Cuerden, R., Hynd, D. Neale, M. Traffic Casualty Research - The Engineering Medical Link. Presentation to the British Trauma Society Annual Scientific Meeting, London, UK, October 2003.
16. Cuerden, R. On The Spot Accident Investigations. Roads04 Trunk Road Management Conference ‘Keeping Customers Moving’ Highways Agency. Manchester, UK, September 2004.
17. Cuerden, R. Crash Investigation Studies (OTS): Evidence-based Traffic Safety Countermeasures. Presentation to the Road Haulage Association Forum meeting, December 2005 (chaired by Dr Stephen Ladyman).
18. Cuerden, R. OTS Crash Investigations: A review of the headline findings – Presentation made to the Vehicle Design Working Party of the Parliamentary Advisory Council for Transport Safety (PACTS), January 2006
19. Cuerden, R. On The Spot: Speed, Survivability and Life Altering Injuries ‘Technological issues of vehicle design’. Presentation made to the Vehicle Design Working Party of the Parliamentary Advisory Council for Transport Safety (PACTS), May 2006.
20. Department for Transport, Road Casualties Great Britain: 2003 and 2005, DfT National Statistics, see <http://www.dft.gov.uk>
21. Department for Transport, Development and Implementation of the UK On The Spot Accident Data Collection Study – Phase I. Road Safety Research Report No. 59, November 2005.
22. Department of the Environment, Transport and the Regions (2000) Tomorrow’s Roads: Safer for Everyone. The Government’s Road Safety Strategy and Casualty Reduction Targets for 2010. London: DETR.
23. D.S.I.R Research on Road Safety. HMSO, London. pp 464–447, 1963
24. Fails, A., Cuerden, R., Lunt, H. Motorcycle and Pedal Cycle Crash Characteristics in the UK. Vehicle Safety 2004 Conference, IMechE. December 2004.
25. Forman, P., Hill, J. R. The new ‘On The Spot’ crash investigation project in the UK. AIRIL 2001 Conference, University of British Columbia, Vancouver, Canada, pp 1–29. August 2001

26. Forman, P., Hill, J. R. The new 'On The Spot' crash investigation project. The Institute of Traffic Investigators Conference, York, pp17–29. York, UK, November 2001
27. Girard Y. In-Depth Investigations of Accidents: The Experience of INRETS at Salon-de-Provence. In Safety Evaluation of Traffic Systems, Traffic Conflicts and Other Measures; Proceedings of the International Co-operation on Theories and Concepts on Traffic Safety (ICTCT) Workshop, Salzburg, 1993
28. Hill, J.R. OTS Crash Investigations: Objectives and Methodology. Presentation made to the Vehicle Design Working Party of the Parliamentary Advisory Council for Transport Safety (PACTS), January 2001
29. Hill, J.R. OTS Crash Investigations: Objectives and Methodology. Presentation made to Nottinghamshire Casualty Reduction Partnership, January 2001
30. Hill, J.R. OTS Crash Investigations: In-depth Crash Research. Presentation made to the Strategic Road Practitioners forum of the Association of Chief Police Officers of England, Wales and Northern Ireland (ACPO), May 2001
31. Hill, J.R., Thomas, P. D., Smith, M. and Byard, N. The methodology of on the spot accident investigations in the UK. ESV Conference, National Highway Traffic Safety Administration, 17th International Technical Conference on the Enhanced Safety of Vehicles, pp 1–10. Amsterdam, June 2001
32. Hill, J. R., Byard, N., Thomas, P.D. 'On The Spot' accident research in the UK. Traffic Safety on Three Continents, pp 1–12. Moscow, Russia, 2001
33. Hill, J. R. 'On The Spot' Accident Research in the UK. Presentation made to the Co-operative Crash Injury Study (CCIS) Symposium. Birmingham, UK, December 2001
34. Hill, J.R. 'On The Spot' research: investigating human highway and engineering factors in accidents, 11th Seminar , Department for Transport, Local Government and the Regions, 11th Seminar on Behavioural Research in Road Safety, Manchester, United Kingdom, pp155–166, ISBN 1 85112 527 2. February 2002
35. Hill, J. R. In-depth Research On the Spot: Investigating Highway, Human & Vehicle Factors. Presentation made to the Road Infrastructure Safety Workshop organized by the AIT&FIA Eurocouncil on behalf of the European Commission, Brussels, November 2002
36. Hill, J. R. Real World Single-vehicle Collisions: Some Notes Regarding Accident Analysis. Presentation made to the Passive Safety Network Workshop on Vehicle Infrastructure Crashworthiness, Rhode, Germany. October 2003
37. Langham, M. P., Forman, P. Conspicuity markings and lighting on Highways Agency vehicles. Unpublished Project Report PR/SE/120/00. TRL Limited, Crowthorne, UK, 2000

38. Lenard, J. and Hill, J. Interaction of road environment, vehicle and human factors in the causation of pedestrian accidents. Proceedings of the Expert Symposium on Accident Research (ESAR), Hannover, 3–4 September 2004.
39. Lenard, J., Dodson, E. and Hill, J. Drivers' perception of accident circumstances and opportunities for crash avoidance through technological intervention. Proceedings of the VDI International Conference: Driver in the 21st Century – Humans as drivers and their interaction with vehicles, Braunschweig, 22–23 November 2005.
40. Lynman, D. A. and Kennedy, J. V. Travel of Errant Vehicles after Leaving the Carriageway. Unpublished Highways Agency Report (PR SE/887/04 – 3/372/R14). Unpublished.
41. Mackay, G. M.; Ashton, S. J.; Galer, M. D.; Thomas P. D. The Methodology of In-depth Studies of Car Crashes in Britain. In: Data Collection, Methodologies and Crash Injury Reconstructions' SAE Publication P-159, Michigan USA, 1985
42. McCarthy, M. G.; and Chinn, B. P. Review Of OECD Motorcycle Accident Data Collection, Volume 2: 'On The Spot' (OTS) Worksheets and Coding Manual. TRL, 1999
43. Millington, V., Cuerden, R., Hulse, S. and Brightman, T. Investigation into 'A' Pillar Obscuration – A Study to Quantify the Problem Using Real World Data. TRL Project Report PPR159, ISSN 0968-4093.
44. Minton, R. and Brightman, T. Behaviour of SUV and MPV-type vehicles in collisions with roadside safety barriers. TRL Report TRL658, ISSN 0968-4107.
45. Morris, A. Pedestrian Crashes and Vehicle Design, Presentation made to the European Vehicle Passive Safety Network 2 (EVPSN 2) Pedestrian Safety Workshop, Cranfield, September 2002.
46. OECD RS9/International Co-ordinating Committee. Motorcycles: Common international methodology for in-depth accident investigations, 1999
47. Otte, D. Description of In-Depth Investigation Team ARU/Medical University Hannover. Workpackage 1 - Data Collection for Standardisation of Accident and Injury Registration Systems, 1997
48. Pittman, M. On The Spot Crash Investigations. Presentation to the Institute of Motor Industry at TRL, November 2001.
49. Ross, R.; Thomas, P.; Sexton, B.; Vallet, G.; Laumon, B.; Martin, J. L.; Lejeune, P.; Otte, D. An Approach to the Standardisation of Accident and Injury Registration Systems (STAIRS) in Europe. Poster and Presentation, 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV), 1998

50. Sabey, B. E., Staughton, G.C. Interacting Roles of Road Environment, Vehicle and Road User in Accidents, 5th International Conference of the International Association for Accident and Traffic Medicine, London, UK, 1975
51. Wood, R.L., Dumbuya, A.D., Zhao, J., Hill, J., Thomas, P.D., Simulation of Driver, Vehicle and Environmental Aspects of Crash Initiation, A new Method to Improve Integrated Safety Effectiveness, Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles, US Department of Transportation, National Highway Traffic Safety Administration, Nagoya, Japan, 8 pp, [CD-ROM]. 19–22 May, 2003

APPENDIX 1

On-scene investigations – Phase I and II crashes

The following tables and figures have been provided to give an outline of the type and distribution of accidents recorded within the OTS Phase I and II database. Please note that the percentages shown are sometimes rounded and therefore the totals might be slightly less than 100%.

Table A1.1 breaks down the crashes attended in Phases I and II by the police recorded injury severity of the accident. The UK Government’s STATS19 database contains details of all injury road traffic accidents which are reported to the police. Table 2.1 in the main body of the report details the number and severity of accidents as reported by the police in the two OTS sample regions. Table A1.2 shows a comparison between the samples of injury road traffic accident attended by the OTS teams within the OTS sample regions against those recorded in STATS19 (Road Casualties Great Britain 2003)²⁰.

Table A1.1: Accident severity distributions for accidents sampled		
Police accident injury severity	Number of accidents	Percent
Fatal	86	3%
Serious	362	12%
Slight	1,304	43%
Damage only	1,216	40%
Unknown	56	2%
Total	3,024	100%

Table A1.2: Injury accident severity distributions (OTS and STATS19)								
Accident injury severity	VSRC area		TRL area		OTS total area		All STATS19 areas (2003)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Fatal	43	4.88%	43	4.94%	86	4.91%	3,247	1.50%
Serious	179	20.29%	183	21.04%	362	20.66%	28,913	13.50%
Slight	660	74.83%	644	74.02%	1,304	74.43%	181,870	85.00%
Total	882	100%	870	100%	1,752	100%	214,030	100%

The OTS sample is skewed towards more serious accidents; this is likely to be a reflection of slight accidents being cleared more quickly than those involving more serious injury (Table A1.2). Table A1.3 includes all OTS road user injury severity classifications (uninjured to fatal). In the OTS database the most common road users are car occupants who are often not injured; these cases do not appear in STATS19.

Table A1.3: Road user type classification

Road user type	VSRC area		TRL area		OTS total area road users		All STATS19 casualties (2003)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Pedestrian	123	3.19%	79	1.99%	202	2.59%	36,405	12.50%
Pedal cyclist	56	1.45%	62	1.57%	118	1.51%	17,033	5.90%
TWMV	173	4.49%	153	3.86%	326	4.17%	28,411	9.80%
Car/taxi	3,086	80.11%	3,182	80.33%	6,268	80.23%	187,242	64.40%
Goods vehicle	342	8.88%	385	9.72%	727	9.31%	9,958	3.40%
Bus/minibus	58	1.51%	47	1.19%	105	1.34%	10,168	3.50%
Others	14	0.01%	53	1.34%	67	0.01%	1,390	0.50%
Total	3,852	100%	3,961	100%	7,813	100%	290,607	100%

Cars were the over-riding vehicle type examined by the OTS teams, followed by light goods vehicles (LGVs) and heavy goods vehicles (HGVs) (see Table A1.4). Table A1.5 details the number of pedestrians who were involved in accidents which were attended by the OTS team.

Table A1.4: Number of vehicles within the OTS database

Vehicle type	Car/CDV	LGV	HGV	Bus	Motorcycle	Pedal cycle	Other	Unknown	Total
No. of Vehicles	4,268	305	310	78	306	117	14	51	5,449
Percentage	78.33%	5.60%	5.69%	1.43%	5.62%	2.15%	0.26%	0.94%	100%

Table A1.5: Number of pedestrians within the OTS database

Pedestrian age group	Adult	Child	Unknown	Total
No.	116	76	10	202

Table A1.6 describes the number of accidents by vehicle type involvement. The largest group of accidents involved only two cars ($n = 848$) followed by single-car accidents ($n = 816$). The number of pedestrians shown in Table A1.5 differs from

Table A1.6: Accidents by accident type and type of vehicle involved

Vehicle type	Single vehicle		2 vehicle accidents							3+ vehicle total	Total accs
	With Ped.	No Ped.	Car	LGV	HGV	Bus	M/C	P/C	Other		
Car	146	816	848	106	163	27	169	82	21	400	2,778
LGV	5	30	106	5	8	2	14	7	3	98	278
HGV	5	34	163	8	7	2	4	2	1	65	291
Bus	12	6	27	2	2	2	2	0	0	23	76
Motorcycle	1	72	169	14	4	2	0	4	1	34	301
Pedal cycle	0	6	82	7	2	0	4	0	1	13	115
Other	1	2	21	3	1	0	1	1	0	2	32
Total	170	966	1416	145	187	35	194	96	27		

those detailed in Table A1.6 due to a number of accidents that involved either more than one pedestrian or more than one vehicle.

Table A1.7 breaks down the total number of accidents attended in Phases I and II by the police recorded injury severity and road type. The greatest number of accidents attended occurred on A-class roads (37% of accidents attended). ‘A’ roads also had the greatest number of fatal or serious accidents.

Table A1.7: Number of accidents by police severity and road classification

Road classification	Police accident severity					Totals
	Fatal	Serious	Slight	Non-injury	Unknown	
Motorway	5	29	143	253	2	432
Trunk road	5	24	65	80	3	177
A road	37	163	498	421	14	1,133
B road	18	53	186	132	10	399
Unclassified	19	88	400	310	25	842
Tram line	0	0	0	1	0	1
Unknown	2	5	12	19	2	40
Total	86	362	1,304	1,216	56	3,024

Figure A1.1 displays the distribution and actual number of accidents attended by the OTS teams by time of day. The greatest numbers of accidents were attended between 17:00 and 18:00, which is reflective of the evening rush-hour.

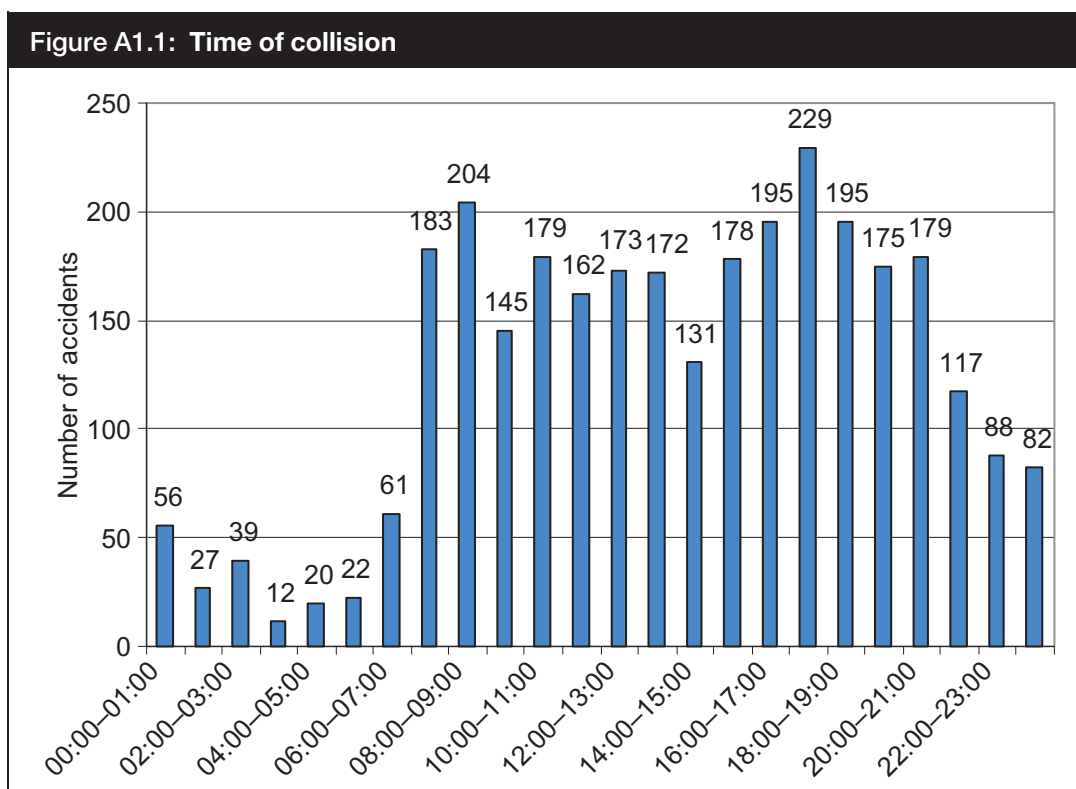
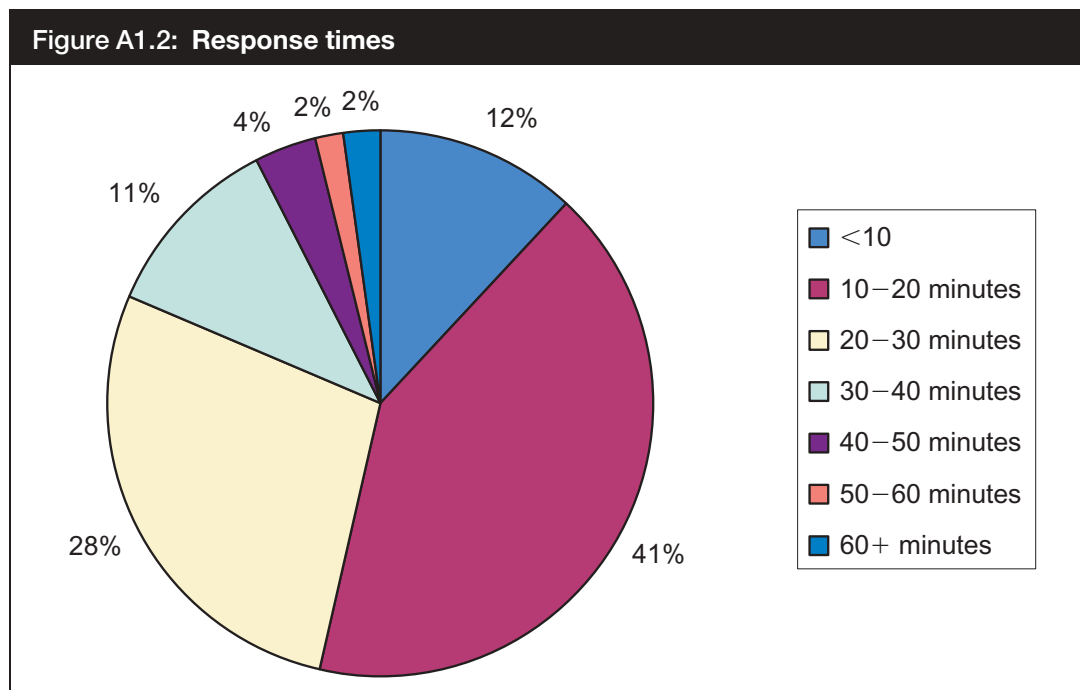


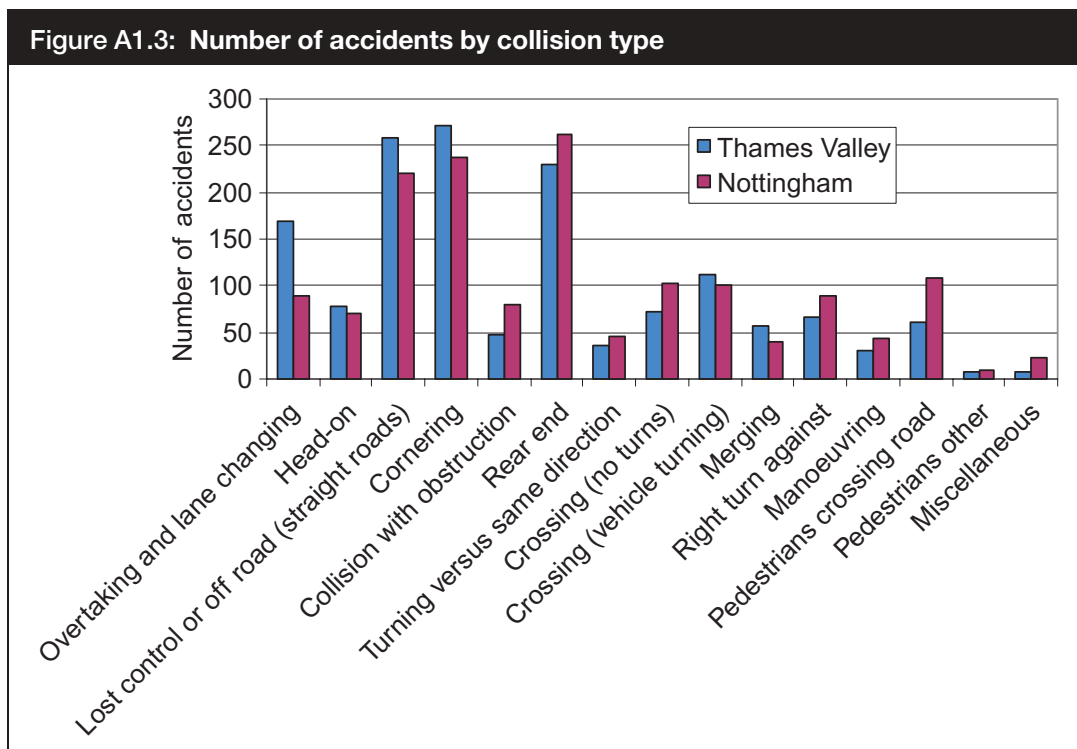
Figure A1.2 displays the combined response times for the two research teams; the majority (53%) of accidents were attended within 20 minutes of the accident.



In Phase II, a description was added to the database in order to allow accidents to be grouped by type. Phase I cases were enhanced to include this categorisation too. Table A1.8 breaks down the 3,024 accidents within the OTS Phase I and II database by their collision type and sample area. Figure A1.3 gives a graphical representation of these results.

Table A1.8: Number of accidents by collision type

Code	Collision description	Thames Valley	Nottingham	Total
A	Overtaking and lane changing	169	90	259
B	Head-on	77	71	148
C	Lost control or off road (straight roads)	258	220	478
D	Cornering	272	237	509
E	Collision with obstruction	47	80	127
F	Rear end	230	262	492
G	Turning versus same direction	36	46	82
H	Crossing (no turns)	73	102	175
J	Crossing (vehicle turning)	112	100	212
K	Merging	57	40	97
L	Right turn against	67	89	156
M	Manoeuvring	31	43	74
N	Pedestrians crossing road	60	108	168
P	Pedestrians other	8	9	17
Q	Miscellaneous	8	22	30
			Total	3,024



It is interesting to note the different distributions of accident types within the two sample regions. This may be a reflection of the geographical make-up of the two areas, with the Nottingham area covering a more urban region. Most notably, the accident types which differ greatly between the areas are overtaking, crossing (no turns) and pedestrians crossing the road.

Table A1.9 shows a break down of the 3,024 cases in Phases I and II by the precipitating factors. The most common precipitating factor was loss of control of vehicle, followed by failed to give way.

Precipitating factor	No. of cases	Percent
Failed to stop	301	10
Failed to give way	479	16
Failed to avoid pedestrian	26	0
Failed to avoid object/vehicle on c/way	390	13
Failure to signal or gave misleading signal	14	0
Loss of control of vehicle	1013	34
Pedestrian entered carriageway (driver not blamed)	147	5
Pedestrian fell in road	7	0
Swerved to avoid object on carriageway	77	3
Sudden braking	39	1
Poor turn or manoeuvre	352	12
Poor overtake	107	4
Drove wrong way	17	0
Opened door carelessly	3	0
Other precipitation	52	2
Total	3024	100

Table A1.10 details the contributory factors for all drivers and riders in the OTS database using the Contributory Factors 2005 coding system. Each vehicle in the OTS database is assigned a pre-impact movement code, which describes the intended movement of the vehicle prior to impact. Table A1.11 cross-tabulates these pre-impact movements by vehicle type.

Contributory factor	No.	Percent
Injudicious action	1,891	17.96
Error or reaction	4,456	42.33
Impairment or distraction	767	7.29
Behaviour or experience	2,062	19.59
Vision affected	463	4.40
Other factors	888	8.44
Total	10,527	100

Code	Vehicle pre-impact movement	Vehicle type						Total
		Car	LGV	HGV	Bus	Motor-cycle	Pedal cycle	
1	Driving into a parking place	8	0	0	3	0	0	11
2	Stopping on the carriageway (not parking or turn)	236	13	9	3	1	0	262
3	Waiting to go ahead but held up	265	23	5	5	6	1	305
4	Starting off	40	4	2	1	3	0	50
5	Stopped waiting to turn right	57	5	4	0	1	1	68
6	Stopped waiting to turn left	12	2	0	1	3	1	19
7	Going into junction to turn right	18	3	2	1	2	0	26
8	Going into junction to turn left	60	2	2	1	0	2	67
9	Going round a roundabout	156	2	22	1	17	7	205
10	Going round a mini-roundabout	35	1	1	0	2	3	42
11	Turning from side road into main road	222	16	3	1	1	7	250
12	Turning from main road into side road	150	8	3	2	4	1	168
13	Pulling out of lay-by onto main road	10	1	5	0	0	1	17
14	Pulling into lay-by from main road	3	1	0	2	2	0	8
15	Driving along a straight road	1,447	115	120	33	147	35	1,897
16	Driving around a right-hand bend	306	22	13	5	18	5	369
17	Driving around a left-hand bend	262	18	12	6	24	2	324
18	Driving around a series of bends	23	2	2	0	3	0	30
19	Changing lanes from outside to nearside	34	2	17	0	0	1	54
20	Changing lanes from nearside to outside	48	3	35	0	1	0	87
21	Swerved to avoid animal in road	4	0	0	0	0	0	4
22	Swerved to avoid other vehicle	46	2	4	0	1	0	53
23	Swerved to avoid person in road	2	1	0	0	0	0	3
24	Pulling out to overtake	13	2	0	0	2	0	17
25	Overtaking moving vehicle on the left	80	9	2	2	34	2	129
26	Overtaking parked vehicle on the left	23	1	1	1	5	1	32
27	Undertaking moving vehicle on the right	9	0	0	0	1	0	10

Table A1.11: (continued)								
Code	Vehicle pre-impact movement	Vehicle type						Total
		Car	LGV	HGV	Bus	Motor-cycle	Pedal cycle	
28	Reversing along carriageway	5	1	1	0	0	0	7
29	Reversing out of driveway	7	0	1	0	0	0	8
30	Reversing into driveway	2	0	2	0	0	0	4
31	Reversing out of car-parking space	5	0	0	0	0	0	5
32	Reversing into car-parking space	1	0	0	0	0	0	1
33	Turning on carriageway	7	1	1	0	0	0	9
34	Making U-turn on carriageway	29	2	0	0	0	0	31
35	Turning right at crossroads	50	3	2	2	0	0	57
36	Turning left at crossroads	10	0	3	0	0	1	14
37	Going straight over at crossroads	161	7	6	0	7	6	187
38	Merging from slip road onto main carriageway	47	7	2	1	0	0	57
39	Exiting from main carriageway onto slip road	21	0	1	0	0	0	22
40	Parking manoeuvre	6	0	0	0	0	0	6
41	Illegal manoeuvre	14	2	1	0	2	2	21
42	Driving in slow-moving traffic	42	9	6	0	3	0	60
43	Lost control of vehicle	88	1	4	7	3	2	105
88	Other (includes parked/unoccupied and pedestrians)	183	12	15	0	13	33	256
99	Unknown	21	2	1	0	0	3	27

Table A1.12 details the number of interactions assigned to humans in the OTS database. The most frequent interaction type was conflict, followed by perception.

Table A1.12: Human-level interactions	
Interaction description	No.
'Legal', not related to prosecution	877
Perception: expecting, looking, planning	1,934
Judgement: understanding, deciding, acting	1,376
Loss of vehicle control	1,304
Conflict: interpersonal communication	3,171
Attention	1,049
Impairment	402
Truly helpless (no opportunity for interaction)	610

Table A1.13 breaks down the road users in charge of the vehicle by their age.

Table A1.13: Humans by age band and road user type							
Road user in charge of involved vehicle	Age band						Total
	0-4	5-15	16-24	25-59	60+	Unknown	
Car driver	0	2	693	2,019	314	1,188	4,216
LGV driver	0	1	19	158	9	111	298
HGV driver	0	0	7	173	15	111	306
Bus driver	0	0	1	41	6	30	78
Pedestrian	5	61	24	55	29	28	202
Cyclist	1	34	19	43	8	12	117
Motorcyclist	0	0	98	158	6	43	305
Other	0	0	1	9	1	3	14
Unknown (untraced vehicle)	0	0	0	0	0	52	52
Total	6	98	862	2,656	388	1,578	5,588

Table A1.14 details the number and type of road users and cross tabulates these against whether or not they were injured.

Table A1.14: Injury status by road user type				
Road user type	Injured	Uninjured	Unknown	Total
Car occupant	1,731	3,956	581	6,268
LGV occupant	74	287	18	379
HGV occupant	42	290	16	348
Bus occupant	11	90	4	105
Pedestrian	173	14	15	202
Cyclist	89	12	17	118
Motorcyclist	259	35	32	326
Other	2	11	2	15
Unknown (untraced vehicle)	1	46	5	52
Total	2,382	4,741	690	7,813

These tabulation and figures give a snapshot of the type and nature of the data contained within the OTS Phase I and II database.

APPENDIX 2

Executive summary of the project report on OTS Phase I

Extract from Hill, J. and Cuerden, R. (2005) *Development and Implementation of the UK On The Spot Accident Data Collection Study – Phase I*. Road Safety Research Report No. 59. London: Department for Transport.

The ‘On The Spot (OTS) Accident Data Collection Study’ has been developed to overcome a number of limitations encountered in earlier and current research. Most accident studies (such as the UK Co-operative Crash Injury Study, CCIS) are entirely retrospective, in that investigations take place a matter of days after the accident and are therefore limited in scope to factors which are relatively permanent, such as vehicle deformation and occupant injuries. They do not, in general, record information relating to evidence existing at the crash site, such as post-impact locations of vehicles, weather and road surface conditions; nor do they consider events leading up to the accident, such as the driving conditions encountered as the protagonists approached the crash site and their behaviour. It is these factors which give an insight into why the accident happened. The police, who do attend the scenes of accidents while such ‘volatile’ data is still available to be collected, tend to have other priorities, such as ensuring the injured receive help, clearing the scene to restore the flow of traffic and looking for indications that any of the parties involved has broken the law. The philosophy of the OTS project was to put experienced accident researchers at the crash scene at the same time as the police and other emergency services. The study is thus still retrospective, in that the accident has already happened, but the timing is such that it should be possible to gather information on the environmental and behavioural conditions prevailing just before the crash. This provides valuable in-depth data on the causes as well as the consequences of crashes, and allows counter-measures to be developed in the fields of human behaviour and highway engineering as well as vehicle crashworthiness. This is potentially a major improvement on the data currently available from other studies. A study of this type had not been conducted in the UK for over 20 years, and comparison of the results of the current study with those of the previous one should provide interesting insights into the changes which have taken place over that period.

The study involves two teams, from the Vehicle Safety Research Centre at Loughborough University (VSRC) and the Transport Research Laboratory (TRL), working in close co-operation to produce a joint dataset. Work on the development of the study design and procedures began in 1998. Protocols were developed to be consistent with recent international activities. These include the EC proposals for the development of a Pan-European Accident Database based on recommendations from the Standardisation of Accident and Injury Registration Systems (STAIRS) project. Similarly, the Organisation for Economic Co-operation and Development

(OECD) RS9 Committee's Common International Methodology for In-depth [motorcycle] Accident Investigations was considered 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 to make crash research data compatible across international projects. Valuable co-operation and assistance has been received from the Medical University of Hanover (MUH), which has been conducting at-the-scene accident research for many years. The full study protocol was harmonised, based on modules developed using a range of expertise from VSRC, TRL, and the University of Birmingham's Automotive Safety Centre. The method was tested and further developed using pilot studies in Nottinghamshire and the West Midlands during 1997 and 1999. The methodology which grew out of this development work is one in which a holistic approach is taken to each investigation. This means that vehicle safety, human factors, highway engineering and injury outcome are all investigated together.

Funding for the project came from the Vehicle Standards and Engineering Division and the Road Safety Division at the Department for Transport (DfT) and from the Highways Agency (HA). Full data collection began in 2000 with a requirement to collect detailed information on 1,500 accidents over a three-year study period. This was a large and complex activity, involving close collaboration between two geographically remote research teams operating from TRL in Berkshire and VSRC in Nottinghamshire. Both teams developed the project using common protocols and liaison techniques with the emergency services, hospitals, HM Coroners and local authorities and including routine technical links with the expertise available at the two institutes, the MUH and others.

The study has seen a very close working relationship between the research teams and their respective local police in Nottinghamshire and Thames Valley. This link was strengthened by the inclusion of a serving police officer on each team, which provided a secure, direct and reliable link with the local police command and control systems, thus ensuring immediate crash notifications. Response vehicles, fitted with blue lights and driven by seconded police officers, were used to transport each research team safely to the scene. In this way it was possible to cover a larger area than in previous studies. The response technique ensured that the combination of a relatively large area and increased traffic densities on modern roads allowed larger samples of crashes to be investigated than were attained in some earlier studies.

Given the attention to detail in establishing the necessary infrastructure, the well designed sampling plan and conformity to common investigation protocols, the DfT/HA OTS project provides an example of 'best practice' in this field. As far as the authors are aware, no other country is systematically collecting on-scene data, to a pre-defined sampling plan and with such effective co-operation from all relevant public services contributing to the necessary input data. It takes many years to establish useful databases and it is essential to have continuity to gain the best value

from the database over the long term. The OTS project has two main strengths, compared with more conventional studies. The first is having access to volatile scene data including transient highway factors and climatic conditions, which are particularly important for determining accident circumstances, especially when investigating vulnerable road user accidents. The second is the ability to interview witnesses at the scene, thus gaining an insight into behavioural characteristics, and how these may have been influenced by the transient factors referred to above.

This report describes the development and implementation of the process required to establish Phase I of the study together with the methodology used by VSRC and TRL. Annexes to the report give some information about the number and types of accidents attended. Phase II of the OTS study started in September 2003 and is scheduled to run for three years.