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

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November 2005

Department for Transport: London

£17.00

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ISBN 1 904763 60X
ISBN 13978 1 904763 60X

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Printed in Great Britain on paper containing no less than 75% recycled fibre.

November 2005

Product Code 56RRLG02341/59.

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EXECUTIVE SUMMARY

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 2 of the OTS study started in September 2003 and is scheduled to run for three years.

GLOSSARY OF ABBREVIATIONS

ACEA	European Automobile Manufacturers Association
AiDamage	Software package used to calculate delta-V from residual vehicle crush measurements
AIS	Abbreviated Injury Scale
APVRU	Advanced Protection for Vulnerable Road Users
CCIS	Co-operative Crash Injury Study
CPS	Crown Prosecution Service
Delta-V	Change of velocity at impact
DfT	Department for Transport
EACS	European Accident Causation Study
EC	European Commission
GIDAS	German In-Depth Accident Study
HA	Highways Agency
INRETS	Institut National de Recherche sur les Transports et leur Sécurité
MAIDS	Motorcycle Accident In-Depth Study
MUH	Medical University of Hanover
OECD	Organisation for Economic Co-operation and Development
OTS	On The Spot
QMC	Queens Medical Centre (Nottingham)
SCRIM	Sideways force Co-efficient Routine Investigation Machine
SHORSEN	Short Range Sensors for automotive applications
STAIRS	Standardisation of Accident and Injury Registration Systems
SVO	Special Vehicle Order
TRL	Transport Research Laboratory
VSE	Vehicle Standards and Engineering division
VSRC	Vehicle Safety Research Centre, Loughborough University

1 INTRODUCTION

The On The Spot (OTS) Accident Data Collection Study was commissioned by the Department for Transport (DfT) and the Highways Agency (HA) to enhance road safety and 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 UK Department for Transport has targeted a substantial reduction in the injuries and loss of life that result from road crashes by the year 2010 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 Highways Agency's aim to deliver a high quality service to all its customers by improving road safety.

The Vehicle Safety Research Centre (VSRC) at Loughborough University and the Transport Research Laboratory (TRL) were awarded joint contracts to develop common protocols and the infrastructure to support the investigation of 1,500 accidents in two separate geographical locations over a three-year period commencing in the summer of 2000.

This report describes the research design and methodology to develop a collaborative approach that enables 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.

1.1 Research background

The Department for Transport has long recognised the vital part that real-world accident data plays in the development of safer road transport. The UK was home to some of the earliest rigorous and scientific on the spot crash research carried out at the scene of road traffic crashes. Such in-depth investigations were begun in the UK in the early 1960s by the then Road Research Laboratory[1]. In the mid 1970s further TRL on the spot crash investigations assessed factors that included the causes of crashes and quantified the role of the environment, vehicle and human factors[2]. Around the same time the Accident Research Unit at the University of Birmingham expanded its crash investigation activities to include on the spot pedestrian crash research yielding results relating to vehicle design, velocity and injury patterns[3].

Despite the considerable value of on the spot 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 best respected studies is the UK Co-operative Crash Injury Study (CCIS) which has been running since 1983[4]. 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 and weather, visibility and traffic conditions. Such information is lost during the clearing of the accident scene and it is only by prompt attendance at the scene of the crash that such information can be reliably obtained[5].

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 cleared. Current and accurate real world data is 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 on the spot accident investigation studies active across Europe today. These include the German In-Depth Accident Study (GIDAS) maintained by teams at the Medical University of Hanover[6] and the Technical University of Dresden and the work of French Laboratory INRETS currently examining crash causation in Salon de Provence and pedestrian injuries in Lyon[7]. The European Accident Causation Study (EACS) is 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[8].

It is against this background that the new UK OTS study has been set up to provide a greater understanding of present day accident causes and consequences and to direct the development of effective accident counter-measures by providing high quality real world accident data for use by researchers and policy-makers. It is expected that the results from the OTS study will make a significant contribution to road safety, vehicle crashworthiness and road user protection. The safety improvements which will undoubtedly arise from this work are likely to be seen not only in the UK but also in many other countries.

1.2 Scope of work

The study was set up to achieve the following objectives:

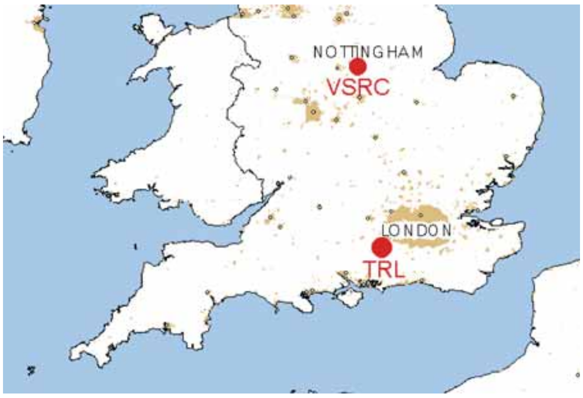
- To conduct 1,500 in-depth accident investigations over three years using a systematic methodology.
- To establish a statistically valid, in-depth research database of a representative sample of road accidents in the UK.
- To gain a better understanding of the effects of human, vehicle and highway factors on the causes of accidents and injury outcomes.
- To provide associated expertise to support both Government and safety research activities.
- To assist in the development of solutions.

2 PROJECT INFRASTRUCTURE

2.1 Location of OTS teams

The locations of the two teams are shown in Figure 1.

Figure 1: Geographical locations



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 catchment 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 and B roads, rural, urban 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, when 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 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 and Table 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 to the national average.

Table 1: Distribution of road accidents (1998), classified by accident severity

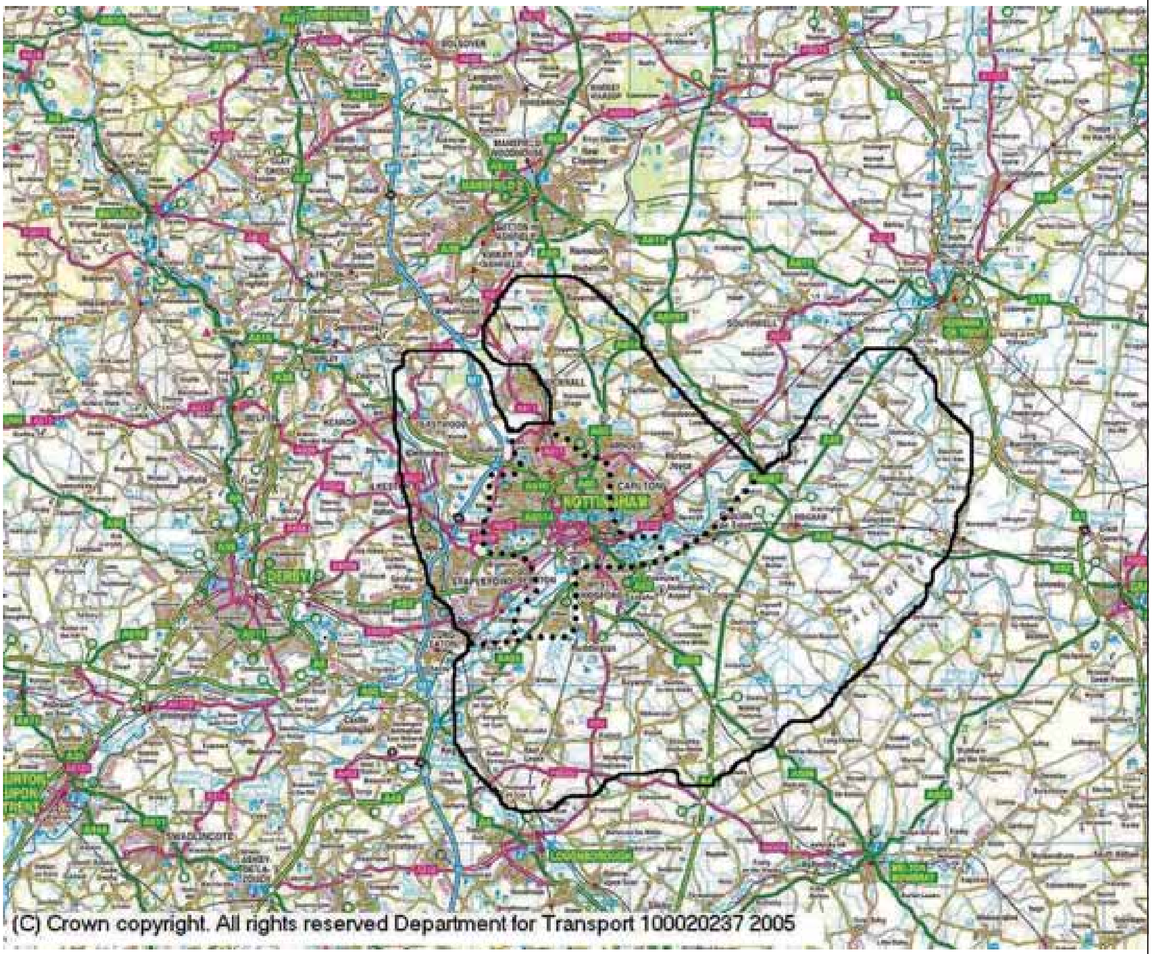
Accident injury severity	VSRC study area		TRL study area		OTS total area		GB national statistics	
	N	%	N	%	N	%	N	%
Killed	41	1.6	32	0.8	73	1.2	3,137	1.3
Serious	514	20.3	373	9.8	887	14.0	34,633	14.5
Slight	1,979	78.2	3,392	89.3	5,371	84.8	201,153	84.2
Total	**2,534**	**100**	**3,797**	**100**	**6,331**	**100**	**238,923**	**100**

Table 2: Casualties in road accidents (1998), classified by road user type

Type of casualty	VSRC study area		TRL study area		OTS total area		GB national statistics	
	N	%	N	%	N	%	N	%
Pedestrian	596	17.2	518	10.2	1114	13.0	44,886	13.8
Pedal cyclists	283	8.2	459	9	742	8.7	22,923	7
TWMV[1] rider	238	6.9	439	8.7	677	7.9	24,610	7.6
Car/taxi occupant	2,078	60	3,425	67.5	5,503	64.5	208,693	64.2
Goods vehicle occupant	106	3.1	132	2.6	238	2.8	11,116	3.4
Bus/minibus occupant	150	4.3	81	1.6	231	2.7	11,382	3.5
Other vehicle occupant	13	0.4	20	0.4	33	0.4	1,602	0.5
Total	**3,464**	**100**	**5,074**	**100**	**8,538**	**100**	**325,212**	**100**

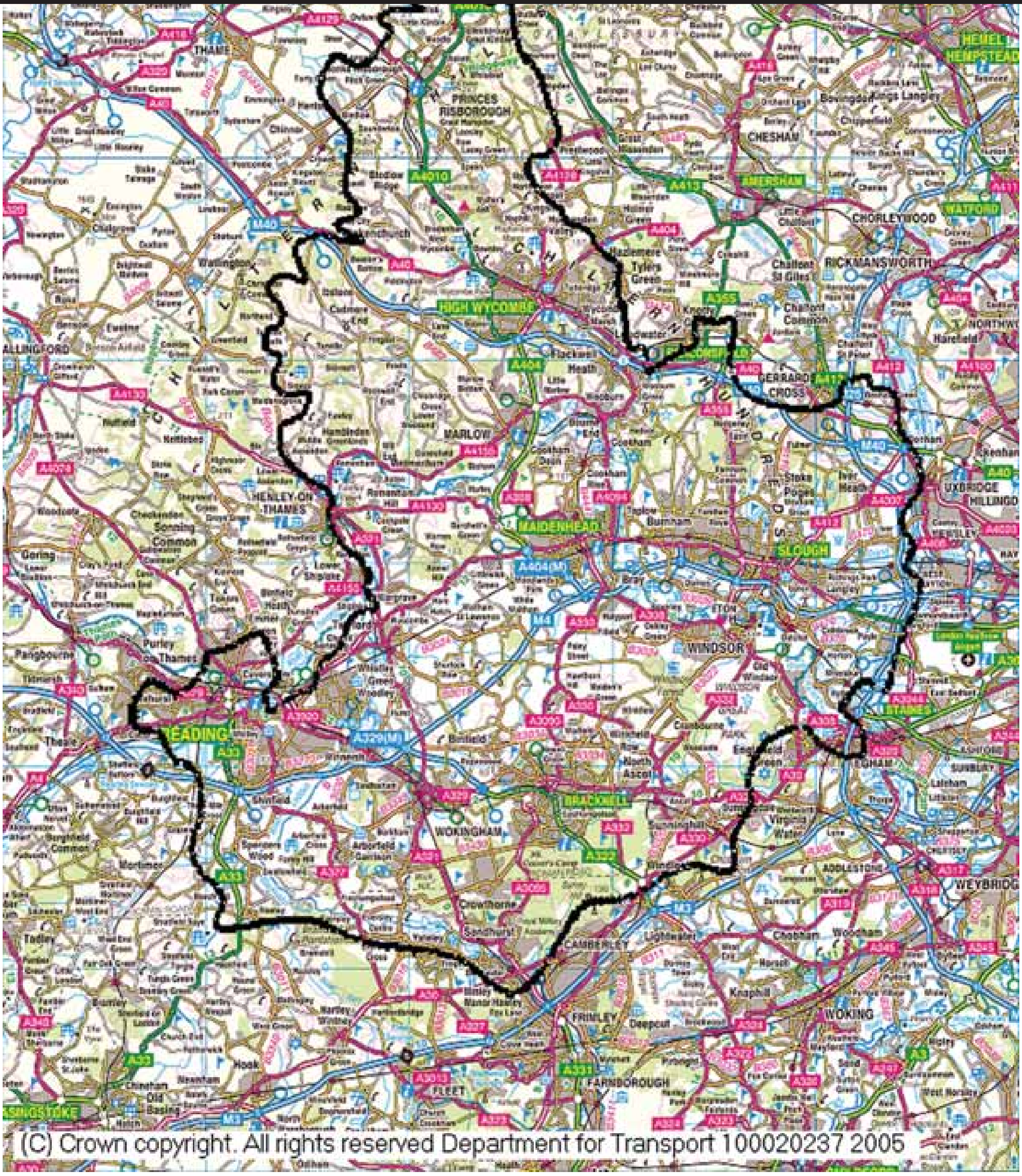
[1] TWMV rider refers to a two-wheeled motor vehicle user

Figure 2: VSRC catchment area



As well as choosing geographical areas which were broadly representative of national statistics with respect to the two variables considered in Tables 1 and 2, the STAIRS project[9], with which OTS has been designed to be compatible, demonstrated the need to sample from a rigorously defined area 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 much more reliable scaling of findings from the study to the national situation. The study catchment areas thus had fixed geographical boundaries, which were made to be coincident with the catchment areas of the hospitals which were prepared to co-operate 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.

Figure 3: TRL catchment area



2.3 Links to other studies

2.3.1 International motorcycle accident investigation activities

To maximise benefits from motorcycle accident investigations, the two teams participated in established international activities involving the Motorcycle Accident In-Depth Study (MAIDS) [10] and the OECD/RS9[11] Quality Control Subcommittee. MAIDS consisted of five teams from Italy, France, Germany, Holland and Spain, while the OECD subcommittee was responsible for co-ordinating the OECD's common international methodology for in-depth motorcycle accident investigations which was used by MAIDS. That methodology had already been incorporated into the OTS integrated protocols, wherever possible.

Compatibility of OTS procedures with OECD methodology was assessed by Dr Terry Smith from the OECD/RS9 Quality Control Subcommittee, who spent time with the OTS teams to see if procedures were sufficiently compatible to permit the OTS data to be merged with the MAIDS database. A case comparison exercise was also carried out. The work concluded that, while OTS covers 80% of the information required for OECD/RS9, a number of specialist procedures were not feasible under the OTS protocol if it was to remain flexible enough to address all types of road user.

The primary differences between the two data-recording formats were found to be:

- Additional in-depth variables found in the OECD protocols, OTS does not routinely conduct intrusive mechanical investigations of the motorbike, such as dismantling components to assess their condition.
- The greater use of 'free text' summarising vehicle damage and witness testimony in the OECD protocols.

2.3.2 Standardisation of Accident and Injury Registration Systems (STAIRS)

The OTS study also conformed to the STAIRS European accident investigation protocols[9]. 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 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, statistical methods for data analysis, terminology and ethical considerations.

2.4 External co-operation and support

The successful implementation and development 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.

2.4.1 Police liaison

The chief constables at Nottinghamshire and Thames Valley police provided considerable support and enthusiasm for the study, playing an essential role in the project through the provision of fully qualified police response drivers seconded to the VSRC and TRL teams respectively.

The seconded police officers formed part of the study investigation teams and brought with them considerable knowledge of road accidents and the essential aspects of evidence found at the scene. Both officers proved an immense asset to the project while setting up the infrastructure and they arranged for police accident investigators working in the respective areas to attend briefings at VSRC and TRL to learn about the project aims and objectives. This served to introduce the researchers to the accident investigators and so assisted greatly in assuring the co-operation of the police at the scenes of accidents.

In addition to driving the response vehicles to enable the investigation teams to arrive at the scenes of accidents in good time and in safety, the police also provided essential links to their control room systems to provide accident notifications. This arrangement is described later in this report.

In the case of the VSRC team, Nottinghamshire Police also provided a dedicated team office which was rented to the project at no overhead charge and housed the three team members who were on call.

2.4.2 Crown Prosecution Service liaison

Several meetings were held with the Crown Prosecution Service (CPS) to clarify the situation relating to data disclosure. It was agreed with the CPS that OTS would work within CPS guidelines and if required produce a disclosure schedule for the data collected.

The CPS, for their part, understood the nature of the data collected and that it was for research purposes. They considered it unlikely that the study would need to disclose data. No disclosure of research data was required during the life of the project.

2.4.3 Hospital liaison

The requirement for medical data to support the project was important for understanding the injury outcome aspect of the accidents. VSRC already had well established links with hospitals in the East Midlands region through their involvement in providing injury information for the UK Co-operative Crash Injury Study (CCIS). As the OTS study area was centred around the city of Nottingham, the vast majority of accident victims attended the Queens Medical Centre (QMC) one of the UK's largest trauma hospitals. Routine acquisition of both injury data for all types of casualty and supplementary anthropometric data for pedestrian casualties was facilitated by the expert support of staff at the QMC overseen by the Accident and Emergency Consultant, Mr Esberger. The procedures used had full approval from the Ethics Committee at the QMC.

Because CCIS does not operate in the immediate vicinity of TRL, there were no previously established links with local hospitals. The TRL OTS team therefore had to develop and implement injury data collection systems specifically for this study with hospitals local to their area. The hospitals that supported the TRL team for the OTS project were:

- Wexham Park Hospital, Slough;
- Wycombe General Hospital, High Wycombe;
- The Royal Berkshire Hospital, Reading; and
- Frimley Park Hospital, Frimley.

In cases where those injured were taken to other hospitals, the team's hospital liaison officers worked to obtain the injury data. This was successful in many cases but in a few instances the lack of an established relationship with the hospitals resulted in data not being forthcoming.

2.4.4 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.

2.4.5 *Local authorities*

Nottinghamshire City Council and Nottinghamshire County Council co-operated with the project throughout and the VSRC team benefited from the good will and support of local road safety engineers.

2.4.6 *Vehicle recovery operators*

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 visited the main recovery operators in their respective sampling areas to explain the nature of the project. This proved successful in gaining and maintaining the co-operation of the recovery operators involved in accident clearance in the sampling areas.

2.5 Data confidentiality

Any accident data study involved in occupant injury research will require access to sensitive personal data. This issue is always of primary concern when establishing the infrastructure of such projects and gaining the co-operation of necessary parties.

TRL and VSRC have been at the forefront of accident research for over 20 years, and have considerable experience in matters of data protection and handling sensitive personal data. In order to set out clearly the operational methodology for information processing and data protection, a combined generic protocol for data confidentiality was produced, representing a distillation of the systems in use in each organisation. This document (which represents current best practice) was initially produced for the Department for Transport and was adopted by DfT and the Highways Agency for this and other accident data studies. It includes procedures to ensure that each staff member is fully briefed on all issues of confidentiality and ethics, and that they are provided with the written version of the Code of Practice. Staff members are also required to sign a confidentiality agreement. The protocol is reproduced in Appendix A.

This protocol proved of great assistance in reassuring co-operating organisations that information passed to the OTS teams would only be used for the purposes of accident research, and that no personal data would be included in the project database or passed to any third parties.

2.6 Ethical approval

Both teams obtained approval from their local ethical committees to access and use relevant medical data. Procedures for OTS staff to follow while carrying out their duties were designed to ensure compliance with approved ethical protocols.

3 PROJECT ORGANISATION

3.1 Team structure

Each OTS team was made up of investigators including a team manager, senior officer and a serving police officer. The project provided funding for both team police officers on a full-time basis. These officers were highly skilled advanced police drivers with crash investigation training and experience.

These core teams grew over the three-year study period to become efficient units with experience of a wide variety of road traffic accidents, involving all types of environment, vehicles and injury outcomes. An efficient working practice was established for working a shift system which allowed accidents to be sampled representatively from all hours of the day and all days of the week. Follow-up activities were undertaken on subsequent days with the interpretation of results to enter findings into detailed computerised case reports. Together with expert support from within each centre, and the wider consortium, it was possible to address a wide range of safety issues and questions over the three-year investigation period.

3.2 Shift systems

Typically, the two teams remained on standby for an eight-hour shift period ready to respond immediately to an accident notification from the local police control centre. Both teams used a rotating system of shifts which was specially devised to ensure that each part of the day and night was adequately represented. The plan also ensured 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.

Table 3: VSRC 30-day shift roster cycle

Day	Shift	Day	Shift	Day	Shift
1	Day	11	Day	21	Day
2	Day	12	Day	22	Day
3	Afternoon	13	Afternoon	23	Day
4	Afternoon	14	Afternoon	24	Afternoon
5	Night	15	Night	25	Afternoon
6	Night	16	Night	26	Afternoon
7	Rest of day	17	Rest of day	27	Rest of day
8	Rest of day	18	Rest of day	28	Rest of day
9	Rest of day	19	Rest of day	29	Rest of day
10	Rest of day	20	Rest of day	30	Rest of day

Day = 7am–3pm Afternoon = 3pm–11pm Night = 11pm–7am

Table 4: TRL 96-day shift roster cycle							
Day	**Shift**	**Day**	**Shift**	**Day**	**Shift**	**Day**	**Shift**
1	Day	14	Day	27	Day	79	9am–5pm
2	Day	15	Day	28	Day	80	Night
3	Day	16	Day	.	Day	81	Night
4	Day	17	Day	.	Day	82	Night
5	Afternoon	18	Afternoon	.	Afternoon	83	Night
6	Afternoon	19	Afternoon	.	Afternoon	84	Night
7	Afternoon	20	Afternoon	.	Afternoon	85	Night
8	Afternoon	21	Afternoon	.	Afternoon	86	Night
9	Rest of day	22	Rest of day	.	Rest of day	87	Rest of day
10	Rest of day	23	Rest of day	.	Rest of day	88	Rest of day
11	Rest of day	24	Rest of day	.	Rest of day	89	Rest of day
12	Rest of day	25	Rest of day	77	Rest of day	90	Rest of day
13	Rest of day	26	Rest of day	78	Rest of day	91	Rest of day
Day = 6am–2pm		Afternoon = 2pm–midnight		Night = midnight–6am			

3.3 Accident notifications

The efficient and timely notification of crashes was essential for the study to work. The serving police officer on each team ensured a secure, direct link with the local police command for immediate accident notifications. Both teams utilised police radio and computer command and control systems to ensure immediate response to pertinent incidents. All reported crashes of all severities (including damage only) that occurred on public roads within the study areas were investigated where practical when the teams were 'on-call'.

3.4 Response vehicles

Ease of access to all accidents in the study areas was a significant factor. Earlier trials using blue light methods of reaching crash scenes had shown that all parts of each study area needed to be reached within 15 minutes or essential information would be lost. This had to be possible when maximum traffic congestion occurred as well as in quiet traffic conditions at night. As a result, the project required an appropriate vehicle to transport the research teams safely to the scenes of accidents. The vehicle was also required to carry the accident investigation equipment necessary both for investigation at the scene and any follow-up investigations.

The VSRC team owned and operated the OTS response vehicle based at the team's response centre in Nottingham. A Ford Galaxy was chosen to meet the project requirements and was fitted to Nottinghamshire Police traffic vehicle specifications, including police livery, a blue light, communication equipment and specially mounted video equipment for recording scene data.

Figure 4: **VSRC response vehicle**

The TRL team decided to lease a Mercedes-Benz E-Class estate car which was fitted out to police specifications including a specially designed Whelen Edge 9000 series full-width roof lighting bar. The vehicle livery was chosen on the basis of experimental work carried out at TRL into the conspicuity of vehicles[12]. The vehicle markings and lighting arrangement required a Special Vehicle Order (SVO) from the Department for Transport (VSE5) which permitted the vehicle on the road for the purposes of the project and also permitted the use of the fitted siren and blue lights provided the vehicle was driven by a serving police officer.

Figure 5: **TRL response vehicle**

3.5 Data collection forms

The project data collection protocol included a comprehensive system of fields and forms that allowed results and conclusions to be noted for the full range of vehicle, highway and human factors encountered on UK roads. The nature of the study required an interactive data structure where all road users, irrespective of class could be related to one another and their associated accident circumstances (scenes).

VSRC was commissioned to design an integrated set of forms on paper for immediate use at the start of the project, and TRL was commissioned to convert the forms into an electronic database. A comprehensive set of data collection forms had therefore been produced on paper before the start of the project. There were over 200 forms for recording a wide range of findings in detail, including various highway factors, and all types of road user commonly encountered.

3.5.1 Electronic system

The electronic system came into operation in May 2001, providing the project with MS Excel workbook templates for the compilation of each accident report. A utility programme was also provided to export data from Excel into a set of MS Access tables. In practice, it proved necessary to run the utility programme on computers at TRL, and this process has resulted in a combined database with VSRC and TRL accident data in the same set of Access tables.

All case reports from this phase were fully entered and checked in the Excel workbooks. Photographs, plans and drawings were also held in electronic format alongside the Excel system and, to ensure anonymity, all names, addresses and vehicle registration numbers were removed.

To complement the data entry system, a case validation program was written as well as a program to convert data for analysis using the statistical software package SPSS.

4 PROJECT MANAGEMENT

4.1 Training

Detailed training programmes for the investigators were undertaken at each centre, as well as a number of joint training courses involving both investigation teams. The initial investigator training programmes were designed to develop the skill base for those staff members who would be involved in accident investigation for the project. This training covered vehicle factors, highway design and accident causation and provided some real world accident investigation experience.

At TRL, highway design awareness was provided by undertaking night visits to various locations around Berkshire with an experienced highway engineer and an accident investigator. The practical demonstration of the possible role of highway design in accident causation proved extremely valuable to the investigators. Simulated accident scenarios were also set up on the TRL test track with vehicles from TRL's testing programme. The investigators collected the data from the simulated scenes, and then reconstructed the accidents and discussed the results with the experienced investigator in charge of the training. In addition to these specially organised training courses, all the investigators on the call-out teams attended a four-day formal police training course in road traffic accident investigation. As the project progressed, both centres sought to provide appropriate training to ensure accident investigators possessed the necessary skills to undertake thorough and accurate data collection. Particular areas covered included accident reconstruction, drugs impairment recognition, fatigue and sleep-related accident recognition and motorcycle handling characteristics.

These training exercises were extremely valuable as they provided a safe environment to learn about accident investigation, and also encouraged the researchers to view the accident investigation process from the research viewpoint prior to attending the real scenes of accidents.

Professor Dietmar Otte from the Medical University of Hanover (MUH) was actively involved in the OTS study throughout, not only in providing specialist expert reconstructions, internal case reviews and assisting with quality assurance, but also in providing ongoing advice, training and technical support for on scene research, based on extensive experience gained over 25 years' involvement in this type of research at Hanover.

The ongoing training of the investigators involved in the collection of data at the scene was critical to the success of the study. The investigators often had to use their skills to arrive at an initial understanding of the accident at the scene, which in turn guided the collection of data and the direction of their investigations. This approach differed markedly from that of the police accident investigators, who were primarily concerned with evidence for potential prosecution or coroner's inquest.

4.1.1 Workshop on driver sleepiness

Within the programme of collaboration, a workshop on 'Investigating Driver Sleepiness on the Spot' was held in December 2002 for VSRC, TRL, the Highways Agency and officers from Nottinghamshire Police and Thames Valley Police involving Professor Jim Horne and colleagues from the Sleep Research Centre at Loughborough University. The objective was to produce an overview of sleep-related factors to be considered in OTS investigations, including investigation methods and the key research issues. Each team presented OTS case examples which resulted in useful discussions and conclusions.

4.2 Health and safety

Protocols and procedures to ensure the health, safety and welfare of staff working on the OTS study were a major consideration. The two centres operated different, but broadly comparable health and safety policies (VSRC's set by its parent organisations and TRL's being part of its ISO 9001-accredited project management system). The risk assessments undertaken for the OTS study were prepared in accordance with the requirements of ISO 9001, and were further reviewed and approved by a qualified risk manager. These requirements did not replace the duty of care under the *Health and Safety at Work Act (1974)*, and all necessary steps were taken to ensure compliance with the requirements of the Act.

In addition, the particular hazards associated with crash investigation activities conducted at the scene of accidents were covered by the Health and Safety Risk Assessment Policy specially developed for OTS.

For the VSRC team, the protocols for this policy were based on the Nottinghamshire Police policy for their Crash Investigation Unit; procedures included training in first aid, traffic safety at the accident scene and radio procedures, including the call sign system. TRL has considerable experience of working in hazardous conditions on all parts of the highway network. This expertise, along with that of a number of health and safety experts on its full-time staff and the TRL safety adviser, was used to provide training for all staff at TRL attending accident scenes. Training for on scene protection and the use of cones and signs was provided to the call-out team, along with further training in working on site. In addition, all team members at the two centres involved in the collection of data at the scene were trained in the basics of first aid by St John's Ambulance and the Royal Berkshire Ambulance Service respectively, with re-training provided as required.

Travel to accident sites was undertaken under the control of the Nottinghamshire and Thames Valley police officers on secondment to VSRC and TRL, using the team response vehicles described earlier. VSRC continued to use this system throughout the study, with Nottinghamshire Police providing back-up police officers when necessary. TRL found in practice that it was unnecessary to use the blue lights when attending accident scenes in their area. This enabled other members of the investigation team to drive to accident scenes when the police officer was unavailable.

Biohazard assessment for team members working at the scene indicated there was a small risk of infection from tetanus or hepatitis ‘B’. All team members at each centre were therefore offered immunisation against these agents and all voluntarily agreed to be immunised.

Post-traumatic stress was identified as a risk and procedures were put in place to ensure all team members involved in data collection were regularly debriefed at the end of each shift pattern. Nottinghamshire Police made their counselling services available to the VSRC and were willing to provide full-time crash investigators with annual screening for stresses and strains associated with exposure to traumatic events. At TRL, the services of a professional counsellor were arranged for the call-out team should the need arise.

Other staff welfare issues included protection of physical health through the provision of appropriate clothing and equipment, and special personal injury insurance was also purchased to cover OTS team members for the duration of the project.

4.3 VSRC and TRL team collaboration

During the project, VSRC and TRL developed mutual support and collaborative practices with the specific purpose of providing the funding group with maximum data quality. Informal workshops and group meetings were held at regular intervals and cases of particular interest were routinely prepared for presentation at these meetings. The areas of most benefit were identified as those involving technical collaboration and are recommended for any on going studies.

These areas include:

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

5 ON THE SPOT METHODOLOGY

The basic methodology developed for OTS Phase I and still in use in Phase II focuses on:

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

5.1 On scene procedures

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

The serving police officers on the OTS teams make contact with the police officers in charge of the accident scenes and brief them as to the intended activities of the investigators. After safety and protocol issues are addressed, the team can then make contact with the various elements and people involved in the crash as inobtrusively as possible.

5.2 Scene data collection

Attendance at the accident scene provides data for the scene and approach aspects of the data set. It also provides information in varying quantity regarding the vehicle and human aspects of the accident. Scene information is collected for all relevant aspects of the accident location, road environment, weather conditions and traffic density as close to the time of the accident as possible. This is particularly important, as this type of volatile data can not be obtained from fully retrospective studies. Approach information is collected for each road user, including pedestrians. This covers details of the intended direction of travel of the accident participant with respect to the road environment, the road type, road condition, and the possible view (or lack of view) of the accident participant involved.

Collection of scene and approach information relies on attendance at the scene in sufficient time to ensure that the conditions have not changed and that details of the approaches of the individual accident participants are still evident. The scene examination also provides information regarding the vehicle aspects of the accident. This ranges from the basic number and type of vehicles through to the nature of damage suffered, likely number of collisions and state of roadworthiness. The level of information available is determined by the individual accident scenario.

Information on the human aspect of the accident is obtained by speaking with the accident participants present and those involved in the care and rescue of the injured. Postal questionnaires are also sent retrospectively to people involved in non-fatal accidents, excepting those who are judged to be unsuitable candidates to receive questionnaires, for example casualties with serious head injuries. Data requested in this way includes details of the hospital attended, whether the injured was driver or passenger, their gender, age, likely injuries etc. Informal interviews with the accident participants at the scene also provide a large amount of useful background information regarding the accident and this is used by the investigators to enlarge their understanding of the causes of the accident.

A library of some 200 OTS forms is available, covering all accident eventualities and possible vehicle, casualty and highway environments likely to be encountered. A key objective is to capture within minutes of the crash the volatile data which is present at the scene post impact. The forms are therefore structured into three priority levels such that the investigators begin with the most volatile information and progressively obtain as much additional information as possible, often obtaining some second and third level information during follow-up activities on another day.

On-the-spot priority levels:

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

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

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

5.3 Investigative procedures

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

5.3.1 The casualties

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

5.3.2 The vehicles

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

- collision avoidance systems including ABS and speed limiters;
- controls and lights: usage and condition on all vehicle types, including pedal cycles;
- defects: tyres, brakes, steering, suspension;
- crashworthiness: structures, bumpers, under-run guards (specification and fixings);
- damage assessment: full description, documentation and crash-energy calculations;
- restraint systems: seatbelt usage, airbag effectiveness, pre-tensioner presence, child restraint type, mounting and overall effectiveness;
- occupants: injury causation (contacts), ejection/trapping; and
- loads: restraint and movement.

5.3.3 The highway

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

- highway layout and design;
- traffic density;
- road surface: texture, temperature, friction, contamination;
- views and sight lines;

- signage including visibility and positioning; and
- meteorological conditions: precipitation, light levels, cloud cover, visibility, wind speed, temperature.

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

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

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

5.3.4 *Witness interviews*

Witnesses are identified, whenever possible, at the scene of the accident. If they give their consent, brief interviews are conducted immediately. Key witnesses' details are then recorded, permitting more extensive interviews during follow-up investigations. Much consideration has been given to the style and labelling of the high conspicuity clothing worn by the teams in an attempt to differentiate the research staff from the police attending the accident scene. The choice of clothing, which is different from that of the police emphasises the neutral and independent stance of the investigators, since uniformed police officers do not interview crash participants for research purposes. In this way it is hoped that the researchers can gain the confidence of the interviewees and so obtain unbiased responses to research questions.

5.3.5 *Follow-up investigation*

Further work is necessary after the scene has been visited for those cases where vehicles cannot be examined, witnesses cannot be interviewed at the scene or casualty details cannot be collected. The follow-up of the accident investigation takes the form of post-accident vehicle examination (usually at the recovery operator's premises), sending questionnaires or conducting telephone interviews with those involved in the accident and reconstruction of the events that led to and followed the accident. This information is used to provide a complete picture of the accident and ensure that the data collected is as thorough as possible.

The highway may also be further examined during a follow-up visit, when specialist expertise may also be available. Skidding co-efficient measurements may be taken by a Sideways force Co-efficient Routine Investigation Machine (SCRIM) to determine whether road surface friction was a contributory factor. For motorcycle crashes, traffic flow exposure data is recorded under similar traffic conditions one week later, as required by OECD methodology. Highway data held by local authority engineers may also be consulted in order to assess any previous history of crashes at the site.

Physical data recorded at the scene, including trace marks and debris locations, is used to calculate approach speeds and trajectories. Vehicle damage assessments also facilitate the determination of speed change at impact (delta-V). Finally, an analysis of time and distance factors may be attempted to determine velocities where possible.

5.3.6 Human data

The human data collected at the scene is supplemented by data collected from hospital records, HM Coroners' reports and questionnaires sent to accident participants. Injury information is collected at the co-operating hospitals and is made anonymous at source. Where necessary, coroners are contacted and they provide post mortem reports for the fatally injured casualties. Some injury information is also provided by accident participants completing questionnaires. This information is received by the teams and stored in accordance with the Data Protection Code of Practice. The injury information is coded using the Abbreviated Injury Scale (AIS 1990) [13] and injuries correlated to their cause where possible. The results are used to understand the accident from the human injury aspect.

Details coded for casualties include:

- characteristics: age, gender, mass, stature, predisposing medical conditions;
- selected treatment details;
- injury details: nature, extent, location and severity according to the Abbreviated Injury Scale (AAAM, 1990)[13];
- anthropometric data suitable for reconstruction of pedestrian kinematics and possible mathematical modelling of interactions between pedestrians and vehicles;
- general clothing, including motorcycle clothing; and
- motor and pedal cycle helmet specifications and damage.

A postal questionnaire is sent to selected crash participants requesting further details concerning driving experience, familiarity with routes taken, vehicle details, injuries and other details.

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

- vehicle design, e.g. lighting, mirrors, road worthiness;
- road design, e.g. sight lines, lighting; and/or
- driver experience/skill/judgement/impairment, e.g. training implications, alcohol.

5.3.7 Case reviews

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

- contributory crash factors;
- crash prevention and remedial measures (in place or recommended, including new/future technologies);
- relevance to current research and/or regulatory matters;
- feedback to investigators concerning methodology and improved practices; and
- quality control.

Contributory factors are classified using methodology developed by Broughton *et al.* (1998) [14]. Causes of crashes are broken down into precipitating factors (the action or failure which directly led to the accident, e.g. 'Driver failed to avoid pedestrian') and associated contributory factors (the reason why that precipitating factor happened, e.g. 'view obscured by glare from sun'). Each contributory factor is coded as 'definite', 'probable' or 'possible'.

5.3.8 Case report concluding remarks

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

- Impacts to vehicles:
  – precipitating factors
  – causation factors
  – possible counter-measures

- Injuries to casualties:
  – causation factors
  – possible counter-measures.

5.4 Case assembly

The collection of information by the investigators at the scene is only one part of the case processing effort. This section describes the work done by the support team to convert the data collected at the accident scene into completed cases.

5.4.1 Processing team

The first part of the data collection at the accident scene requires the investigators attending to complete an accident notification. This contains:

- accident time and date;
- accident location;
- accident description;
- names and addresses of those involved in the accident;
- interactions description; and
- basic scene diagrams.

This information is then passed to a member of the processing team to create the case in the OTS database. Over time, both centres have developed their own computer-based systems to merge and log both case completion and quality in ways suited to the individual team practices, reflecting slight variations in team staffing and local working arrangements.

Following case initialisation, the forms and other media are filed to await the production of the remainder of the case.

5.4.2 Occupant questionnaires

After case initialisation, the information from the management database and case notification is used to send questionnaires to those people involved in the accident who meet certain criteria. Questionnaires are only sent where personal details (name and address) are known and the injury severity is unlikely to prevent a return. This excludes those accident participants who:

- were involved in a fatal accident;
- had a serious head injury; and/or
- had injuries assessed at the scene as being life-threatening.

For all other accident participants, a questionnaire is sent to the address provided to the investigation team. Reminders for the questionnaire are sent four weeks after the date of posting and, if no response is received within two months, the questionnaire is marked as abandoned.

Over the life of the project the return rate of questionnaires was excellent, running at approximately 60% of all questionnaires sent. These provided a large amount of important accident causation information as well as data on human characteristics, such as height and weight, which could not be obtained from other sources.

5.4.3 Medical data collection

The notification and case initialisation system also instigates the process for collecting the required medical information relating to accident participants. This is collected by each team's hospital liaison officer from the hospitals that support the work of the OTS study.

In the case of fatal accidents, the post mortem report on the deceased is obtained from HM Coroner for the relevant county area. A follow-up request is sent if the post mortem is not received within four months of the initial request.

Injury data is evaluated according to the reliability of its source, and this information recorded in the database. All injury information is coded using the (AIS 1990)[13] injury coding system. The injuries are coded in accordance with the protocols used in the Co-operative Crash Injury Study (CCIS)[4] to ensure consistency within that study and with other DfT research databases.

VSRC were able to access injury data on all casualties attending hospital, but in the TRL area some of those injured were taken to hospitals outside the sample region. Some of these hospitals were already co-operating with the CCIS Study and, in these cases, medical data was routinely requested and was usually provided. However, some other hospitals did not have the infrastructure in place to support the project, so medical information could not be accessed. In these cases, information from the questionnaire was used to provide an indication of the injuries suffered by the victim.

5.4.4 Case completion

During the medical data collection activity, the remaining information for the case is prepared by the investigation teams. The remaining scene paperwork is produced and is checked for self-consistency with the notification, photographs taken at the scene and other information. Any inconsistencies are raised with the investigation team and the data corrected.

The scene data paperwork is entered into Excel spreadsheets and the scene photographs are renumbered and downloaded together with any video footage taken at the scene. At this stage, the road user interaction codes for the case are completed where necessary.

Once the medical data and questionnaire information has been coded and entered onto the case paperwork, the investigation team review the case. Contact correlations are undertaken, with the aim of identifying the causes of injuries suffered. Contact correlation is the process undertaken to assign each injury a contact or cause, for example a pedestrian may have suffered a broken leg (tibia) that is attributed to a contact or impact with a car bumper. However, the information available from the rapid vehicle examination at the scene is less detailed than that obtained from fully retrospective studies such as CCIS, and so positive contact correlation is not always possible.

The case is considered complete when the final case data is assembled on Excel spreadsheets ready for appending to the master Access database.

6 DISSEMINATION OF INFORMATION

6.1 Project brochure and website

At the beginning of the project, a brochure was produced describing the OTS research programme (Appendix B). This proved to be a useful medium for informing the wider organisations co-operating with the project and other interested parties, before a project website had been made available. A new website has, however, now been created and is available at www.ukots.org

6.2 Publications and presentations

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

Forum	Venue	Date	Ref
Parliamentary Advisory Council for Transport Safety, PACTS	London	Jan 2001	15
Nottinghamshire Casualty Reduction Partnership	Nottingham	Jan 2001	16
Association of Chief Police Officers (ACPO)	Cumbria	May 2001	17
International Technical Conference on the Enhanced Safety of Vehicles (ESV)	Amsterdam	June 2001	18
International Conference on Accident Investigation, Reconstruction, Interpretation and the Law (AIRIL)	Vancouver	Aug 2001	19
Traffic Safety on Three Continents, Conference	Moscow	Sep 2001	20
Institute of Traffic Accident Investigators' Conference (ITAI)	York	Nov 2001	21
Institute of Motor Industry	TRL	Nov 2001	21
Co-operative Crash Injury Study (CCIS) Symposium	Birmingham	Dec 2001	22
Behavioural Research in Road Safety, 11th DfT Seminar	Manchester	Feb 2002	23
European Vehicle Passive Safety Network, Pedestrian Safety Workshop	Cranfield	Sep 2002	24
British Trauma Society Annual Scientific Meeting	Leeds	Oct 2002	32
European Commission Road Infrastructure Safety Workshop	Brussels	Nov 2002	25
Parliamentary Advisory Council for Transport Safety, PACTS	London	Jan 2003	35
Pedestrian Protection Workshop at Autoliv	Havant	Mar 2003	33
Foresight Vehicle Committee Meeting	TRL	Mar 2003	34
Society of Motor Manufacturers	London	Apr 2003	37
International Technical Conference on the Enhanced Safety of Vehicles (ESV)	Nagoya, Japan	May 2003	26, 27
British Trauma Society Trauma Nursing Course	London	Sept 2003	38
European Vehicle Passive Safety Network, Vehicle Infrastructure Crashworthiness Workshop	Rhode, Germany	Oct 2003	28
British Trauma Society Annual Scientific Meeting	London	Oct 2003	39
Roads '04 Trunk Road Management Conference	Manchester	Sept 2004	40

6.3 Press and publicity

Appropriately for a major new initiative in the field of road accident investigation, OTS has maintained a high profile and has attracted media interest. For example, at the beginning of the project, VSRC worked alongside Nottinghamshire Police press office to produce a press release describing the aims and objectives of the OTS working partnership.

VSRC and Nottinghamshire Police also staged a crash on private land for the benefit of the local media, including television and radio news programmes and the local press, in June 2002. A clip from the BBC television 'East Midlands Today' programme is available on the website.

The OTS study has been covered in the science programme 'Tomorrow's World' and the TRL team has been featured on BBC South and in the *Sunday Times* newspaper.

6.4 Visits

Senior staff at DfT and the HA have been given numerous presentations on the workings of OTS and demonstrations of OTS equipment and facilities both at VSRC and TRL. A particularly notable visitor was His Royal Highness the Duke of Gloucester, who spent time with the VSRC team during his official opening of the new Nottinghamshire Police Operational Support Division in November 2002. Nottinghamshire Police were keen for the team to prepare an exhibition and make a presentation to His Royal Highness, because they regard OTS as a priority project based in their new facility.

6.5 National and international links

As described earlier in this report, both national and international links have been made with other real world data collection studies, namely CCIS, MAIDS, GIDAS and the EC Vehicle Passive Safety Network. The OTS project was also described at international fora including the ESV conferences held in 2001 and 2003. Other conferences and workshops are given in Section 6.2.

7 SUPPLEMENTARY ACTIVITIES

7.1 Data analyses

7.1.1 OTS data analysis project

Following substantial work to explore and format the data recently entered into the Access system in useful quantities, VSE Division at DfT funded some initial analysis of the data. Commencing during 2003, VSRC and TRL carried out separate analyses, although co-operation between the two centres was arranged through joint meetings and co-ordination of analysis topics and formats. A joint workshop was held in March 2004, before the release of the final report.

7.1.2 Pedestrian crash analysis

A project has been completed at VSRC with support from the Jaguar Research Group in order to assist research on the Foresight Vehicle projects Advanced Protection for Vulnerable Road Users (APVRU) and Short Range Sensors for automotive applications (SHORSEN). OTS data and materials was made available for this purpose with permission from the DfT. The project ran from April 2003 to July 2003 with the objective of assisting in the development of pedestrian sensing and protection strategies through the provision of in-depth information available from OTS investigations.

The project allowed a number of activities, including:

- overview of causes of pedestrian accidents and injuries;
- enhanced, detailed reconstruction of vehicle and pedestrian velocities, their kinematics, and other factors relating to pedestrian sensing technologies;
- analysis of video recordings showing the driver's view on approaching the point of impact; and
- database browsing and presentation tools for the wide range of OTS media.

Reports and a CD-ROM from this study are available for review.

7.2 Ph.D. p rogramme

A Loughborough University studentship commenced during 2002 with the aid of funding from the Highways Agency, and involved close co-operation with the OTS team. The programme allowed a Ph.D. student to make an objective investigation of real world crash events based on an integrated highway-vehicle-driver simulation environment. Early progress on this new approach to the computerised simulation of road accidents was presented at the ESV conference in 2003.

7.3 Special investigations

In 2001 a requirement to extend the gathering of real world crash injury data beyond arrangements that existed in CCIS and OTS was identified. This involved a need for special crash investigations, which were defined as real world crash investigations pertaining to areas of special research interest.

The benefits of such investigations were seen to be as follows:

- The investigations would provide an anecdotal data-set useful for examining special crash circumstances or outcomes from an engineering perspective.
- A capability to locate unique real world crashes would be developed to provide crash information in a timely manner which would in turn be utilised by the safety community to improve the performance of state-of-the-art safety systems.
- Individual and select groups of cases could contribute to improving the safety performance of motor vehicles (including passenger cars, light trucks, mini-buses and buses) and of the highway infrastructure.

A list of areas of possible special research interest was drawn up in consultation with DfT which included the following crash situations:

- crashes involving any occupant in a seat position protected by a deployed air bag who receives a severe, life threatening, or fatal injury;
- crashes in which advanced side protection measures have been deployed;
- elderly pedestrian impacts;
- pedestrian crashes involving vehicles with good EuroNCAP pedestrian protection ratings;
- crashes involving commercial drivers carrying unsecured loads;
- crashes involving children;
- van crashes;
- bus and minibus crashes involving fatal injuries to occupants; and
- other crashes that are of special research interest to the DfT or HA.

The OTS contract was extended to include special accident investigations from 2002. Unlike the CCIS and OTS studies, which have systematic sampling plans, crashes were identified for potential investigation only if they were considered to be of special research interest.

The principal steps in special crash investigations were as follows:

1. Teams receive/obtain notifications of accidents from local police forces, media reports, local recovery yards and other sources within the local area network.
2. Teams consult with DfT to confirm interest in pursuing a special crash investigation.
3. Inspection of vehicles involved and/or crash site as appropriate.
4. Gathering of injury information as appropriate.
5. Gathering of participant or witness information as appropriate.
6. Case data compilation, crash/injury reconstruction.
7. Case reporting.

7.4 Anthropometric study of injured pedestrians

VSRC have uniquely established a routine for obtaining limb and overall body measurements from pedestrian casualties. This has been achieved by working in co-operation with the Accident and Emergency (A&E) Department at the Queens Medical Centre (where the majority of casualties were taken from OTS accidents), and involved the registrar requesting informed consent from the casualty. Providing consent was given in writing, measurements could be taken and other details recorded (as a useful back-up procedure) concerning clothing and other factors also verified on scene.

This procedure proved to be especially valuable both for reconstruction of the causes of injuries and possible future mathematical modelling of vehicle and pedestrian interaction and the causes of injuries. The VSRC have agreement that this procedure can be continued into any following phases.

The first request for pedestrian anthropometric data was made in June 2001. Difficulties were encountered initially in implementing the most effective methods of communicating requests to the QMC A&E Department because of its medical staff shift systems. However, of the requests that were followed through successfully, half produced the required data and only one patient refused permission.

7.5 Application of technology

The On The Spot Accident Data Collection project provided an excellent opportunity to evaluate existing and new technology for usefulness in both protecting personnel at the scenes of accidents, collecting data or reducing risk in data collection operations. The following are examples of the technologies investigated.

7.5.1 *Provida calibrated video system*

The Petards Mobile Intelligence Provida system is a reliable means of recording high quality video overlaid with key data for speed enforcement and constitutes ‘eyewitness’ evidence for motoring offence prosecutions, and it seemed likely that it could provide benefits to the OTS teams both in speeding up and improving the quality of scene and approach data collection.

The Provida system was permanently fitted to the vehicle with a fixed camera, and not only enabled the TRL investigators to obtain video evidence of accident scene approaches without the need to revisit the scene, but also ensured that scene approach data was always collected from the same vantage point. This meant that any comparison of scene approaches was always made on a ‘like with like’ basis. In cases where the viewpoint of the Provida camera was not representative of the driver’s eye view (such as in HGV accidents), a hand-held camera was used where possible to obtain details of the approach from a representative viewpoint.

Distance measurements on the approaches to the scene could also be recorded using the Provida system, generally removing the requirement to measure distances using a trundle wheel.

7.5.2 *Photopic tint testing*

DfT provided additional funding for the purchase of equipment for measuring the variable light transmission of helmet visors and vehicle glazing from March 2001 which has proved to be a valuable additional investigation tool for both teams.

7.5.3 *3-D laser scanning*

TRL has pioneered the use of three dimensional (3-D) laser scanning techniques in road traffic accident investigation. The OTS team based at TRL has used this technology on a sub-sample of representative real world crashes to quickly collect data minutes after the crash occurred to construct dimensionally accurate 3-D images of the accident scenes. To undertake accurate crash reconstructions it is vital to have very detailed plans of the crash site including all the pertinent information such as road geometry, debris, vehicle positions and trace marks. The 3-D laser scanning technique was shown to offer many advantages over more traditional mapping procedures, one of the most important being the speed with which data can be accurately collected. It is often the case that a traffic incident has not only caused harm to those involved, but can also disrupt the local road network, causing significant congestion problems; a priority for the police is therefore to clear the carriageway as quickly as possible. 3-D laser scanning was shown to be an efficient procedure to obtain all the necessary evidence for future investigations in the shortest time. The 3-D accident plans created can be used to investigate sight lines and vehicle paths at a personal computer, away from the scene.

7.5.4 SCRIM

The Sideways force Co-efficient Routine Investigation Machine (SCRIM) is the standard technique used by highway engineers to measure skidding resistance of in service roads. Its main advantage is that it gives comparative readings on the route to and through the site, highlighting differences in the skidding resistance and surface texture. These differences can be a contributory factor resulting in vehicles' loss of control and subsequent accidents, and are often undetected with other skidding resistance measurement techniques. The deployment of SCRIM at selected accident scenes proved useful in providing relevant data, in cases where it appeared that the skidding resistance may have had an influence on the cause of the accident.

8 CONCLUSIONS AND RECOMMENDATIONS

The OTS study has allowed VSRC and TRL to build new and effective teams of investigators both at the respective centres and in the wider local safety community. OTS is established as a powerful research tool with great potential for assisting safety professionals and government safety policy. The body of experience is now considerable, both on scene and in the post scene follow-up phases of vehicle examination, reconstruction of circumstances, interpretation of evidence and assessment of injury.

Both teams ended the first phase fully ready and keen to continue this rewarding work into a second phase, which will allow for the natural expansion of methodologies and expertise to give a larger and richer source of essential new information to government and the safety research community.

Operational experience and changing requirements have inevitably required that the original integrated protocols be enhanced and modified over time. Key enhancements are outlined below. A full and detailed list of changes, omissions and improvements in the methodology, as made during this phase, may be found in the document prepared for DfT in support of the work specification for OTS Phase II, which commenced in September 2003.

Key recommendations for Phase II include:

- database development and management;
- priority guidelines for investigations;
- enhanced reconstruction and survey procedures;
- enhanced interview procedures;
- a unified sampling plan;
- continued consistency in methodology and collaborative approaches;
- a data analysis (call-off) facility;
- a public domain data-set;
- an enhanced website; and
- continuation of special accident investigations.

9 ACKNOWLEDGEMENTS

This multi-disciplinary, crash research project would not be possible without help and support from a great number of individuals and organisations. The authors would like to thank everyone who has helped to make this project possible, especially the following:

- The DfT and Highways Agency for their financial support of the OTS study.
- Representatives of DfT at Vehicle Technology and Standards Division, Road Safety Division and the Highways Agency for their continued help and guidance.
- The chief constables of Nottinghamshire, Thames Valley, Hampshire and Surrey Police and all their officers, together with police officers in many other forces that have provided help or granted access to crash information.
- The consultants and staff at the Queens Medical Centre, Frimley Park Hospital, Royal Berkshire Hospital, Wycombe General Hospital and the Heatherwood and Wexham Park Hospitals Trust for their co-operation with this research.
- Her Majesty's Coroners in the study regions for their willing provision of information.
- The local authority engineers at Nottingham City Council and Nottinghamshire County Council.
- The Medical University of Hanover and, in particular Professor Dietmar Otte, for his ongoing advice and support.
- Ford and Jaguar for their support and advice during early pilot studies and protocol development at VSRC.
- The staff at Loughborough University and TRL who have helped to establish and carry out this project, especially Mo Bradford, Stuart Amor, Nigel Byard, Ben Carter, Dawn Chambers-Smith, Martyn Chambers-Smith, Penny Crosgray, Simon Crowther, Robert Cyples, Adrian Fails, Paul Forman, Shane Goodhand, Sue Hester, Jim Hill, Sharon Hulse, Linda Kingsmill, Jane Kohlhoffer, James Lenard, Hayley Lunt, David Lynam, Andrew Morris, Iwan Parry, Mike Pittman, Iain Rillie, Denise Roper, Adrian Runacres, Jonathan Sanders, Dean Southall, Tim Sterling, Pete Thomas and Louise Turner.
- 3M and HALO for providing and fitting the high conspicuity retro-reflective marking materials to the TRL OTS response unit.
- Serco plc for provision of the communications equipment fitted to the TRL response vehicle.
- VDO Kienzle for the supply and fitting of journey and incident data recorders in the TRL response vehicle.

- AiTS for providing AiDamage software and training.
- West Midland Police Officers Tony Allsopp and Jim Field for providing training to the investigation teams.

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APPENDIX A – DATA PROTECTION CODE OF PRACTICE FOR THE USE OF ACCIDENT DATA BY RESEARCH ORGANISATIONS

1 INTRODUCTION

The Department for Transport (DfT) aims to provide ‘better transport and thriving, prosperous, safe communities’. As a part of this, DfT (and its executive agencies) aim to ensure that the UK has the modern transport system it needs to achieve sustainable economic growth, whilst also:

- minimising adverse impact as possible on the environment;
- ensuring personal safety and freedom of choice; and
- providing transport at a cost the country can afford.

In support of the objective of ‘reliable, safe and integrated transport for everyone, which respects the environment’, the DfT requires scientific studies which provide detailed information relating to road traffic accidents. The Highways Agency also requires such studies to enable them to meet key objective six, ‘To improve safety for all road users and contribute to the Government’s new safety strategy and targets for 2010.’

The principal aim of any scientific study which collects and/or uses road traffic accident data is to use accurate, up-to-date information to expand the knowledge of road traffic accidents and hence develop innovative casualty reduction policies and counter-measures, which are based on real world accident data.

The numerous benefits of accident research studies include:

- providing data to develop innovative solutions to road accident problems and so save lives;
- improving the understanding of human involvement, vehicle design and highway design on accident causation and injury mechanisms;
- helping in the design of safer cars, road infrastructure and road environments;
- providing a research reference which will allow the development of road safety policy; and
- enabling the monitoring of effectiveness of introduced accident reduction strategies and vehicle occupant injury counter-measures.

Research studies which access accident data do so to answer specific questions about the causes and consequences of accidents. The accident data is of critical importance in developing safer roads and vehicles, and giving insight into the complexities of human behaviour.

Accident files used in research often contain personal information, and scientific ethics demand that such information must be handled sensitively so that no individual is disadvantaged.

The *Data Protection Act 1998* sets out eight principles of data protection which are legally enforceable rules designed to ensure that the rights of individuals are protected. These principles, sometimes referred to as the principles of 'good information handling' must be complied with by data controllers processing personal information.

Except to the extent that any data controller is able to claim an exemption from any of the principles (whether on a transitional or outright basis) the principles apply to all personal data processed by data controllers. However, in some instances it is not possible for research studies to comply with the entire Act; for example, it may be impossible to trace individuals, or not feasible to contact the number of individuals involved.

Despite these issues, it is paramount that all research centres using accident data shall work to the highest standards of data handling, confidentiality and ethics. This document presents a code of practice relating to how the collection, dissemination, and storage of personal information within accident data studies shall be handled to satisfy issues of confidentiality, data protection, and ethics.

2 DATA PROTECTION

The *Data Protection Act 1998* establishes the principles of data protection. These state that:

> 'Anyone processing personal data must comply with the eight enforceable principles of good practice'.
>
> They say that data must be:
> 1. Fairly and lawfully processed.
> 2. Processed for limited purposes.
> 3. Adequate, relevant and not excessive.
> 4. Accurate.
> 5. Not kept longer than necessary.
> 6. Processed in accordance with the data subject's rights.
> 7. Secure.
> 8. Not transferred to countries without adequate protection.
>
> Personal data covers both facts and opinions about the individual. It also includes information regarding the intentions of the data controller towards the individual, although in some limited circumstances exemptions will apply. With processing, the definition is far wider than before. For example, it incorporates the concepts of 'obtaining', 'holding' and 'disclosing'.
>
> (© The Information Commissioner, www.informationcommissioner.gov.uk)

When handling raw and electronic data for research purposes, accident data studies must wherever possible conform to the requirements of the *Data Protection Act 1998* and adhere to the eight principles of data protection.

The following sections specifically state how research organisations shall manage the processing of accident data to ensure compliance with the *Data Protection Act 1998*.

2.1 Role of the data controller

The research organisation will formally nominate a data controller. The duties of the data controller are to:

- Liaise with the main data provider(s) (e.g. police forces), to provide a single point of reference and communication.
- Obtain a statement from the study manager for each research study which wishes to use accident data, specifying:
  a. The aim and purpose of the study (to ensure the data is processed for limited purposes in accordance with Principle 2).

b. The length of time for which data is to be held (to ensure the data is not kept longer than necessary in accordance with Principle 5).
c. Any special data requirements (to ensure data held is adequate, relevant and not excessive in accordance with Principle 3).

- Ensure that all data collected and processed is for the specific purpose nominated in the statement.
- Maintain a Register of Authorised Persons who are permitted to access the data and control access to the data through appropriate security measures.

2.2 Security

The completed database or report produced by any research study using accident data will store or present all data regarding accidents, injuries or vehicles in an anonymous format. No personal data may be stored or held within the database or report which specifically identifies any person, whether living or dead.

However, for 'work-in-progress', it is necessary to process personal data and store it whilst it is being processed. Personal data shall only be processed for the minimum time to ensure the accuracy of the database or report produced by the research study. This ensures compliance with principles 4 (accurate) and 5 (not kept longer than necessary) of the principles of data protection. It will be the responsibility of the data controller to ensure that personal data is processed in accordance with these principles.

In addition, Schedule 1, Part 1, paragraph 7 of the *Data Protection Act 1998* states that:

> 'Appropriate technical and organisational measures shall be taken against unauthorised or unlawful processing of personal data and against accidental loss or destruction of, or damage to, personal data'.

The following sections set out how research organisations will comply with this part of Schedule 1 of the Act and ensure the security of personal data.

2.2.1 Confidentiality

The following code of practice specifies how the research organisation will collect and store personal information.

- The data controller will issue a copy of the Data Protection Code of Practice to each person who requires or is required to work with personal data.
- Each person who requires or is required to work with personal data will sign a statement confirming they have received a copy of the Data Protection Code of Practice and will fully comply with its content.

- All persons who have signed such a statement will be registered by the data controller as authorised persons and their name included on the Register of Authorised Persons for an appropriate period determined by the data controller.
- No authorised person shall under any circumstance pass on personal or identifiable information, whether verbal or written, to anyone who is not an authorised person directly involved in the study.

2.2.2 Processing of personal data

The physical security of personal data is essential to comply with the requirements of Schedule 1, Part 1, paragraph 7 of the *Data Protection Act 1998*. Physical security will be maintained in accordance with the following code of practice:

- Personal data will be collected by authorised persons.
- After collection, personal data shall not be left unattended and will be brought to a designated secure storage area as soon as is reasonably practicable.
- All files with identifiable personal data will be stored in a designated secure storage area.
- Access to the designated secure storage area will be limited to authorised persons.
- Files will be removed from the secure storage area for processing and will be returned to the secure storage area when processing is complete.
- Once processing is completed, the files are transferred to a locked central filing room, access to which is controlled by the data controller.

2.2.3 Anonymous storage of processed data

The following section relates to the research databases that are used for analysis. These output databases have all personal details removed from the data so that the research database is anonymous.

All processed data that is stored in an anonymous record format does not fall under the auspices of the *Data Protection Act 1998*.

The following code of practice will be observed when anonymising data for storage in a database or inclusion in a report:

- Raw data will be collected and stored using a unique identification number which cannot be used to identify the individual.
- All reference to the individual's identity (e.g. name and address) will be removed before the data is taken from the point of collection.

- No personal data (names, addresses or vehicle registrations) shall be stored on the completed research databases.

2.2.4 Auditing

The data controller will have the right to audit the data processing system on an ad hoc basis to ensure that the terms and conditions of this document are in force.

3 SPECIAL REQUIREMENTS FOR MEDICAL DATA PROCESSING

On many occasions it is necessary to determine the causes of injuries to accident victims. Such information is extremely sensitive and so the use of medical information necessitates the following extra requirements.

- Prior to accessing any medical data, all authorised persons within the research organisation involved in the processing of data obtained from hospital records will be made aware through a verbal briefing by the data controller of the confidential and sensitive nature of the data being handled.
- All members of the research organisation involved in any way in the collection, handling or processing of medical data obtained from hospital records must be authorised persons.

3.1 Permission to access hospital records

If a study requires access to road accident injury data from hospitals, the research organisations must seek the approval from the consultant in charge of the Accident and Emergency Department before any approach is made to collect the required injury data.

In addition, the consultant in charge of the Accident and Emergency Department may require that the research organisation seeks the approval of the Hospital Ethics Committee before collection of information can take place.

3.2 Permission to access post mortem reports

If a study requires access to road accident injury data relating to fatal road accidents, this is obtained from Her Majesty's Coroner for the area in which the accident occurred. Permission for disclosure of the post mortem report relating to the victim shall be addressed to the Coroner for the area in which the accident occurred, which may not necessarily be the same as the area in which the victim died.

3.3 COLLECTING INJURY DATA FROM HOSPITALS

Injury data is collected in one of two ways. In some cases the data controller may be permitted to visit the hospital in order to extract relevant injury data directly from the hospital case notes. At the discretion of the hospital, this can be under the supervision of a medical consultant, or other hospital staff member.

Alternatively medical consultants dictate injury data onto a tape which is later transcribed, or records are transcribed onto paper collection sheets.

Hospital records will never be removed from the hospital. Only data relating to injuries sustained in the road traffic accident shall be accessed, with any other information relevant to the understanding of the accident. Access to this information complies with the requirements of Principle 3 (accurate, relevant and not excessive).

4 QUESTIONNAIRES

Questionnaires can be an important source of information regarding road accidents. However, collection of personal data using questionnaires is still controlled under the auspices of the *Data Protection Act 1998*. The following code of practice shall be observed when employing questionnaires within a research study:

- Clearance for the use of the questionnaire shall be sought from the UK Survey Control Unit.
- Ethical clearance must be obtained from the UK Survey Control Unit if personal information is requested.
- Questionnaires must not be sent to people in accidents where there has been a fatality.
- In cases where people involved in the accidents have sustained serious head injuries or severe life threatening lesions, injury data must first be obtained from the hospital to assess whether or not it would be appropriate to send a questionnaire.
- When sending a questionnaire, an accompanying letter must be included which shall indicate:
  - the purpose of the research study for which the information is requested
  - that the research organisation is aware of the sensitive nature of the research
  - that any information contained in the questionnaire is strictly confidential and will not be passed to a third party in any form that will identify that person.
- The content of the accompanying letter shall be agreed with the customer project officer.

- A single point of contact (usually the research study manager) must be identified in the covering letter to enable questionnaire recipients to contact the research organisation when necessary.

APPENDIX B – OTS: ACCIDENT RESEARCH ON THE SPOT

A new On The Spot (OTS) accident research project is now underway in the UK with funding from the Department of the Environment, Transport and the Regions and the Highways Agency. This research will help ensure that our roads become safer for everyone and also contribute to the Government's Road Safety Strategy of 40% road casualty reduction target for 2010. The project enables expert investigators to attend the scene of an accident within 15 minutes of the incident occurring. There are teams at VSRC in the Midlands and TRL in the South. Together they will study 500 crashes in depth, each year. Objectives include establishing an in-depth database, and better understanding the causes of crashes and injuries.

In-depth crash investigations are essential for understanding what happens in the real world. Also, much of the information necessary to understand complex road safety questions is only found at the scene.

OTS investigation allows this 'perishable' accident data to be gathered. This includes information relating to 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.

The OTS teams work alongside the Nottinghamshire and Thames Valley Police and include a serving police officer on each team who ensures a secure, direct link with the local police command for immediate crash notifications.

Specially marked high conspicuity response vehicles are used, driven by the trained police drivers, these officers are also highly experienced and extremely knowledgeable road traffic accident investigators.

1 OBJECTIVES

OTS accident data collection has been established with the following objectives;

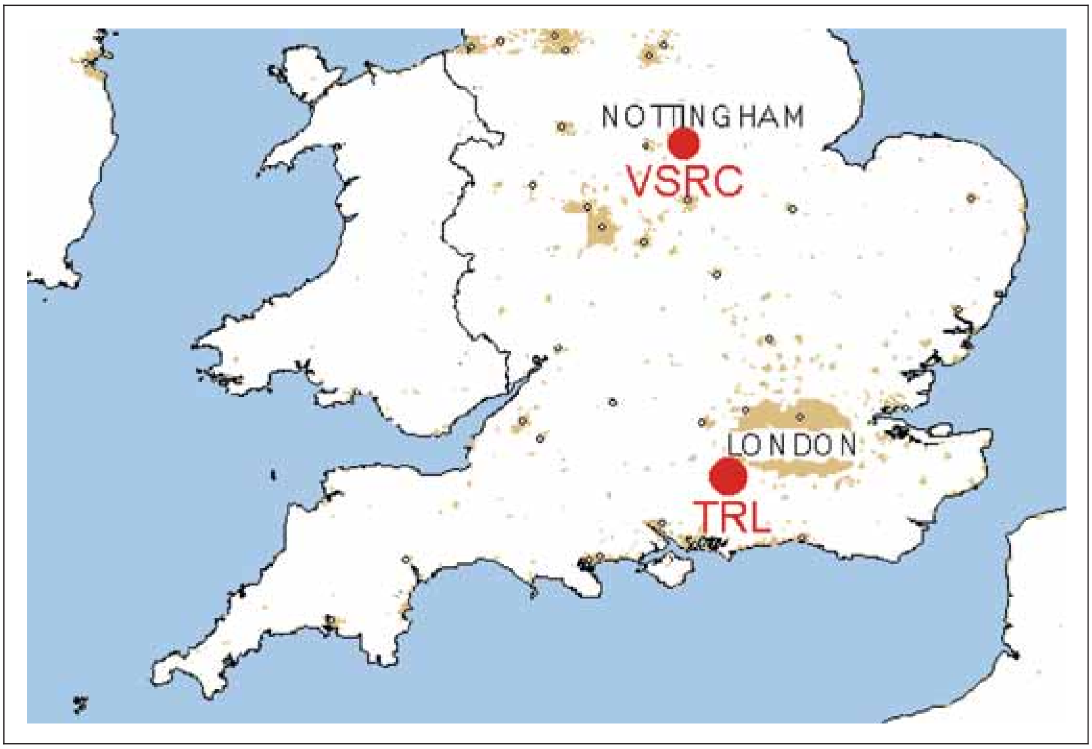
1. To establish an in-depth research database of a representative sample of road accidents in the UK.
2. To understand better the causes of crashes and injuries.
3. To assist in the development of solutions.

The project focuses on:

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

2 STUDY AREAS

Two regions of the UK were selected so that accident severities correlate well to the national distribution of accident numbers, The regions were also chosen to ensure that a representative sample of accidents involving different road users was examined.



3 THE BENEFITS OF OTS RESEARCH

It is expected that the results from the OTS Accident Investigation Project will make a significant contribution to road safety through improved vehicle safety, crashworthiness and occupant protection.

The safety improvements which will undoubtedly arise from this work will be seen not only in the UK but also in many other countries which will be able to benefit from the high quality research currently being carried out by the Vehicle Safety Research Centre and TRL.

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TECHNICAL ANNEX

1 ACCIDENT INVESTIGATIONS

This section of the report provides an overview of the accidents that were investigated during the first phase of the OTS Accident Data Collection project.

A total of 1,519 accidents were investigated by the teams. VSRC carried out 764 investigations, of which 11 were considered to be outside the sample protocol, and TRL carried out 755.

1.1 Accident frequency and location

Figure A1 shows the frequency and location of accidents over the four administrative regions that make up the VSRC sample area in South Nottinghamshire. Figure A2 provides similar information for the TRL sample area.

Figure A1: Frequency and location of accidents investigated by VSRC

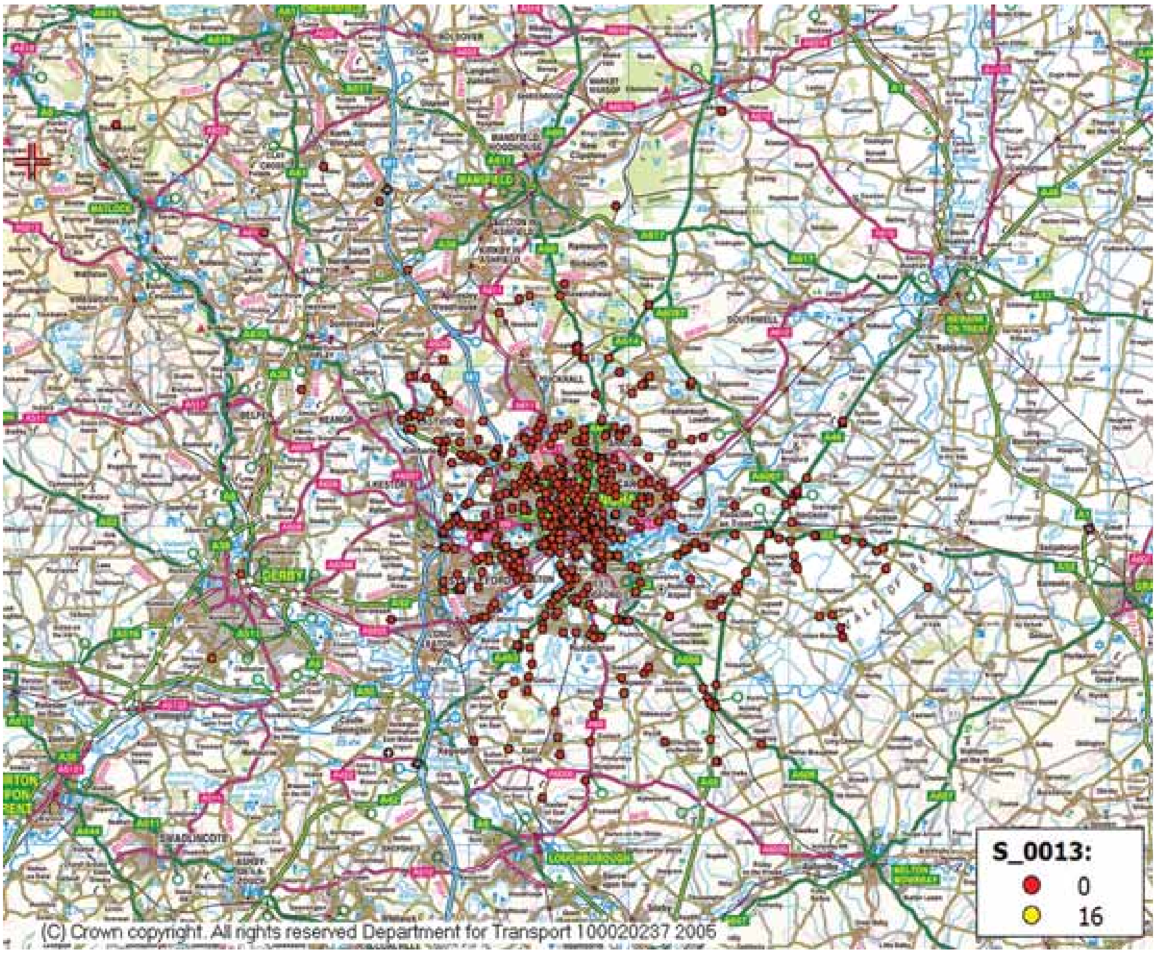
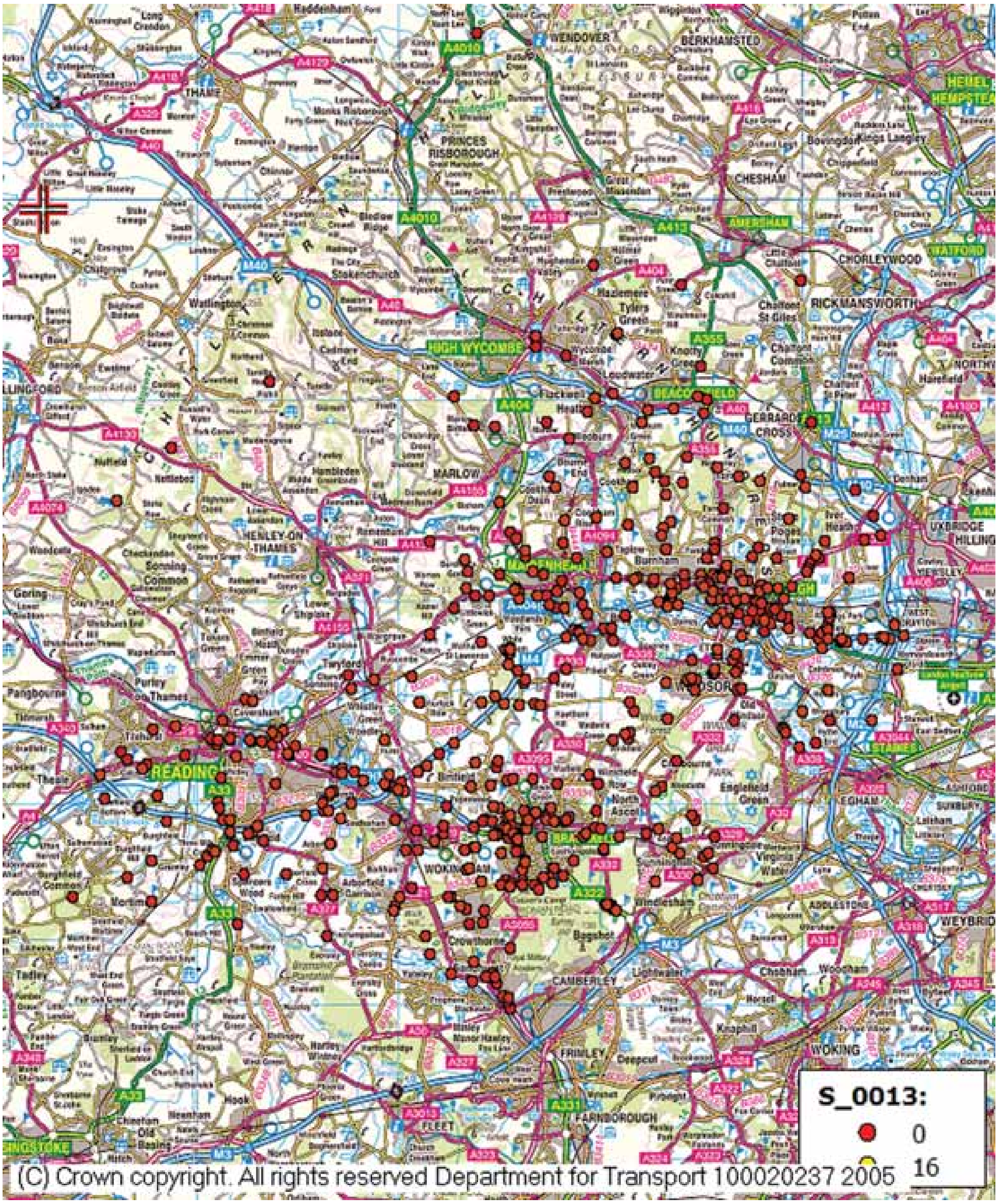


Figure A2: Location of accidents investigated by TRL



1.2 Investigation rate

Figures A3 and A4 show the progress of case investigations by the two teams over the life of the project, from October 2000. The VSRC investigation rate was quite steady but, at TRL, initial difficulties with the incident notification procedures resulted in a lower than expected rate of investigation. This was addressed in the latter half of the project, resulting in a significant upturn in the number of cases investigated.

Figure A3: VSRC team investigation progress

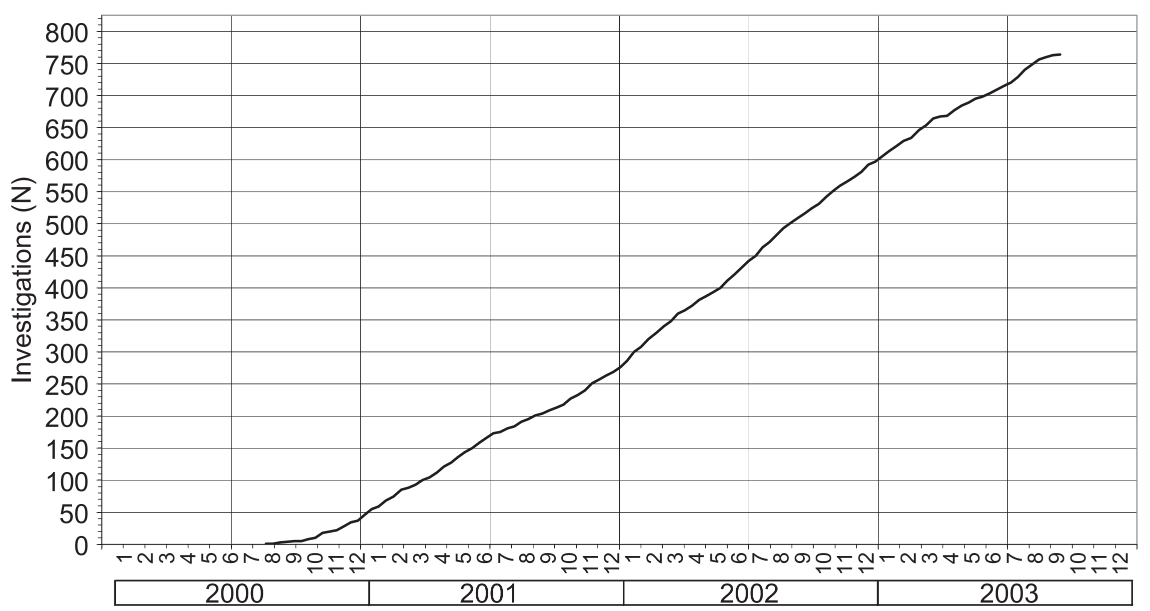
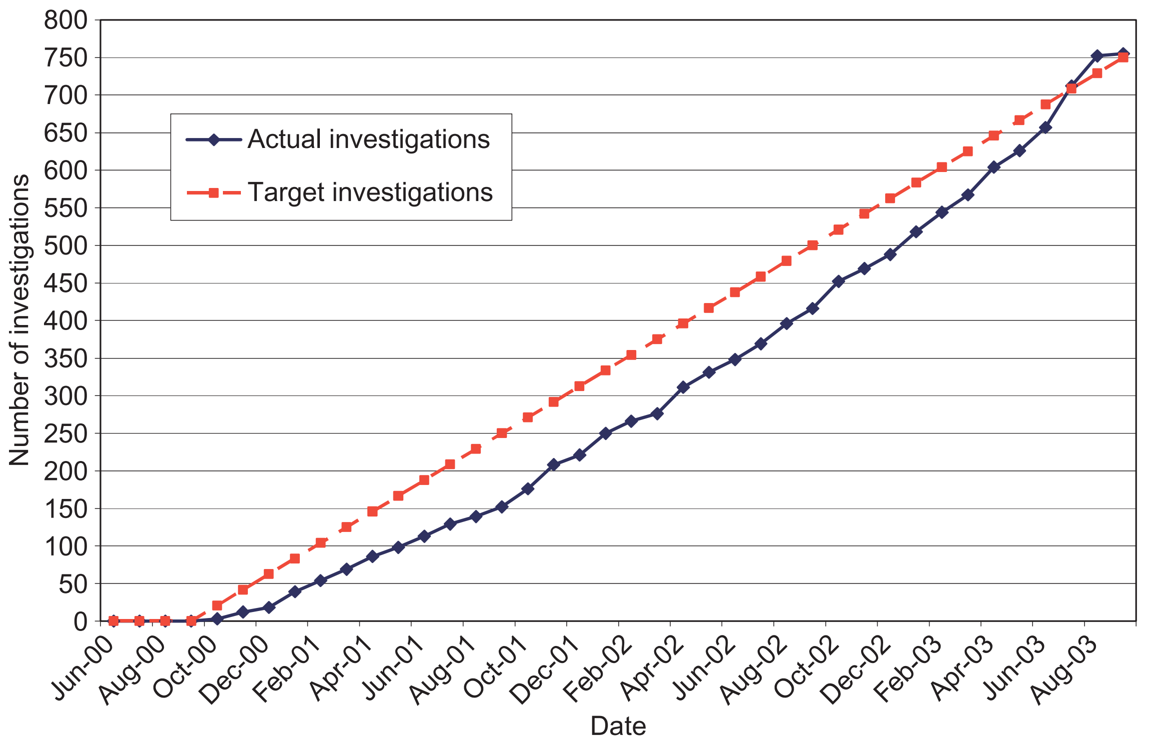


Figure A4: TRL team investigation progress



1.3 Accident severity

Table A1 shows the severity distributions for the 1,508 cases investigated, along with the total numbers of injury accidents recorded in the OTS areas, from Table 1, for comparison.

Table A1: Accident severity distributions for accidents sampled

Injury severity*	VSRC investigations	TRLI investigations	Total cases investigated		OTS area stats (from Table 1)	
			N	%	N	%
Fatal	24	31	55	6.4	73	1.2
Serious	104	83	187	21.9	887	14.0
Slight	303	310	613	71.7	5371	84.8
Total injury accs	431	424	855	100	6331	100
Damage only	303	314	617	40.9		
Not known	19	17	36	2.4		
Total	**753**	**755**	**1,508**	**100**		

*Injury Severity shown in Table A1 is the OTS estimate of severity to be shown in UK national statistics (Stats19). Please note that this estimate may occasionally differ from national statistics, which are updated by the police in the days following the accident. VSRC are currently exploring a mechanism to link OTS data with the national records for accident injury severity.

Slightly over 55% of the accidents sampled in OTS are judged likely to be classified as injury accidents, and so to appear in national statistics. Of these, OTS has sampled a higher proportion of more serious accidents. However, because the true severity distribution in the OTS area is known, the OTS results can be scaled to give nationally representative figures.

1.4 Time of accident

Figure A5 below shows the distribution of accidents by time of accident. The data is also summarised in Table A2.

Figure A5: Time of accident

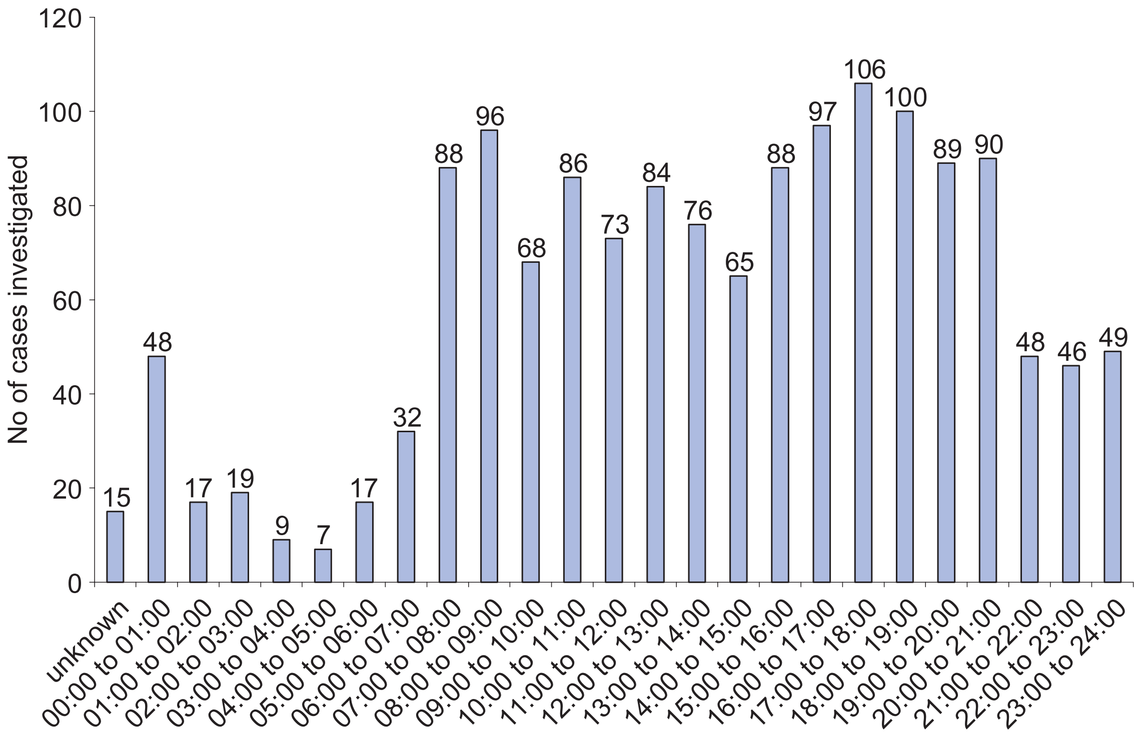


Table A2: Time of accident

Time of accident	VSRC cases		TRL cases		Total cases	
	N	%	N	%	N	%
00:00 – 06:00	83	10.9	23	3.0	106	7.0
06:00 – 12:00	197	25.8	249	33.0	446	29.4
12:00 – 18:00	287	37.5	236	31.3	523	34.4
18:00 – 24:00	197	25.8	218	28.9	415	27.3
unknown			29	3.8	29	1.9
Total	**764**	**100**	**755**	**100**	**1519**	**100**

1.5 Vehicles involved

Table A3 shows the distribution of vehicle types in the OTS database, in the two sample areas. Note that OTS records pedestrians as active road users in their own right. Consequently the 'vehicle' with which a pedestrian is associated is actually the pedestrian himself, and pedestrian thus becomes a vehicle type, and is represented at vehicle level in the database. This is in contrast to the convention adopted in Stats19, where a pedestrian is associated with the vehicle which struck him, and is only recorded at casualty level. This tends to produce difficulties if, for example, the pedestrian is struck by more than one vehicle, and it can also lead to confusion in coding; for example it is not uncommon for a bus passenger who alights and is then struck by a car to be associated with the bus, not the car, or for a car driver who alights and is struck by an HGV to be associated with his own vehicle, not the HGV. The OTS system should alleviate both these problems.

The slight over-representation of pedestrians in the VSRC area is to be expected, given its predominantly urban nature, and was predicted in Table 2, based on national statistics.

Table A3: Vehicles by vehicle type

Vehicle type	VSRC cases		TRL cases		OTS total cases	
	N	%	N	%	N	%
Car	983	73.6	1086	74.3	2069	74.0
Light goods	47	3.5	78	5.3	125	4.5
Heavy goods	65	4.9	87	6.0	152	5.4
Bus	15	1.1	13	0.9	28	1.0
Motorcycle	62	4.6	80	5.5	142	5.1
Pedal cycle	27	2.0	32	2.2	59	2.1
Pedestrian	76	5.7	43	2.9	119	4.3
Other, not known	60	4.5	43	2.9	103	3.7
Totals	**1335**	**100**	**1462**	**100**	**2797**	**100**

1.6 Humans

Table A4 is based at Human level, and shows the age group distribution for pedestrians and other road users.

Table A4: Humans by road user type and age Ggroup

Age group	VSRC cases		TRL cases		OTS total cases	
	N	%	N	%	N	%
Vehicle occupants						
Adult	969	53.7	614	32.3	1583	42.8
Child (<16)	335	18.6	85	4.5	420	11.3
Age n/k	386	21.4	1105	58.2	1491	40.3
Pedestrians						
Adult	33	1.8	14	0.7	47	1.3
Child (<16)	37	2.1	10	0.5	47	1.3
Age n/k	3	0.2	20	1.1	23	0.6
Road user type not known						
Adult	8	0.4	1	0.1	9	0.2
Child (<16)	30	1.7	0	–	30	0.8
Age n/k	3	0.2	49	2.6	52	1.4
Totals	**1804**	**100**	**1898**	**100**	**3702**	**100**

1.7 Exposure data at motorcycle accident locations

Follow-up video recordings were made at the scene of all motorcycle accidents at the same time of day and, wherever possible, one week after the incident to capture near similar traffic conditions. This procedure matches the OECD RS9 protocol for motorcycle investigations and therefore provides a one-hour long video recording commencing half an hour before the time of the accident. Traffic counts have subsequently been made for 76 incidents, and these are logged ready for analysis. Videos are also logged and available for inspection.

1.8 Injury data

Injury data was requested from hospitals or coroners on a total of 911 injured people involved in the 1519 RTA accidents attended by the two teams (including the 11 VSRC cases later deemed to be incompatible with the study criteria). Full injury data was available for 806 of these (89%). The remaining requests were either untraceable at the hospitals or the victims did not attend hospital. For these people police injury data was used to complete the cases. Table A5 shows the figures for the individual centres.

A total of 2608 questionnaires were sent to injured and uninjured people in the two areas, of which 1215 (46.6%) were completed and returned. Again, Table A5 separates the TRL and VSRC figures. A return rate of 41% (as achieved by VSRC) is comparable to the CCIS return rate for postal questionnaires and is considered slightly higher than the national average for obtaining this type of data, while 53% (achieved by TRL) can be considered an excellent rate of return.

As described earlier, VSRC established a complementary study that would provide anthropometric data on pedestrians involved in the OTS accidents. This study started in June 2001. From that date, 16 requests were made via the QMC Accident and Emergency Department and just over half were successfully processed.

Table A5: Injury, questionnaire and anthropometric data

Source of injury and personal data	VSRC			TRL			Totals		
	Requested	Returned		Requested	Returned		Requested	Returned	
		N	%		N	%		N	%
Hospital/coroner	612	543	88.7	299	263	88.0	911	806	88.5
Questionnaire	1385	563	40.6	1223	652	53.3	2608	1215	46.6
Pedestrian anthropometrics	16	9	56.3	–	–	–	16	9	56.3

2 THE OTS DATABASE

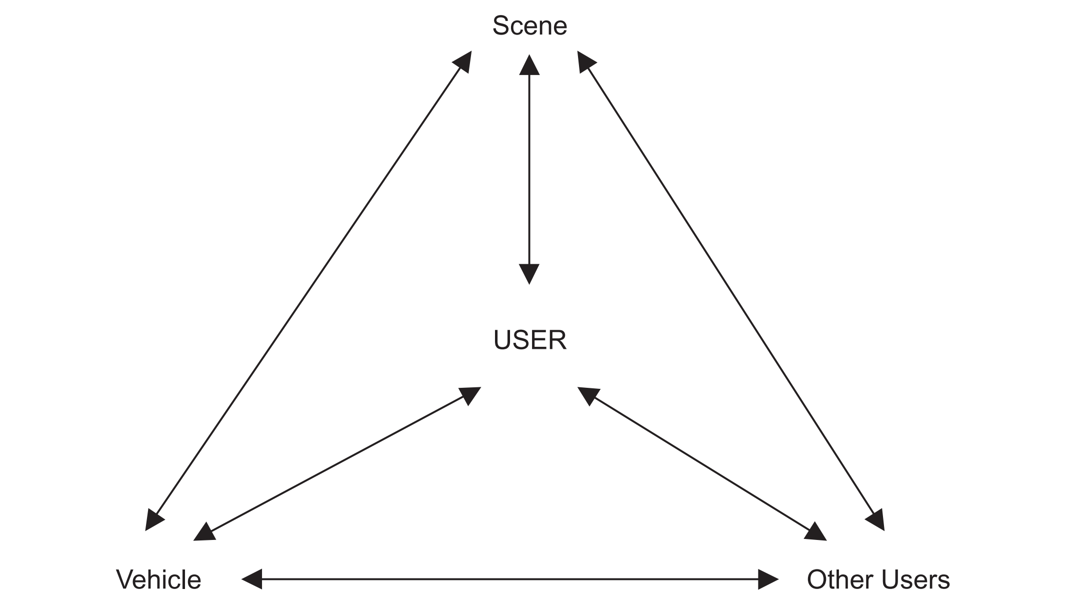
As part of the overall project, TRL was commissioned to produce a database to hold the information collected at the accident scenes. This would be used to hold the information collected by the accident investigators and processed by the support teams. The structure was capable of accepting data from both TRL and VSRC, which would eventually result in a 1,500 record database for research and analysis. This section describes the structure and implementation of the OTS computer database.

2.1 Structure

The operational database was developed using MS Access which allowed the complex data collected from all OTS-investigated road traffic accidents to be recorded in an electronic format. The database contains in excess of 3,000 fields, describing highways, cars, goods vehicles, buses, pedestrians, pedal cycles and motorcycles. Drivers, riders, passengers and their injuries are also described in detail.

The nature of the study required an 'interactive' data structure where all road users, irrespective of class, could be related to one another and their associated crash circumstances (scenes). As such, the database was developed in such a way that each facet of an accident was linked to all other facets of that accident.

Figure A6: The OTS database model



In order to create this database system successfully, the data collection forms had to be harmonised to ensure that the data from the forms was stored at the correct database level.

The storage of data at the correct level is vital to the successful analysis of the data held in the database. The data from the study is 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 data set, the database is structured in a hierarchy of different levels. 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. UK national accident statistics (Stats19) are collected using this structure. For the On the Spot database, these levels are split further to enable more flexible use of the data. The main data levels are Scene, Approach, Vehicle, Human and Injury.

The Scene level contains all the data relating 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.

The Approach 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.

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

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

Unlike the Stats19 database, in which pedestrians are associated with the vehicle that impacted them, the OTS database records pedestrians as active road users in their own right. Consequently the vehicle with which a pedestrian is associated is actually the pedestrian himself, and the pedestrian becomes a vehicle type.

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 collision events (be they impacts or rollovers) as well as having many occupants.

2.2 Interaction codes – cause(s) of the crash

One particular branch of the structure is a new innovation, first used in this database. Each human being who took an active role in the crash is described as having displayed many different interactions with the other road users, their vehicle and their highway environment.

TRL has developed an innovative system for the OTS project to define the cause(s) of the crash. This ‘Interaction’ coding system allows each active road user to be classed by seven different sub-categories. An active road user is defined as anyone who contributes to a crash or is not a passive bystander. Vehicle passengers are rarely contributory. Active road user behaviour could be described as walking into the road or driving the bus that failed to stop at the give-way junction. The sub-categories that comprise each active road users’ ‘interaction codes’ are:

Legal: To the team’s best interpretation, not just related to prosecution (e.g. disobeyed signs or markings or was legally unfit to drive due to alcohol).

Perception: Expecting, looking, planning (e.g. did not look for other vehicle or saw but did not perceive a hazard).

Judgement: Understanding, deciding, acting (e.g. interpreted information incorrectly from a road sign or travelled too close).

Loss of vehicle control: (e.g. due to excessive braking or excessive cornering).

Conflict: Interpersonal communication (e.g. adopted a path conflicting with that of another road user or behaving aggressively towards another).

Attention: (e.g. suffered a distraction due to a mobile phone or was distracted by another road user).

Impairment: (e.g. suffered illness or impairment due to fatigue).

Every active road user is considered against these seven sub-categories and attributed a set of interaction codes describing their actions which contributed towards the cause of the collision. In practice, it was found to be rare for an individual to have more than three codes. A strong feature of the system allows interactions between various active road users to be linked within the database providing an effective way to connect road users and their associated accident information for subsequent analysis.

£17.00
ISSN 1468-9138
Product code 56RRLG02341/59

ISBN 1-904763-60-X
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