Impact

The Journal of the Institute of Traffic Accident Investigators
Spring 2021 Volume 28, No.3

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From the Guest Editor

Following my 2019 brush with the NHS, and even closer contact with a defibrillator, the task of producing the Institute's journal has fallen to other willing volunteers. The Institute now relies upon the good offices of Steve Cash who, after several months of dealing with 'home schooling' and work commitments, is also now contending with the mountain of cardboard boxes that inevitably accompanies a move of house. Understandably, Steve has temporarily had less time available for *'Impact',* and I have been pleased to assist as Guest Editor for this single issue.

You'll see (at pages 21 - 25) that a paper by Dr Richard Lambourn - **'Motorcycle Speeds and Sliding Distances'** - has been reprinted from the Spring 1991 edition of *'Impact'.* Despite the 30 year interval, the content of the paper remains relevant and is a useful reference document for those dealing with motorcycle incidents. During my own working career, I made frequent reference to the data contained within the paper, and seized every opportunity to participate in 'drop and slide' tests on a variety of disused airfields !

When offering to assist with this edition, I niaively hoped that the additional time available to authors as a result of lockdown and furlough schemes might ensure that suitable papers for publication in *'Impact'* would be plentiful. Not so ! For a variety of reasons, technical papers, case studies or test results, from within the membership are hard to come by. On that basis, colleagues are again urged to consider submitting material. You may rest assured that the Editor will be delighted to hear from you, and only too pleased to deal with any queries that you may have.

In the meantime, I'm grateful to those authors who have contributed to this edition, and to those organisations that have agreed to material being reprinted in *'Impact'.*

Tony Foster

The Institute of Traffic Accident Investigators

General information concerning Membership Grades, Fees, Annual Subscriptions and *'Impact'*

The Institute of Traffic Accident Investigators provides a means of communication, education, representation and regulation in the field of traffic accident investigation. Its main aim is to provide a forum for spreading knowledge and enhancing experience amongst those engaged in the discipline.

Further, the Institute seeks to promote a professional approach to traffic accident investigation and, through its rules and discipline procedures, to encourage honesty and integrity.

The current membership represents a wide spectrum of professions, including police officers, researchers, lecturers in higher education, and private practitioners.

Membership of the Institute will be of assistance to anyone wishing to be informed of current developments and thinking in the discipline of traffic accident investigation, in addition to those in a career where the use and understanding of the principles of accident investigation are required.

The Institute is not a police organisation, nor is it a trade union or political pressure group.

Membership Grades

There are 5 grades of membership - (i) Student (in full time education), (ii) Affiliate, (iii) Associate, (iv) Member and (v) Retired. Membership at any level is restricted to individuals. There is no corporate membership.

Affiliate membership is open to anyone who has an interest in the field of traffic accident investigation and the Institute will accept direct membership applications to the various grades. Associate and Member status will be granted by the Grades Assessment Panel subject to the meeting of specific criteria, further details of which can be obtained from the Institute's website **www.itai.org**

A full Member of the Institute is permitted to use the letters MITAI. Similarly, an Associate is permitted to use the letters AMITAI.

Student, Affiliate or Retired members may refer to their membership in any curriculum vitae or the like, but it must be clearly understood that those levels of membership are not to be regarded as any form of qualification.

Fees and Subscriptions

Currently there is a non-returnable registration fee of £15 on first application for grades of Affiliate, Associate and Member. Those registering as Student members are not charged a fee. There is a £60 administration and assessment fee in respect of application for full Member or Associate membership.

(i) Student annual subscription is £20
(ii) Affiliate annual subscription is £50
(iii) Associate annual subscription is £60
(iv) Full Member annual subscription is £70
(v) Retired member annual subscription is £20

The subscription payable on first application is calculated on a quarterly basis.

Impact (The Institute's journal)

'Impact' (in hard copy or electronic form) is distributed free of charge to all members three times each year. Non-members are able to subscribe by application to the Institute's Administration Department, or by making the appropriate payment at the Institute's on-line shop - (see details set out below). Back issues of *'Impact'* can also be purchased via the Institute's Administration Department or on-line shop.

Letters to the Editor are welcomed. Opinions expressed in letters and articles within *'Impact'* do not necessarily reflect those of the Editorial Board or the Institute.

Visit the Institute's website at www.itai.org

'Impact' subscription, and all other enquiries should be addressed to

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Certificate of Professional Competence In Forensic Collision Investigation

James Keenan : Chairman of ITAI

Introduction

As we are all aware, the world continues to change, and what was acceptable yesterday may not be considered suitable today. The Institute understands its responsibilities to maintaining the highest standard from our members, and the importance of developing processes which will ensure we can demonstrate the level of credibility which will be the 'Gold Standard' for our specialised area of Forensic Engineering.

As an Institute we welcome the introduction of a degree based standard for Collision Investigators as this increases the academic level for the profession, notwithstanding the practical experience of the older members.

The credibility of experts giving evidence in the Criminal and Civil Courts is a matter which has been brought to the attention of the Forensic Science Regulator, and this affects us as members of the Institute of Traffic Accident Investigators, as well as all other interested bodies. The Institute, as the only organisation which is dedicated to the furtherance of Road Traffic Accident Investigation has put into place a revised regime, which will ensure that Full Members of the Institute are regularly peer group reviewed and can maintain the highest standard of expertise in our specialist field. As the only body which has the capability to peer group review and maintain standards the Institute has a responsibility to be the leader in the continual development of our profession.

I am pleased to announce that, following various pilot studies, The Institute of Traffic Accident Investigators (ITAI) is launching its Certificate of Professional Competence [CPC] in Forensic Collision Investigation. This is not open to corporate bodies and is available only to individuals.

Initially, ITAI had planned to entitle this process as, 'Accreditation in Forensic Collision Investigation', however, after taking advice it was decided that this may have caused confusion with that being afforded by UKAS. After careful consideration ITAI Council decided to name our process: '*Certificate of Professional Competence in Forensic Collision Investigation'* and the full document can be found on the ITAI members' website.

That document sets out qualification and experience requirements for applicants and supplies a protocol for a subsequent assessment process leading to an independent and impartial CPC in Forensic Collision Investigation. It should be read in conjunction with the *"Membership Grades Assessment Procedure"* which provides a description of the various grades of membership available to individuals, together with qualifying requirements, a copy can be found on the ITAI members' website.

ITAI, with its partners, also offers a route to professional registration with the Engineering Council.

In addition to grades of membership and professional registration, ITAI will accredit its Full Members, who are engaged in forensic roles and who meet ITAI's protocol, with a Certificate of Professional Competence in Forensic Collision Investigation [CPC FCI].

The purpose of this process is to recognise, accept and approve an individual working in a forensic capacity beyond that inferred by Full Membership of ITAI. It is a recognition by ITAI of an individual's ability and currency in the field of collision investigation.

This is a three-part assessment process, the first part being acceptance as a Full Member of the Institute, and will examine an individual's expertise and competence when attending collision scenes to collect the available evidence, and thereafter to report on his or her findings in a written document and present evidence before a panel / court.

The award of this CPC provides a continued level of confidence in an individual Collision Investigator when he or she offers a forensic service to the Criminal Justice System or in a Civil Litigation or Tribunal Hearing.

Authority

The International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC) have produced standards pertaining to crime scene investigations :

- ISO/IEC 17020 is entitled "*Conformity Assessment – Requirements for the Operation of Various Types of Bodies Performing Inspection*".

- ISO/IEC 17025 is entitled *"General Requirements for the Competence of Testing and Calibration Laboratories"*.

Whilst the ISO/IEC standards relate to accreditation processes undertaken by bodies and laboratories when analysing evidence, they do not specify an accreditation process for individuals working within an accredited organisation [(1)]. Some disciplines, particularly those that have a forensic science element but are primarily non-forensic science, have professional bodies which may accredit practitioners [(2)]. We believe ITAI is just such a professional body.

It is on these principles that ITAI has developed an independent and impartial process that is designed to accredit individuals who practice collision investigation and reconstruction in a forensic setting and who meet ITAI's protocol. It is not designed for bodies or laboratories.

Assessment Process

The assessment process is a three-part program: Units A, B and C.

Assessment Unit A requires that the candidate be a 'Full' Member of ITAI. The process for becoming a Full Member is documented in the *"Membership Grades Assessment Procedure"*.

An application for 'Full' membership may be considered by The Institute simultaneously with an application for this CPC. It is intended that duplication of effort in instances of simultaneous applications for Full membership and CPC is avoided thereby streamlining the process wherever possible. Such streamlining will not, however, diminish the stringency of either process.

Units B and C assessments shall take place only after recommendation of the Grades Assessment Team that the applicant be awarded 'Full' membership.

Assessment Unit B relates to accident/collision scene work. Candidates will be invited to attend a location within the UK, chosen by ITAI, where they will be asked to evaluate either :

(i) one or more staged collision scenes
(ii) one or more virtual reality (VR) simulated collision scenes
(iii) be provided with plans and photographs of one or more collision scenes

and be assessed against the criteria as shown in Appendix 3 of the CPC document.

During the evaluation, an Assessor will question the Candidate about the scene(s) and on issues listed in Appendix 3. This process will be overseen by an ITAI appointed invigilator / umpire and / or an Internal Quality Assurer [IQA].

Assessment Unit C relates to an examination of an individual's understanding through interview. Candidates will be assessed against the criteria as shown in Appendix 4 of the CPC document.

Candidates invited to participate in Unit C of this process will attend an interview that will be held in the UK at a place nominated by ITAI. This could be a face-to-face meeting or via video conferencing.

The Interview Panel or Board will consist of 2 Assessors and they will interview each Candidate for a period not exceeding one hour to determine the extent and depth of knowledge of the candidate.

The case file submitted by the Candidate in support of the application will be available to the Panel, who will have already read the file. The file should cover a case which has been found to show novelty or required research from the Candidate. The Candidate will be invited to talk through his or her investigations and reconstructions. Thereafter, the Panel may ask questions to determine the Candidate's depth of knowledge on subjects associated with and peripheral to the report.

Additionally, prior to, but on the same day as the interview, the Candidate will be provided with an archive case file and will be asked to comment, in general terms, on :

(a) The procedure to be followed during a site / locus examination ; and

(b) The way he or she would address the forensic analysis of the evidence avail able ; and how he or she would pro pose to investigate the causation of the incident.

A general discussion will follow to probe into the Candidate's knowledge on aspects of reconstruction that have not been covered in the first 2 stages above.

Outcomes

Upon completion of the Units B and C assessments, the Assessors involved will discuss the assessment and reach a decision. The Interview Panel shall recommend to the Council of Management either that:

(a) certification is granted ; or

(b) the application is declined.

The Candidate will be notified of the decision within 5 working days of the interview date.

Where an application for CPC is successful, ITAI shall accredit the Candidate with a Certificate of Professional Competence in Forensic Collision Investigation and the applicant may use the post-nominals 'MITAI (CPC FCI)', or shortened to CPC, with immediate effect. In this context, FCI is an abbreviation of Forensic Collision Investigation.

Successful applicants' names and membership numbers will be shown on the Institute's website, unless the applicant specifically requests otherwise.

A CPC will expire on the 4th anniversary of the date printed on the member's CPC certificate. However, to maintain uninterrupted CPC accreditation, the member must re-pass both the 'scene evaluation' and the 'interview' parts of the competence process during the fourth year of their certification. The onus is on the member to apply for assessment in sufficient time to prevent their CPC accreditation expiring.

Assessment Team

The assessment of applicants for this CPC will be conducted by the 'Assessment Team' on behalf of the Council of Management.

The team will comprise one or more Assessors who are each Members of ITAI (MITAI) who hold a Level 3 Certificate in Assessing Vocational Achievement (CAVA) and will also include one or more Internal Quality Assurers [IQAs] who hold a Level 4 Award in Internal Quality Assessment Vocational Achievement. They shall be appointed by the Council of Management.

Exemptions

Existing 'Full' Members of ITAI will be accredited with Unit A of this protocol.

Candidates who have been granted professional registration with Engineering Council via ITAI and its partners within the preceding three years to application for CPC shall be exempt from Units A and C of this protocol. The qualifications providing this exemption are : Engineering Technician (EngTech), Incorporated Engineer (IEng) and Chartered Engineer (CEng).

However, on renewal of their CPC, all Candidates will have to complete Units B and C.

Fees

The following are the current fees that Candidates for CPC will incur :

Unit A – Transfer to Full membership	£60.00
Unit B – Scene evaluation	£200.00
Unit C – Interview	£100.00
Renewal in the 4th year of certification Units B and C	£300.00

References

(1) Paragraph 79, House of Lords Science and Technology Select Committee published report "Forensic science and the criminal justice system: a blueprint for change".

(2) Paragraph 92, House of Lords Science and Technology Select Committee published report "Forensic science and the criminal justice system: a blueprint for change".

James Keenan
Chairman

January 2021

Impact

Submissions invited

Next Edition Summer 2021

As ever, the Editor would be very pleased to hear from members, non-members or subscribers, who have produced material that they feel would be of interest to readers of *'Impact'*. Details of research projects or relevant collision investigation testing would be particularly welcome. Attracting sufficient numbers of articles for publication in the Institute's journal remains a difficulty ! Whilst the Editor is delighted to receive papers from overseas contributors, a greater supply of 'home grown' material would also be very welcome.

If you have any questions regarding the publication of an article / paper, or simply wish to discuss the possibility of preparing a piece for the journal, please contact Steve Cash, at **editor@itai.org**

Drink Driving as the Commonest Drug Driving -
A Perspective from Europe

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Editor's Note : This article is reprinted from the International Journal of Environmental Research and Public Health - an Open Access Journal by MDPI : *Int.J.Environ.Res.Public Health 2020, Volume 17, Issue 24, 9521*

Abstract: People mixing driving motor vehicles with consuming alcohol increases deaths and injuries on the roads, as was established irrefutably in the mid-1960s. This commentary discusses how society across Europe has responded since then to this burden by managing drink driving in the interests of road safety. The principal response has been to set, communicate and enforce limits on the level of alcohol in the blood above which it is illegal to drive and to deal in various ways with drivers found to be exceeding the limits. Achieving reduction in drink-related road deaths has benefitted public health, though the aim to change behaviour of drinking drivers has been a challenge to the profession. Other achievements have included changes in public attitude to drink driving, and reduction in reoffending by convicted offenders through rehabilitation courses and use of the alcohol interlock, which prevents starting of a vehicle by a driver who has drunk too much. There is scope for improved recording of road deaths identified as drink-related, greater understanding of effectiveness in enforcement of the legal limit and improved availability of the alcohol interlock.

Relevance of experience with drink driving to management of other drug driving and prospects for building on the achievements so far are discussed.

Keywords : drink-driving ; social acceptability ; blood alcohol concentration (BAC) ; risk of collision ; legal BAC limit ; enforcement ; penalties ; rehabilitation ; alcohol interlock ; drug driving

1. Introduction

Across Europe, about 50 people each year per million population are killed in road traffic and about five times as many are seriously injured [1], consumption of alcohol is high by global standards [2], and a widely quoted estimate [3] is that about a quarter of the road deaths are related to drink driving.

The more than half a century since evidence from the USA [4] made it irrefutable that drink driving increases the number of road deaths has been a time of growing cohesion among many European countries. So it is interesting to look back on how efforts to manage drink driving have evolved across Europe, take stock of what has been achieved and consider what more might be done. The aim of this commentary is to do just that in respect of legislation, regulation, public information, enforcement, and dealing with convicted drink driving offenders. Drink driving is as much an issue for public health as for traffic law, and so work by health professionals in addressing social, behavioural and medical challenges related to drink driving warrants a counterpart commentary.

In contributing to worldwide efforts to reduce the burden upon individuals and society of premature death and life-changing injury on the roads, our concerns about driver behaviour are often focused upon just how drivers are dealing with the risks that they are encountering minute by minute as they drive. However, when we address the issues of drink driving and other kinds of drug driving our concern about driver behaviour extends backwards in time for some hours, and in the case of heavy drinking many hours, before the driver has taken to the road. In this extended concern we face the challenge of a conflict in terms of road safety between two deep-seated sources of satisfaction and risk in modern life: driving motor vehicles and consuming alcohol or other recreational drugs.

This commentary is based substantially on the author's involvement in addressing this challenge, beginning with his role in interpreting the game-changing data from the USA in 1964–1965 [5] and continuing until his sharing in pan-European work on drink driving in this century through the European Transport Safety Council (ETSC). It builds upon the European Transport Safety Lecture he gave in October 2016, which is accessible online as part of a videorecording of an event [6] but has not previously appeared in print or as a Powerpoint presentation. The commentary provides only selected references, but readers who seek more comprehensive coverage of the literature can find it in the reports cited here from the ETSC over the last decade drawing upon widespread European expertise including that of the author.

The commentary begins by demarcating the specific challenge of drink driving within the much wider challenge of alcohol in society and goes on to cite leading examples of work to quantify the effects of alcohol on drivers' risk of involvement in collisions and thus on the general level of risk to road users. It then describes regulation of drink driving by setting a legal limit to the level of alcohol in the blood while driving: the setting of the limit, its communication to those required to comply with it and its enforcement in order to deter and detect driving while over the limit. It goes on to deal with the treatment of convicted drink driving offenders, including the gradually growing role in Europe of the alcohol interlock in reducing reoffending. Comments on the relevance of this approach to drink driving to managing other forms of drug driving are offered. Concluding sections discuss progress that has been made in addressing the challenge of drink driving, and steps in research and practice that offer the prospect of further progress.

2. Alcohol in Society and in Driving

Alcohol can provide pleasure and relief in ways that many people find helpful in enjoying and coping with life, but its use can also cause harm and suffering to users, their associates and society more widely. It does so with a scope and severity that gives rise to far-reaching responses in terms of information, regulation and mitigation that are ongoing subjects of debate and sometimes controversy.

This is the wider context in which the specific issue of drink driving and its management is set, and those concerned with drink driving are wise to be aware of and ready to learn from the wider context, but at the same time to keep their efforts focused on reducing that part of the burden of death injury and damage on the roads that would be prevented if drivers drank less before driving or drove less after drinking.

Well before the motor age, being drunk in charge of a vehicle was recognised as being undesirable and made an offence, but research demonstrating the effects on capability of even modest quantities of alcohol also began before the motor age. So by 1960 evidence of adverse effects of modest levels of alcohol upon capability to drive was clear [7] and by this token many drink drivers are far from being drunk. The offence of being drunk in charge of a vehicle, which was in any case hard to enforce, was seen to have only limited relevance to much of drink driving. Scandinavian countries had long experience of having instead set limits to the level of alcohol in the blood at which it was legal to drive, but direct evidence of the effect of modest levels of alcohol on involvement in collisions, and thus on numbers killed or injured and amounts of damage, was still very limited. In the absence of evidence this effect was vigorously debated.

That situation was changed decisively by publication in 1964 [4] of findings of an extensive case-control field study in Grand Rapids, MI, USA, in 1962–1963, soon to be further analysed by the author [5]. These findings were confirmed and refined by a repeat study in Fort Lauderdale, FL, and Long Beach, CA, USA, in 1997–1999 [8]: helped by statistical techniques that had not yet been devised in the mid -1960s, this yielded the graph in Figure 1. This shows how the risk of involvement in a collision, however slight, relative to the risk without alcohol, was estimated to vary with level of alcohol in the blood, measured in g/L, among the populations driving in these cities.

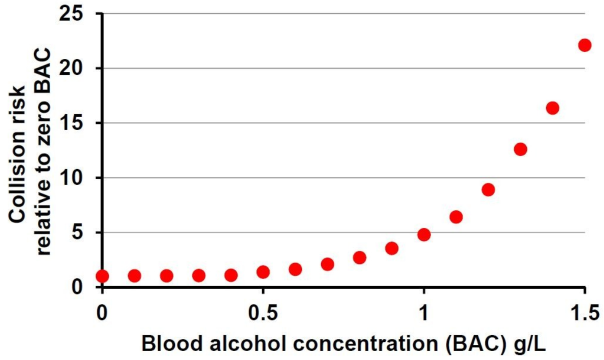

Figure 1. Variation in the risk of involvement in a collision, however slight, with level of alcohol in the blood as estimated in a repeat of the Grand Rapids study by Compton et al. [8].

The strength of evidence from the Grand Rapids study of risk nearly doubling by 0.8–1.0g/L and rising rapidly thereafter proved decisive in influencing North America and much of Europe within a few years to follow the longstanding example of Scandinavian countries in setting limits to the level of alcohol in the blood at which it was legal to drive. Many of the limits set at that time were either 1.0 or 0.8 g/L, and 0.8 g/L is even now the limit in much of North America and the UK.

However, Figure 1 massively understates the harm done by drink driving. It is dominated by variation in the risk of involvement in the large proportion of collisions that result in no more than material damage or minor injury, whereas the currently widely accepted "Safe System" approach [9] to reduction of risk on the road concentrates on reducing the number of collisions resulting in death or life-changing injury. Neither the Grand Rapids nor the Fort Lauderdale and Long Beach studies tried to analyse variation of risk with blood alcohol concentration (BAC) according to severity of collision, and had they done so the numbers of fatal collisions even in their large samples would have been too few to enable the variation with BAC of risk of involvement in a fatal collision to be estimated reliably. This had to await much larger scale assembly of data concerning BACs of drivers in general and of those involved in fatal collisions.

Data of these kinds for Great Britain and the USA enabled analyses leading to the estimates shown in Figure 2 of the variation with BAC of the risk of involvement in a fatal collision. Findings like these in various countries indicate that the risk of involvement in a fatal collision is about doubled at a BAC of 0.3 g/L and multiplied by 5 at 0.5 g/L and by 10 at 0.8 g/L. It is numbers like these that should inform response to the challenge of drink driving, taken with information about how many lives are being lost and life-changing injuries are taking place in collisions occurring at various levels of BAC. Indeed they have contributed to the widespread adoption of limits lower than 0.8 g/L and by 2012 most countries, of what is now the European Union, had a limit of 0.5 g/L, many of them with lower limits for commercial or novice drivers, and with one exception the others had limits of 0.2 g/L or zero [10], the latter being a doubtfully enforced survivor of erstwhile Soviet influence. However, arguments are still being advanced for more public education, stricter enforcement, and further reduction of limits, supported by estimates that numbers of road deaths that are related to drink driving remain large. An estimate quoted widely in Europe is that up to 25% of road deaths in the European Union are so related, which stems from an extensive study for the European Commission in 2014 of drink driving in Europe which concluded that 20 to 28 % of all road deaths in the European Union in 2012 could be attributed to drink driving [3].

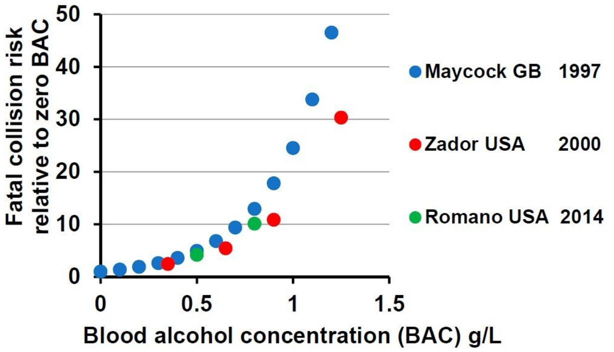

Figure 2. Variation in the risk of involvement in a fatal collision with level of alcohol in the blood as estimated by Maycock [11], Zador et al. [12] and Romano et al. [13].

Ways of counting life-changing injuries on the roads that are comparable among countries have yet to be agreed. Doing the same for the deaths also has its difficulties, but European countries publish numbers of road deaths that are widely treated as comparable. These countries vary in the coverage of measurements of the BACs of drivers and other road users involved in fatal collisions, but this has not prevented countries from estimating how many of the deaths on their roads each year are "drink-related". A starting point for achieving comparability among these estimates would be an agreed definition of a drink-related road death. An important step was made by the European research programme SafetyNet [14], which proposed a performance index implying the definition : -
death from a collision where any driver, rider, or pedestrian involved has a BAC above the legal limit.

This definition has had widespread influence upon practice in European countries but has three serious shortcomings: the legal limit differs among jurisdictions, application of the definition requires more breath-testing in the immediate aftermath of collisions than is in some countries practicable or affordable, and the deaths that would have been less likely to occur if the relevant road users had drunk less are not confined to incidents where the legal limit has been exceeded. For example, the author has estimated [15] that in England and Wales in recent years for every four deaths recorded in collisions where the limit of 0.8 g/L has been exceeded there has been in addition one death in a collision involving a drink-driver without the limit being exceeded.

It seems important to look for a definition which is independent of the legal limit, is widely applicable and includes all deaths that might have been avoided if the relevant road users had drunk less.

Lack of such a definition and thus of comparability among numbers of road deaths recorded as drink-related in different European countries presented a challenge to the ETSC in the programme PIN [16] which since 2006 has been ranking road safety performance in countries across the European Union and some neighbouring countries. This challenge was addressed in respect of progress in tackling drink driving in the first annual PIN report [17] under the author's leadership by noting that although differences in recording of deaths as drink-related prevented direct comparison among the resulting numbers for different countries, it did not prevent comparison among the rates of change in these numbers over a period of years during which the criteria for designating a death as drinkrelated remained unchanged in each of the countries being compared. This comparison was made by estimating by log-linear regression for each country the average annual percentage change in the annual number of (a) road deaths recorded as drink-related and (b) other road deaths, and then ranking countries for progress in tackling drink driving according to the difference between the changes (a) and (b) - thus allowing for the fact that many measures taken to reduce road deaths in general also reduce drink-related deaths regardless of performance in tackling drink driving itself. This procedure was first carried out [17] for 20 countries over 9 years ending in 2005 and has been repeated with small refinements every few years, most recently for 23 countries over 9 years ending in 2018 [18] during which the definitions of a drink-related road death had remained as in Table 5 of [18]. The result is shown in Figure 3.

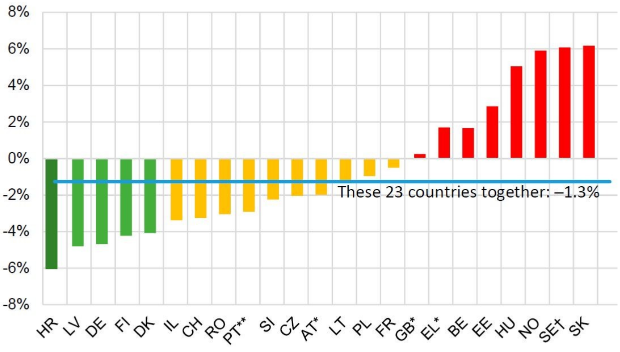

Figure 3. reproduced with permission from the European Transport Safety Council. Difference between the average annual percentage change in the number of drink-related road deaths and the corresponding change for other road deaths over the period 2010–2018 in 23 countries [18]. A negative difference indicates faster reduction in drink-related deaths. * 2010–2017; ** 2010–2015; † driver deaths only; Key to country codes: HR—Serbia; LV—Latvia; DE—Germany; FI—Finland; DK—Denmark; IL—Israel; CH—Switzerland; RO—Romania; PT—Portugal; SI—Slovenia; CZ—Czech Republic AT—Austria; LT—Lithuania; PL—Poland; FR—France; GB—Great Britain; EL—Greece; BE—Belgium; EE—Estonia; HU—Hungary; NO—Norway; SE—Sweden; SK—Slovakia.

Each time this procedure was carried out it indicated faster reduction in drink-related deaths than in other road deaths in about two-thirds of the countries for which data were available, and an aggregate average reduction per annum in drink-related deaths over the period concerned over all the countries compared that was a percentage point or so greater than the corresponding reduction in other road deaths.

It seems therefore that efforts in Europe to address the challenge of drink driving, which consist mainly of the imposition and enforcement of legal limits on drivers' BAC, associated public education and information and driver rehabilitation measures, are contributing if anything somewhat more than their share to the overall effort to reduce deaths on the roads. Against this background, some aspects of these efforts to reduce drink driving are next discussed.

3. Setting, Communicating and Enforcing Legal Limits on Drivers' BAC

3.1. Setting the Limit

Against the background of the longstanding advice "Don't drink and drive" the setting of a BAC limit above which it is illegal to drive can be seen as a matter of how far a specific law can best contribute to promoting a desired behaviour by a large proportion of the population. The findings from Grand Rapids stimulated a clearer recognition than hitherto that a BAC limit should be able do so, with limits in many countries at first being set at a level that would impinge mainly on a minority who are quite heavy drinkers and on them only when they have been drinking heavily. As such the setting of the limit need not have intruded greatly into the lifestyles of the majority - though its effect in reducing drink-driving may well have been fortuitously enhanced by many law-abiding moderate drinkers' overestimating how close their drinking was bringing them to the legal limit. However, as countries have adopted lower limits these have become more intrusive until the lowest limits affect everyone except total abstainers quite a lot of the time. Nevertheless, where a BAC limit has been lowered, the lower limit has usually remained in force.

In the interests of respect for the law, it is important for a new or amended law to attract widespread compliance and be enforced in ways that maintain respect for it. A country is therefore wise to look for a clear balance of opinion in favour of lowering a BAC limit before doing so, and not to set a limit lower than it is practicable to enforce effectively. There are sound practical reasons why it is hard to enforce a limit lower than 0.2 g/L and these should be borne in mind where a limit of zero or so-called zero tolerance is advocated, but wherever the current limit is higher than 0.2 g/L, scope for reducing it should ideally be reviewed regularly.

3.2. Communicating the Limit

For a law to be effective, it is important for affected citizens to understand what the law requires of them and why. When a new law is imposed or an existing one is being changed, there is an onus on government to communicate this understanding and to encourage its acquisition by the affected citizens by use of appropriate means of public information. Government can be helped in this by relevant organisations who may well reach the ears and eyes of some citizens more readily than do channels of communication usually used by government. In the case of a BAC limit, these include manufacturers and suppliers of alcoholic drinks as well as road user and road safety organisations.

This task of communication is not just a once-for-all exercise at the time a BAC limit is introduced or altered; it is also an ongoing task because the drinking population, drinking culture and the range of available alcoholic drinks are continually evolving. Not only does each year a fresh cohort of young people become eligible to drive and, not necessarily at the same age, become eligible to buy alcoholic drinks, but also changing tastes and fashions in social life are continually altering the prevalence and kinds of social drinking among people of all ages and all kinds. Changes in the marketing of drinks of different kinds contribute to changes in taste and fashion, and also include changes in the alcohol content of familiar drinks in familiar-sized containers that make it advisable for drinkers to reassess how best to keep their BACs within their intended ranges. All this adds up to a continuing requirement for public information to help people who consume alcohol to keep within the BAC limit whenever they are driving over the course of day to day life. In European countries up to several decades of continually updated public information has contributed to very large majorities of their populations' regarding drink-driving as socially unacceptable - not just those who strictly don't drink and drive but also many of those whose approach is more flexible.

Those who interpret the advice "Don't drink and drive" flexibly face the question whether to equip themselves with and learn to use devices for measuring their own BAC. These same drivers also need understanding of how to estimate, after they have finished a session of drinking with a BAC over the limit, how long it will be before they are back within the limit and thus able once again to drive legally. For government, the existence of personal BAC measuring devices raises the questions how to regulate their availability, quality, and reliability and to advise on their use in the face of the dilemma that people with access to such devices may use them mainly to discover just how much they can drink without exceeding the limit.

3.3. Enforcing the Limit

For some laws regulating day to day behaviour, the law-abiding citizen hardly needs to be concerned about how they are enforced unless they are tempted to break them or suspected of breaking them or are unfortunately a victim of their being broken. However, the legal BAC limit is not one of these. It is a matter of life and death for all road users and it is broken daily in public by an appreciable minority of drivers, so a jurisdiction that imposes a BAC limit faces a public expectation of transparency as to what is being done to try to enforce the limit effectively.

The availability of portable evidential breath-testing devices makes extensive roadside breath-testing of drivers a practicable and understandable tool for visible enforcement, but this calls not only for careful definition of the requisite police powers having regard to social justice and civil liberties but also for the allocation policing resources upon which society places many other demands.

Effective enforcement has two distinct but closely related purposes: "deterrence" to discourage breaking of the law and "detection" to enable penalties to be imposed on those who do so and steps to be taken to discourage or prevent them from doing so again. Detection contributes to deterrence through reporting in local media of those who are convicted and the penalties they receive, which confirms both that offenders are being detected in the locality concerned and what levels of penalty are actually being imposed. Deterrence in turn relies upon public perception of a real likelihood that if one drives with a BAC above the limit then one may be detected and face conviction and the relevant penalty.

A principal means of detection is for drivers to be stopped and breath-tested at the roadside and to achieve deterrence for this to be believed to happen in such a way that anyone driving anywhere at any time thinks that it might be about to happen to them. This requires police or other authorised patrols both to have the power to require anyone driving or about to drive to take a test before proceeding with their journey and to be equipped to carry out the test reliably, preferably on the spot. Public acceptance of this power in a free society requires spelling out the circumstances in which the power may be used and how it should be exercised. In particular, it is unlikely to be acceptable for breath-testing to impinge disproportionately on certain kinds of people just because they belong to particular social groups.

Because patrols carrying out breath-tests is resource-intensive in terms of both staff-time and money; however, deployment should be deliberately intelligence-led. The general knowledge that a police force has of its area may well include a good deal of understanding of when and where drink driving is more prevalent or less so, and this understanding can be reinforced if there is a policy for breath-testing as many as is practicable of drivers, riders and pedestrians involved in collisions attended by the police or other authorised patrols. The pattern of occurrence of BACs above, say, 0.2 g/L in collisions gives useful indication not just of where and when drink driving is taking place but of where and when collisions are associated with it. Information of these kinds can contribute strongly to a rational basis for allocating available patrol effort - but it is advisable also to devote a small fraction of effort to patrolling at least likely places and times, so that tests may be seen really to be required anywhere and at any time. Once having decided to test at a particular time and place, it is then important for perception of fairness that the first and then each subsequent driver to be tested is chosen in a randomised way so that each driver who is around at the time has the same chance of being tested, irrespective of, for example, personal appearance or type and condition of vehicle.

Roadside breath testing, implemented in a variety of ways, is used extensively in European countries. Only about half of these keep national records of the level of testing, but for those that do so the ETSC has tried to follow the annual numbers of tests per thousand population since 2010 [19].

These differ widely, ranging from about 10 to about 600. The records also show the percentages of test results above the legal limit, which range from less than 1% to over 10%, with some tendency to be higher where the number of tests is lower. This would be consistent with the smaller numbers of tests being more targeted upon times and places where drink driving is more prevalent, but the correlation is not close. As part of wider international research into the attitudes of road users, car drivers in 20 European countries were asked in 2018 [20], quoted in [18] how likely they thought they were to be checked for drink driving on a typical journey. The proportion replying that they thought the probability was high or very high averaged 22.5% over these 20 countries, ranging from about 10% to over 50%, with little correlation except at the extremes with annual numbers of tests per thousand population across the 10 of these countries for which [19] provides this indicator.

Table 4 of [18] shows that 26 European countries recorded numbers of drink-related deaths on their roads in 2017 or 2018, and comparison of these numbers with their corresponding total numbers of road deaths shows that the proportions of road deaths recorded as drink-related ranged from 1% to about 30%, and most are well below the 25% estimated for the European Commission in 2014 [3].

Such a wide range must stem in part from differences in the recording of drink-related deaths, which is understandable in part because breath-testing of those involved in collisions is resource-intensive and subject to practical difficulties. Differences in definition also contribute to the width of the range but this is from 5% to about 30% even over the 19 of these countries that can be regarded from Table 5 of [18] as working towards the SafetyNet definition. Nor do these percentages show any correlation with the annual numbers of drivers per thousand population checked for drink-driving in the 12 countries for which estimates of both figures are available.

This mixed picture indicates a need for research into the recording of drink-related road deaths and into the implementation and effectiveness of roadside breath-testing as a means of reducing drink driving in European countries. However, detection and drivers' perception of the likelihood of detection are not the only important aspects of enforcement that contribute to deterrence; another is the level of penalties imposed on drivers convicted of exceeding the legal limit.

4. Treatment of Convicted Drink-Driving Offenders

Penalties imposed on convicted drink driving offenders in European countries for the offence of driving or being in charge of a vehicle while over the legal BAC limit range from modest fines or a few penalty points through higher fines and more penalty points to requirement to drive only a vehicle fitted with an alcohol interlock, disqualification, seizure of the vehicle, community service, or in extreme cases imprisonment. The level of penalty can depend on the severity and consequences of the offence and can be augmented if the driver is convicted of other offences such as dangerous driving committed at the same time as exceeding the BAC limit. The penalty can include or be abated by participation in a rehabilitation course or other measures to discourage reoffending.

However, imposition of a penalty upon conviction is only the beginning of treatment of these offenders. They will still be around for the rest of their lives and, except for a tiny minority while they are in prison and a few who choose to give up either drinking or driving, they will still be looking to mix choosing to drink and choosing to drive in their day to day living. In terms of the prospect of reoffending they range from feeling remorse or regret, and thus being open to help not to reoffend, at one end of a spectrum to, at the other end, being so affected by alcohol or by other medical conditions as to justify measures intended to result in their not driving at all.

Towards the first end of this spectrum, rehabilitation courses can help offenders to understand better how alcohol affects their behaviour, including their driving, and how to keep their BAC within the legal limit. In Great Britain, for example, a court convicting a driver for exceeding the limit can, if it thinks fit, offer the offender the opportunity to participate, if they wish, in an approved course, and thus reduce by up to a quarter their period of disqualification, which is a mandatory part of the penalty in Britain. A ten-year trial of this provision in a large national sample of courts in England and Wales estimated a halving of reoffending in the three years following conviction among those who took up the option compared with others offered the option in the same courts who chose not to take it up [21]. A Europe-wide study of rehabilitation courses for drink drivers other than problem drinkers also found a halving of reoffending to be achievable [22].

Towards the other end of the spectrum some European countries have defined a category of "high -risk offender", comprising for example repeat offenders and those found to have driven with a BAC above some very high level or after drinking in combination with use of other recreational drugs.

Such offenders can be subjected to extra requirements compared with first-time offenders convicted for exceeding the limit by less extreme margins - for example requiring satisfactory results of tests indicating how their use of alcohol affects their medical condition before their licence is restored after a period of disqualification.

Among the range of penalties short of imprisonment, disqualification probably has the greatest deterrent effect, at least among those who think in terms of complying with it if they became subject to it. However, disqualification does not prevent driving and for those whose driving would not attract the attention of the police, driving while disqualified may incur little risk of detection. So for those who are prepared to drive while exceeding the BAC limit, disqualification may do little to discourage reoffending. This limitation is addressed by technology in the form of the "alcohol interlock", which for as long as it is fitted to the car most used by the offender and is in working order actually prevents reoffending, at least in the form of the offender driving the fitted car.

5. Alcohol Interlocks and Their Use in Europe

An alcohol interlock fitted to a motor vehicle is a device which enables an intending driver to provide a breath sample, estimates a BAC from the sample and allows the vehicle to be started only if the BAC is below a certain limit. When the vehicle is being driven, the device from time to time indicates to the driver that the engine will be turned off unless a further satisfactory breath sample is provided within a stated time. The driver then has that length of time in which to find a safe place to stop and provide the sample in order to continue their journey. The upshot is that the vehicle can only be used by drivers with a BAC within a limit specified in the device. The device can also keep a record of its use and the BAC levels estimated from the breath samples. Readiness for fitting with the device has hitherto differed among various makes and models of vehicles, but revision in 2019 [23] of the General Safety Regulation concerning type-approval of motor vehicles in the European Union should result in all new vehicles there being similarly ready to equip with alcohol interlocks from early in the 2020s.

There are two main kinds of use for alcohol interlocks: voluntary use, in which the vehicle owner has reason to guard against the vehicle being driven by anyone exceeding some BAC limit and fits the device to achieve this, and mandatory fitting and use in the context of enforcement of a legal BAC limit or of a requirement that vehicles used for a certain purpose be fitted.

Examples of voluntary use are fitting by commercial operators who wish to satisfy themselves, and possibly the public, that their drivers will be within a certain BAC limit, and fitting by a household to a household car where it is known that one or more of the household members may be tempted to drive after drinking too much. Voluntary use is simply a private matter of the owner having the device fitted by a supplier and arranging for its maintenance, learning to use it, and learning to use the record that the device can keep of attempts to provide satisfactory breath samples.

Mandatory fitting includes fitting to the main vehicle used by a convicted drink-driving offender to prevent reoffending in that vehicle for a certain period, or fitting by a commercial operator to a vehicle or fleet of vehicles to enable use for a purpose for which fitting is legally required, such as carriage of children on school journeys. Mandatory fitting is necessarily more complex than just acquiring and maintaining the device. There has to be legislation to make the fitting and use mandatory, as is permitted to countries of the European Union under its Driving Licence Directive. Legislation usually provides for monitoring of use, which in turn generates data whose handling has to meet data protection requirements. Agencies of law enforcement and criminal justice each have their parts to play.

As an addition to the range of penalties available to courts in sentencing, the alcohol interlock offers the advantages over disqualification that it may allow the offender to continue in their occupation and thus support dependents, and it may be more effective in avoiding reoffending, but sentencing to impose use of an interlock requires the cost of fitting and operation to be met. It is advisable for its imposition to be accompanied by rehabilitation measures because research has shown that otherwise its effect on the offender's driving behaviour may well not persist beyond the required period of fitting to the vehicle they mainly use. This use of alcohol interlocks is longstanding in North America, where, for example, deaths in drink-related collisions were found in a study covering 2004–2013 [24] to be about eight per cent fewer in 18 states of the USA that had made interlocks mandatory for convicted drink-drivers than in 32 states without such a requirement. In Europe since the turn of the century experience has been gained gradually as use has become progressively more widespread.

The ETSC has monitored this process, including aspects of effectiveness in reducing reoffending, with the help of case studies from various countries, and has offered guidelines to countries which may be contemplating adopting the alcohol interlock as a penalty [25]. Since 2008 the ETSC has kept track of the process in the form of an "Alcohol Interlock Barometer" which features a map showing stages that European countries have reached in using the alcohol interlock in a website providing a range of relevant information country by country [26].

Figure 4 (below) shows the maps for 2008 and 2015, in which the colour blue indicates countries that had reported no use so far and other colours indicate the stage reached by each country. The differences between these two years exemplify the spreading use of the alcohol interlock, which has since continued.

To complement the Barometer, the ETSC published late in 2020 a detailed inventory [27] of the seven national alcohol interlock programmes for convicted offenders then current in Europe, with information about an eighth just then getting under way and steps towards introduction in three other countries.

Issues that have arisen as various countries with their differing legal and judicial systems have explored the mandatory use of alcohol interlocks have rarely been with the technology as such but have included readiness of the judiciary to make use of alcohol interlocks as part of penalties, relationship of requirement to have an interlock fitted to measures to rehabilitate the offender, the cost of the devices and support systems and who pays (for example how acceptable it is for the choice of penalty available to the court to depend on the means of the offender), and use of data recorded by the devices to provide support to the offender and to inform policy.

6. Relevance of Experience of Managing Drink Driving to Management of other Drug Driving

The challenge presented to road safety by other recreational drugs is similar to that presented by alcohol in that they impair capacity to drive safely so that the sensations that they offer to their users are hard to combine with safely of driving. However, there are many practical differences in management of the challenges. The author has no claim to expertise in relation to other drug driving but offers the following comments.

Widespread use of alcohol is very longstanding and its main forms and sources of supply to consumers are also longstanding and are regulated in ways that are familiar to its users. This was the case before the issue of effects on widespread driving of motor vehicles came to be recognised and provided a familiar background against which the challenge to road safety has been addressed.

Many of the other recreational drugs, in contrast, have come into really widespread use only in recent decades, the ranges of substances concerned and patterns of use are wide and quite rapidly evolving, the possession, supply and use of most of them are subject to strict legislation and channels of supply are strongly influenced by criminal activity.

In terms of managing effects of drink driving on road safety, a lot had already been done to deal with alcohol before the use of other recreational drugs became widespread, and this provides experience that can be drawn upon in managing effects of other drug driving, but in doing so it should be borne in mind that management of drink driving is helped by several circumstances peculiar to alcohol.

Alcohol starts to impair driving soon after it enters the bloodstream, the level of impairment is related in known ways to the BAC level, impairment lasts for as long as there is still appreciable alcohol in the blood but no longer, the BAC level can be estimated reliably and non-invasively by breath-testing, the businesses of producing and supplying alcoholic drinks are highly organised and disposed to help society in mitigating adverse effects like those on road safety, and the range and characteristics of drinks on the market evolve relatively slowly.

In contrast, the range of other recreational drugs and their biochemical properties are evolving rapidly, their producers and distributors are hard to involve in managing drug driving, some of the drugs

Figure 4. reproduced with permission from the European Transport Safety Council. Extent of use of alcohol interlocks in European countries in 2008 and 2015 as reported to the ETSC at the time - colour blue indicates no use reported so far.

remain in the body for much longer than the impairment they cause lasts, and not for all of them is there good understanding of the relationship between their level in the body and the resulting level of impairment or how to detect and measure their presence and whether they are causing impairment at the time. All this makes it more difficult than for alcohol to set, keep up to date, communicate and enforce limits on their presence in the body above which driving can be made illegal.

Nevertheless many European countries have introduced legislation, public information and rehabilitation and health care aimed at addressing drug driving. Alongside the use of recreational drugs these can relate also to medication that affects driving, but whereas for medication it may be practicable to determine medically safe levels of use when driving, this is harder to contemplate, let alone implement, for substances whose possession, supply and use are widely illegal. The ETSC has summarised [28] various approaches being adopted in European countries and ways in which they can be used to help tackle drug driving in the context of other underlying issues related to drug use.

7. Discussion

European countries are in their fifth decade of managing drink driving in ways that focus on reducing that part of the burden of death injury and damage on the roads that would be prevented if drivers drank less before driving or drove less after drinking. They have come to be doing this mainly by imposing, enforcing, and tending to lower legal limits on drivers' BAC, with associated ongoing public education and information and driver rehabilitation measures. These efforts are associated with contributing if anything somewhat more than their share in recent years to the overall reduction in deaths on the roads of Europe, and in terms of public attitude, a large majority of people now regard drink driving as socially unacceptable. The latter is a substantial and valuable shift from the days before BAC limits when those opposed to them could argue that people drove better after a few drinks.

However, the signs are that up to about a quarter of road deaths are still drink-related, which taken with the changing nature of drinking culture and in the driving population whose behaviour needs to be influenced means that work remains to be done.

One starting point is to characterise the driving population as comprising two broad groups : those who largely succeed in living by an intention to follow strictly the by now classic advice, "Don't drink and drive", and those who more flexibly mix their choosing to drive with their choosing to drink alcohol. Those in the first group rarely have a collision that might not have happened if they had drunk less so almost all drink-related collisions involve drivers in the second group. Some drivers may move from one group to the other over their life-cycles, and if the first group grows as a result, then road safety should benefit, but it makes sense to suppose that most of the second group will go on as they are. Moreover, the majority of the population who regard drink driving as socially unacceptable is so large that it must include many of this second group, who can thus be supposed to share the widespread understanding that driving after drinking is risky and to wish to keep this risk down.

These drivers need help to make choices that reduce or at least moderate their drink driving and at the very least to comply with the legal BAC limit - help through information and encouragement, and if they are convicted for a detected lapse, through rehabilitation as part of or alongside the penalty the law requires. There remain a minority of the second group who seem to share neither the widespread view that drink driving is socially unacceptable and risky nor respect for the law, and to be ready to drive with high or very high BACs and do so again after being convicted and penalised for the offence.

As indicated for example in a recent report taking stock of management of drink driving in the UK [29], the interests of road safety call for such drivers to be supported in changing their harmful behaviour where there are medical or psychological reasons for it, or otherwise to be persuaded to change it.

Failure to achieve such change leads to a requirement for them to be legally restrained from driving. A jurisdiction reviewing drink driving legislation for its own people having their own variant of these characteristics, even though well informed about experience across Europe, may well find itself lacking in relevant knowledge. In one respect, namely whether enough of its people are ready for a BAC limit to be imposed or an existing limit higher than 0.2 g/L to be reduced, they can find out by commissioning competent surveys of opinion. However, in other important respects, European experience does not yet provide the knowledge the jurisdiction would like to have to guide it.

The jurisdiction would like to estimate how much harm drink driving is causing in its territory through drink-related collisions and how much this could be reduced by legislative measures that it is contemplating, but there is as yet no comprehensive definition of drink-related collisions for this purpose - no definition which is independent of the legal limit, is widely applicable and includes all collisions that might have been avoided if the relevant road users had drunk less. There is a body of evidence about the proportion of those collisions occurring at a certain BAC level that would be prevented if the

BAC level were reduced by a certain amount, but evidence is lacking about the reductions in drivers' BAC levels that would result from particular legislative measures being imposed.

Likewise in terms of enforcement of BAC limits by roadside breath-testing, evidence is lacking about how much drink driving in an area can be reduced typically by a certain expenditure on breath-testing or how best to deploy those resources to maximise the achieved reduction in drink driving.

8. Conclusions

To build upon Europe's half century of progress in managing drink driving thus requires further advances in both research and practice. Better measurement of the burden of road casualties stemming from drink driving requires research into the identification and recording of drink-related collisions.

More effective enforcement of drink driving law requires research into drivers' response in terms of drinking and driving to the deployment of various measures to discourage them from drink-driving or at least to reduce the BACs at which they drive. The latter research would best be embarked upon not with the expectation of finding tidy numerical answers to questions that can be formulated only in rather imprecise terms, but in search of soundly based broad indications to which those making and implementing legislation could look for guidance.

In terms of practice, research in these challenging areas should in no way delay continual sharing of and learning from experience in the strategy, tactics, and operational practice of balancing deterrence and detection in enforcement of drink driving law, in communication of the law to drinkers as their tastes and habits and the range of drinks available to them evolve, and in the use of alcohol interlocks as a penalty accompanied by rehabilitation measures. Nor should there be delay to available steps to make the vehicle fleet simpler to fit with alcohol interlocks when they are needed or to make their fitting and use less expensive, so that they become more readily available to courts for use in sentencing and to voluntary users. There may also be a role for driver assistance devices that can detect inattention reliably and induce an affected driver to take a break. In relation to reducing harmful driving behaviour, there is scope for more supportive trained help enabling people with alcohol problems or other behaviour-influencing health issues to live safely with these. In ways like these and with due determination there is good reason to look for further reduction in drink-related deaths and injury on the roads of Europe.

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Richard Allsop OBE DSc FREng is Emeritus Professor of Transport Studies at the University College London, having been a Professor since 1976 in what is now the Centre for Transport Studies. After graduating in Mathematics from Cambridge, he joined the Road Research Laboratory, now TRL, where his first main task in 1964 was to interpret for Britain the results of the US Grand Rapids study of alcohol and collision involvement – a topic in which he has been active ever since. He has contributed widely to transport research, training and advisory work, including safety research and its application, with leading roles in PACTS and ETSC over the last two decades.

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Crash Test Day 2021 Postponed

Members are reminded that, due to Covid-19 restrictions and general concerns, a decision has been taken to postpone this year's event scheduled to take place in June at Darley Moor Racing Circuit.

Discussions are already under way to ensure that the re-arranged event can be held in the summer of 2022. Further information will be circulated to members as soon as it becomes available.

Quality, cultures and the FCIN

Frances Senior
Head of the Forensic Collision Investigation Network

If you'd asked me 12 plus years ago how I felt about the implementation of Quality Standards into my world of Crime Scene Investigation, I would probably have complained about the significant increase in the level of bureaucracy and how that was getting in the way of doing the job and of doing a good job. I would have protested about the increase in time needed to recover evidence from crime scenes and proclaimed that it would make no real difference in bringing offenders to justice.

No one likes to admit being wrong, but I was wrong. At that time I was tasked with writing the Crime Scene standard operating procedures (SOPs) in readiness for ISO 9001 assessments and I was an ardent sceptic, trying to get the task I had been set completed, so I could get back to my proper job, whilst doubting the benefit of ISO at all.

ISO preparation work took me away from the operational roles I loved into a project post for more than 6 months to write procedure after procedure, qualify as an auditor and embed quality into CSI. It was no easy task and I often struggled with the process and interpretation of the standard and how it would be applied 'into the real world'.

In addition to my often-unintentional recalcitrance, I was up against a groundswell of resistance from peers, staff, and wider colleagues, who frankly didn't understand forensic regulation either or what it meant to be certified/accredited. That did nothing to boost my belief in ISO.

As I reflect on that period, from the position I stand in now where I am totally converted to the regulation of Forensic Science and the importance of achieving and maintaining ISO accreditation, I surprise myself at how my stance has completely changed and it makes me question when the tipping point came and what the blockage actually was in the first place.

I think the answer was simple. It was a matter of culture.

When I talk about 'culture' I am referring to both the organisational culture in which I worked and of my personal cognitive dissonance. Being told how to do a job after years of doing it can lead to perception that you are being told the work you have done is not good enough. It can feel like the science you are undertaking has not been robust enough, that it does not conform to standards or scientific norms, that despite being very experienced, qualified and dedicated examiners you need to be assessed to see if you are actually competent. These can be very difficult concepts to rationalise and accept.

Yet the dichotomy of uncomfortable and often resentful feelings about what quality meant in my own job, was at odds with what I expected everywhere else. Examples of this being when you consider what quality standards means to you as a consumer, or a customer. Would you take your family by the hand down the travellator to board an Airbus A380 for a long-distance flight, if you thought there was a chance that the aircraft was lacking a service record, the cabin crew had never trained in emergency evacuations (after all they are hardly ever used) or that the pilot had not been robustly and regularly tested for their competency ? Would you be comfortable having a boiler fitted into your home, that did not have a safety standard stamp, or associated paperwork to show that it was only approved for domestic use following extensive efficiency and safety testing ? Would you want surgery, where the surgeon preferred their trusty old implements and techniques mastered during their medical degree, long since superseded by tools and new techniques designed for the particular task at hand but no-one dared question them ?

Of course not, none of us would accept that, it seems preposterous to even contemplate it. So why as a community, has there been any question that achieving and maintaining forensic regulation and ISO accreditation, is a good thing to do ?

There is no doubt in my mind, from working with forensic practitioners in every discipline over the years, that we are all hugely proud of our impartiality, expertise, devotion to the truth and professionalism. We all understand that our duty is to the court and that we act with the very best intentions at all times. But we also need to accept that best intentions just aren't good enough in isolation.

I have always been a big advocate of systems thinking – of looking at the whole system and in truly understanding the impacts on any given element of it when one small part changes or no longer performs as expected. As I have grown to truly understand the profession of forensic collision investigation and as the Head of the Forensic Collision Investigation Network, I remain convinced of the benefits of a systems thinking approach.

Implementation of quality standards within collision investigation whilst very challenging, has been a great opportunity to pause and look at the systems and processes that underpin the profession, to ensure the continual optimisation of them. By defining the system (such as by writing SOPs), testing the component parts (as in validation and verification) and learning from the outcomes we have been given the greatest opportunity to identify the weak points, work through the bottlenecks and blockages and have a system that truly encourages growth, improvement, reliability and quality. The inculcation of quality within the system will reward us with the greatest opportunities to learn, develop, improve and ultimately prevent deaths and serious injuries upon our roads.

As forensic practitioners we should not fear, or question scrutiny being paid to the work that we do or to our ability to undertake it. We should welcome the opportunity to prove that not only are we trained, qualified and experienced within our disciplines, but that we are competent to undertake the series of well tested and defined procedures and processes that make up the system. We should all take comfort in the knowledge that as part of such a system, there are safety blankets everywhere, ready to catch any error or oversight before it is propagated further down the line into wrongful outcomes or even worse, wrongful convictions.

The FCIN has been designed with a focus on quality as the culture running throughout the entire system. It might not be our mission statement, but quality by its very virtue is the code of our organisational DNA.

As we have built the network, we have worked hard to get it right, but have never feared getting it wrong. We have been open to trying new methods, technologies and approaches, of writing SOPs and getting them wrong, publishing them to the wider community for critique and ideas. We have carried out validation testing in particularly complex environments, only to learn something new part way through that sent us back to the board room for more head scratching and debate. At times this has been an uncomfortable path to tread, after all as a public body, we cannot waste taxpayer's money and we have an obligation to deliver best value, but we have also accepted that failure often drives innovation and that some of the very best learning is derived from not getting it right the first time, or many times come to that.

The FCIN which is a new organisation within Policing, is responsible for defining, testing and delivering the quality standards that will apply to every FCI in England and Wales. All 43 Police Forces have entrusted the FCIN to deliver quality standards on their behalf and ensure that every FCI Base (FCIB) in the network, is compliant within the deadlines set by the Forensic Science Regulator. This is a large undertaking, with 46 bases, 350+ FCIs and different service levels and working practices to co-ordinate and homogenise.

The FCIN structure comprises of a small team of 22 professional FCIs and forensic practitioners; Regional Managers and Regional Technical Managers, along with a Quality Management Team and leadership team. Currently the focus is on finishing the science underpinning our initial scope, with another 4 extensions to scope planned over coming years.

The level of validation testing that has been undertaken to date has been extensive, requiring thousands of staff hours, hundreds of tyres, multiple vehicles, hire of airfields, snow domes, wind tunnels, road tunnels, bridges and other facilities. Drawing upon the expertise of experts from many disciplines, inside and outside of Policing, academics, technical experts, legal experts, forensic experts and motor industry partners, we have been able to define what the key activities of a forensic collision investigation are. From there we have designed robust experiments using the best practice from around the network to write standard operating procedures and validation tests in order to scientifically prove their effectiveness and accuracy.

The truly remarkable element of all of this work has been the culture of the staff undertaking it. The team has been formed with FCIs from multiple forces, working remotely from one another but all with the ethos of getting the science right, of learning and improving. Any pre-held biases of what best practice is, who does it right, and even accuracy of previous teachings has been put to one side whilst the team have set about to test the limits of their knowledge, their expertise and the science that underpins it. Their shared vision has been to truly understand the limitations and where the weak spots may be, designing them out and sharing that knowledge with every FCI in the network.

This culture of quality allows us to fail fast and move on, to continually learn and develop an organisational 'black box' of Collision Investigation systems thinking and learning. Getting it wrong once during a national experiment on an airfield in order to learn quickly and get it right every time in the future at live scenes – where we cannot afford to get it wrong.

So as the FCIN works at pace, completing scope 1 science, we are in parallel preparing forces for accreditation. Assessments are underway across the entire network to understand the landscape and to support each base as they implement the new national SOPs. We have designed a national competency assessment framework, secured a national test site for ongoing experimentation and competency testing, CPD events and partnership work and have begun planning for the second scope of accreditation.

Collision Investigators within the FCIN will soon all be working to national standards, utilising validated methods, technologies and processes. Work will be peer reviewed across the entire network at multiple stages of the process, ensuring both a consistent standard to the reports and a community of practice and learning.

The FCIN is a fast evolving and developing service; the Forensic Science Regulator has published her latest Codes of Practice and Conduct this week, along with guidance on the development of evaluative opinions and it is clear there is still much for us to consider and implement.

As we have built the FCIN from a paper-based idea into a live network we have worked closely with academic institutions, manufacturers, and scientists from other disciplines. We will continue to engage widely to ensure that quality runs throughout our culture as we strive to deliver a professional, impartial, and accredited service, whilst keeping pace with advancements in science and technology.

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The Origins of *'Impact'*

The journal with a far longer history than the Institute

Members of a certain age, and with a sufficiently good memory, will know that *'Impact'* was first published as the Institute's journal in 1990. The Editor at that time was Dr Richard Lambourn. You may agree that 31 years (and several Editors) later, '*Impact'* remains an important part of the Institute.

What you probably don't know is that again under the editorship of Dr Lambourn (then at the Metropolitan Police Forensic Science Laboratory a photocopied publication called *'Impact'* first appeared as *'A Journal of Accident Investigation'* in 1975 - long before ITAI was even considered.

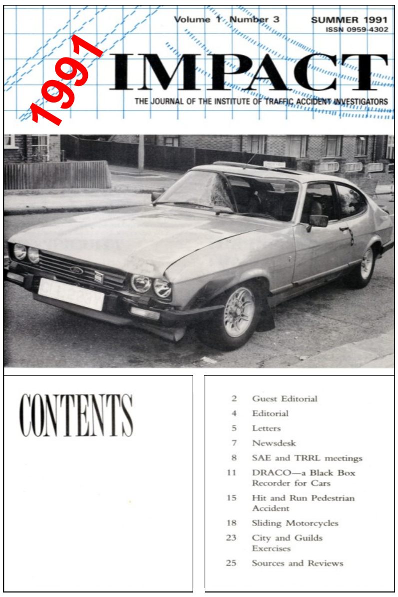
Suggestions as to a name for the 'A I Bulletin' were invited, and it was a Chief Superintendent Lee of the City of London Police who suggested *'Impact'.*

Editorial in that first edition includes the following : -

"We are distributing Impact to everyone in the seven forces which we serve who we think may be interested : - in the City of London, Essex, Hertfordshire, Kent, the Metropolis, Surrey and Sussex".

It continues *"Among those who will be receiving this first issue are Accident Investigation Units, Operational Traffic Patrols, Driving School Staff, Traffic Chief Superintendents and Prosecuting Solicitors".*

When the Institute of Traffic Accident Investigators was founded (effectively in 1989), and Dr Lambourn was appointed as its first Editor, it's perhaps not surprising that the same format and title was used in establishing the *'Impact'* that we now have.



The item that follows on pages 21-25 ('**Motorcycle Speeds and Sliding Distances'**) first appeared in the Spring 1991 (Vol.1, No.3) edition of *'Impact'.*

By including the reprinted article, I hope that it will serve to mark not only the longevity of *'Impact'*, but also the tremendous achievement by members, supporters and volunteer managers / directors in maintaining the Institute over a period now in excess of 30 years.

Tony Foster

MOTORCYCLE SPEEDS AND SLIDING DISTANCES

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This paper was given at the 1991 ITAI AGM.

Introduction

In traffic accidents where a motorcycle has slid freely along a road surface, the sliding distance is often used as a basis for estimating its speed. A calculation is made, similar to that commonly used to find the speeds of vehicles from tyre skid marks, in which the only variables used are the sliding distance s and a drag factor, or coefficient of friction μ. The simple formula used to find the initial speed (u):

$$u = \sqrt{(2.\mu.g.s)}$$

assumes that μ is a constant for the particular conditions and independent of speed. However, it has been suggested by some workers that the sliding coefficient does, in fact, have a speed dependence, whereby it becomes less as the speed increases.

In general the practice of investigators making the calculation has been to either estimate the value of the coefficient μ or to measure it by dragging the motorcycle in question along the road; the latter approach is common among police investigators in Britain.

This paper examines the validity of the dragging technique, and whether μ has a speed dependence. The factors which may affect the values which are assigned to it are also considered. The discussion is confined to hard dry road surfaces (i.e. dry asphalt or concrete).

A more detailed account of this work has already been published elsewhere [1].

REVIEW

This technique of speed calculation has been discussed by Fricke and Riley [2], who describe two methods of measuring the coefficient of friction. The first of these is to drag the motorcycle at a low constant speed along the surface, and measure the force required to keep it sliding; the coefficient is then found by dividing this force by the weight of the machine. In the rest of this paper this method will be called the "drag test".

The second method is to drop the motorcycle onto the surface from a known speed, and allow it to slide to rest, the coefficient then being calculated from the distance it slides. Here this will be referred to as the "slide test".

Clearly, the first of these methods is more suitable for use at accident scenes, while the second is more of a research method.

Fricke and Riley say, from their own experiments and from others they have reviewed (including those by Smith and Day [3]), that on dry asphalt or portland cement concrete the value of the coefficient ranges from 0.40 to 0.75. They briefly discuss why there is this variation, noting that the several tests were done on different surfaces and at different speeds, using somewhat different methods. However, they give no clear guidance on which way the various factors may affect the coefficient.

Collins [4] puts the range of coefficients found on dry asphalt between 0.55 and 0.70 for motorcycles not fitted with crash bars. For machines with crash bars or a fairing he says the value might drop to 0.50 or less.

Collins also points out that in a low speed drag test (which he calls a "quasi-static" test) considerable fluctuation in the dragging force may be expected as edges dig in and release, and says that the value of obtained should be recognised as a lower limit, since some of the machine's protuberances (pedals, kick-start &c.) may have been worn away in the accident.

More extensive investigations into speed dependence, using the slide method, have been made by Becke [5]. The vehicles used were pedal cycles, mopeds and motorcycles, and the method was to drop them from an upright position off a tilting platform at speeds between 50 km/h and 120 km/h.

In their dry tests the results range from 0.35 to 0.55, and, most interestingly, there is a decrease in the average deceleration (which, for the purposes of speed back-calculation, may be identified with the coefficient of friction) with increasing speed.

More recently Golder and Becke have carried out tests on a motorcycle with a full fairing [6], and found that although the machine with the fairing gave a somewhat lower deceleration than the one without, there was not a marked difference.

A similar speed dependence was noted in a series of unpublished tests by Ashton [7] with a Suzuki 100 motorcycle. The machine was suspended horizontally from the rear of a truck with its centre of mass at a height close to its normal position, and released at various speeds between 16 and 77 km/h. His findings were that the average deceleration varied from 0.35 to 0.65, and again decreased with increasing speed.

Ashton also extrapolated his results to lower and higher speeds, and in particular at the lowest speeds, which might be expected to correspond to the quasi-static drag test, a value of about 0.65 was inferred.

If the same downward extrapolation is made with Becke's dry results, a figure of 0.75 or more is found.

If these low speed extrapolations correctly show what the result of a drag test would be, then the consequence is that the drag test is not an accurate procedure. Any coefficient measured by it will be substantially greater than the average deceleration factor found at high speeds, and any speed calculated from that coefficient will be in error by being too high. However, neither Becke nor Ashton performed drag tests to demonstrate this point.

Furthermore, the extrapolated figures of 0.65 or more are, in the present author's experience, unusually high. In several *ad hoc* tests it has been found that a normal result is one in the region of 0.45 to 0.55 (similar to the findings of Day and Smith). Therefore, to settle this point the programme of experiments described below was carried out, in which both drag and slide tests were performed.

EXPERIMENTAL METHODS

Two surfaces, both on a disused airfield, were used in two series of tests. The first surface was constructed of a fine textured asphalt with some inset chippings, smoother than is normal on a public road, while the second was a very coarse asphaltic concrete.

The two series of tests were as follows.

1. Low-Platform Trailer

A trailer, shown in Figure 1, was constructed with a low flat platform on which a motorcycle could be carried on its side. A rearward facing seat carries an assistant who holds the motorcycle with a pair of straps, which he releases to allow it to slide onto the road once the desired speed has been reached.

Fig. 1 Low-platform trailer

There were two particular considerations in designing this arrangement. The first was that the motorcycle should fall through as small a distance as possible before striking the road surface, so that any impact or "digging-in" effects, as opposed to pure frictional effects, would be minimised—hence the low platform. The second was that high speeds should be attainable in the relatively short distance available on the test track—this meant that a truck was unsuitable, and hence the use of a small trailer towed by a car or a van.

Three motorcycles were tested in this series:

1. Honda CB750G, weight 240kg, fitted with crash bars over the crank case ends.
2. Honda CX500, weight 211kg, fitted with a small fibre-glass fairing.
3. Honda C-90, weight 89kg.

The range of speeds tested was 32 to 80km/h, taken in a random sequence to minimise the effects on the results of the wearing away of protrusions in successive runs.

Drag tests were interspersed between the slide tests, so that any changes in the low-speed coefficient of friction could be monitored. The drag tests were made at a brisk walking speed (about 10km/h), it being found that at very low speeds the machine tended to dig in and release, giving wide fluctuations onthe force transducer, rather than slide smoothly.

2. Towed Upright Motorcycle

The second series of tests was designed to simulate the motion of a motorcycle in a real accident, the machine being released from an upright position and made to fall onto its side before starting to slide. Any effects due to the initial impact and digging into the road surface should then become evident.

A bracket was fitted to the rear of an estate car which would hold the front wheel of a motorcycle while its rear wheel rested on the ground. This is shown in Figure 2. Two ropes attached to the head-stock of the machine run down to cleats in the back of the car to hold it upright, enabling the motorcycle to be towed at speed.

An assistant sits in the rear of the car, and when the desired speed is reached releases the ropes, allowing the motorcycle to pull clear of the car. To make it then fall onto its side the front wheel of the machine is loosely tied up, preventing it rolling more than a fraction of a revolution. (If this is not done, the machine will simply follow the car, only falling to its side when its speed has reached a very low level!) Figure 3 shows the method in use, just after the motorcycle has been released.

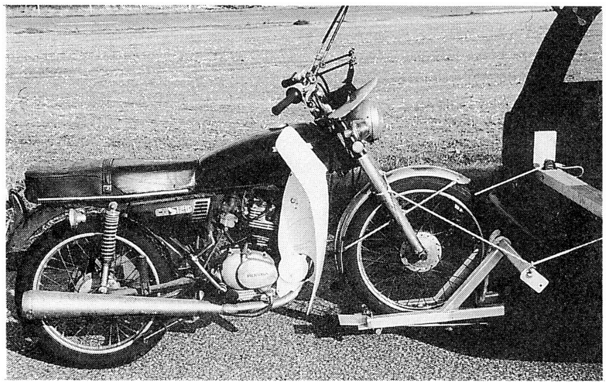

Fig. 2 Upright motorcycle attachment

Four motorcycles were used in these tests:

1. Honda CG125, weight 100kg, fitted with plastic leg shields. The leg shields were present for testing the machine on its right side, but were removed for tests on its left side. This motorcycle was used on the first, fine textured surface only.
2. Suzuki 125ER, weight 100kg. A small trials bike with a prominent side-stand (folded up in the tests) on its left side; used only on the first surface.
3. Honda C-90, weight 82 kg, used only on the second, coarse surface.
4. Yamaha TZR125, weight 107 kg, fitted with a small fairing which had broken off the left side in an earlier minor accident. Used only on the second surface.

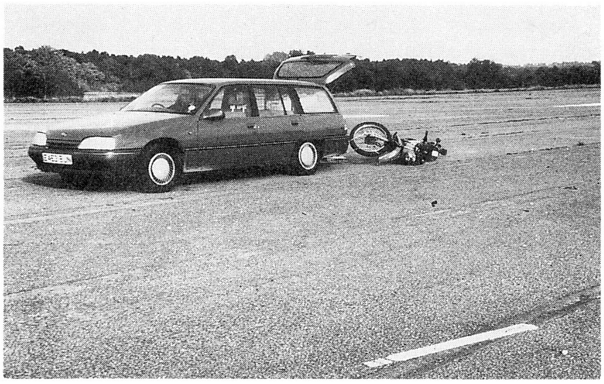

Fig. 3 Car and motorcycle just after release

The test procedure was the same as in the first series, with speeds from 40 to 90 km/h being used.

It will be noted that the motorcycles used in this series were, for the most part, lighter than those in the first series. Further tests are planned using heavier machines.

RESULTS

In all the slide tests the motorcycles slid smoothly to rest, sometimes rotating but never tending to turn over. The scratch marks made on the smooth surface were clear and continuous, but on the coarse surface they were often faint or undiscernible except at the start where the motorcycle first struck the ground.

In calculating the average deceleration in each test the overall distance slid by the motorcycle was taken, starting at the point where the scratch marks were first visible.

1. Low Platform Trailer

The reader is referred to the paper [1] for full details of the results, but in summary they were as follows.

On the smooth surface the average deceleration showed no dependence on speed, although there was quite a large scatter in the results. Furthermore, the drag test results were the same as the slide test figures. However the values obtained were unusually low, at around 0.3.

The results on the coarse surface showed a larger scatter, a higher average value (around 0.4-0.5), and possibly a small (compared with the Becke and Ashton figures) speed dependence. The drag test results appeared to align with the speed dependence.

However, when the results from the tests were plotted out successively, it will be seen that there was a steady decline test-by-test, and that the drag test values followed the slide values quite closely. From this it became evident that the apparent speed dependence on the coarse surface was an artefact produced by the particular sequence of tests, while the wide scatter was due in large part to the wearingdown or smoothing off of the machines.

2. Towed Upright Motorcycle

Figure 4 shows the results with the CG125 in the second series of tests on the fine textured surface. For the first half of the sequence the motorcycle was slid or dragged on its right side, and then for the remainder it was placed on its left side.

Figure 5 shows the same results plotted in the sequence in which they were taken, with the speed of each test slide marked by the data point.

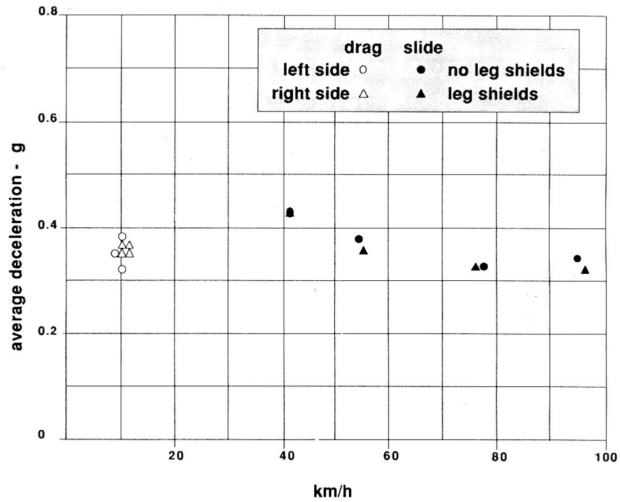

Fig. 4 Towed upright motorcycle: fine textured asphalt speed effects Honda CG125

Similarly Figures 6 and 7 show the results with the 125ER on the smooth surface, and Figures 8 to 11 show the results with the C-90 and TZR125 on the coarse surface.

In Figure 4 (Honda CG125 on the smooth surface) a modest speed dependence can be detected in the slide tests, with the value lying in the region of 0.40-0.45 at 40 km/h, and falling to 0.30-0.35 at speeds of 75 km/h and more. The low-speed drag tests, however, lie around 0.35, and

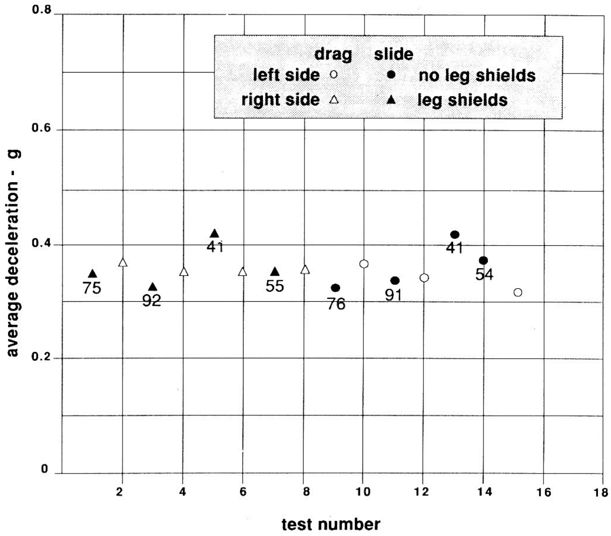

Fig. 5 Towed upright motorcycle: fine textured asphalt wearing-down effects Honda CG125

are close to the slide figures at the higher end of the speed range.

Interestingly, there is very little scatter in the values, and the removal of the leg guards has had no discernible effect. Figure 5 also shows no apparent wearing-down effect.

In Figure 6 (Suzuki 125ER on the smooth surface) the effect of the prominent side stand on the left side of the machine is clear, there being a much higher friction on this side compared with the right. In Figure 7 the wearing-down effect on the side stand is also apparent, which accounts for some of the scatter in the results, but with this machine the speed dependence, if any, is one whereby the friction *increases* with speed. But in any event, the drag tests continue to reflect the values at higher speed.

On the second surface, Figure 8 (Honda C-90) shows no clear speed dependence. There were no anomalies with the drag tests, although on this very coarse surface the dragging force fluctuated wildly at times, and at the first attempt was too erratic to be read.

Figure 9 shows some wearing down effect.

Finally, the Yamaha TZR125 on the coarse surface (Figures 10 and 11) shows some speed dependence, but

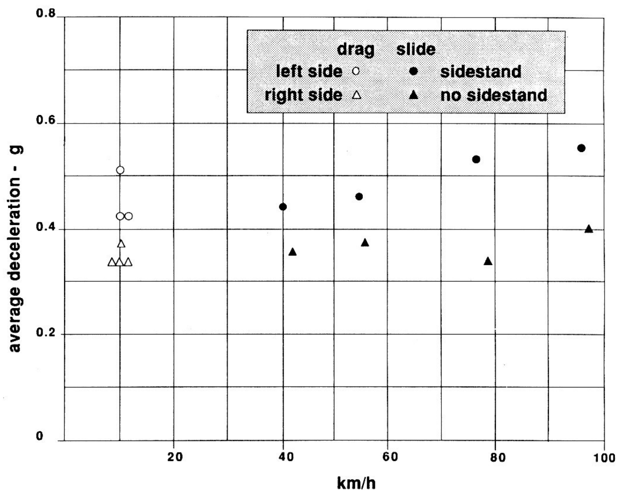

Fig. 6 Towed upright motorcycle: fine textured asphalt speed effects Suzuki 125ER

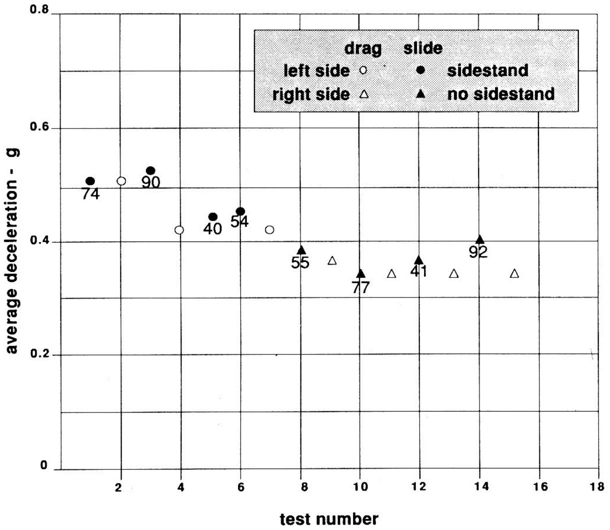

Fig. 7 Towed upright motorcycle: fine textured asphalt wearing-down effects Suzuki 125ER

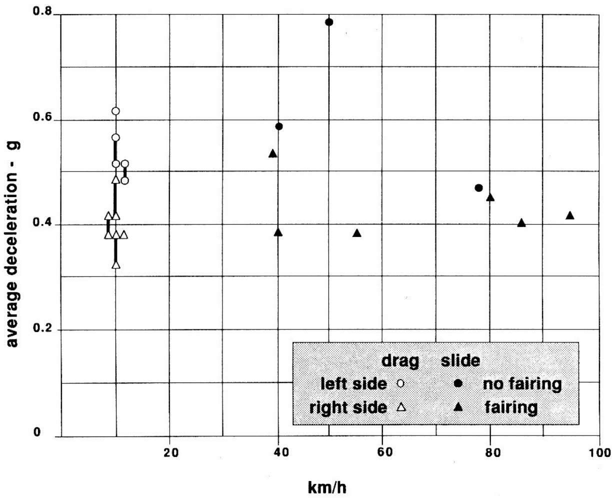

Fig. 8 Towed upright motorcycle: coarse asphaltic concrete speed effects Honda C-90

again this is confused by the wearing down of the protrusions. The left side, without the fairing, gave in its first test, at 50 km/h, the very high value of 0.79. There were on this side some very sharp protrusions which quickly wore down, and which would account for this, as can be seen from Figure 11. Unfortunately, this machine had a small twist to its frame which made it reluctant to fall to its left side, and this limited the number of left-side tests and also introduced a number of unplanned right-side slides.

DISCUSSION

The reason for there being a clear speed dependence in the results of Becke and of Ashton, but not in the tests reported here, is almost certainly due to the fact that in both their experimental methods the motorcycles were dropped a distance onto the road surface. This would subject the machines to a large decelerating impulse as they struck the ground, which would considerably increase the average deceleration in low speed tests but be relatively unimportant in high speed runs.

The results in Figures 5, 7, 9, & 11 show that the drag test figures were close to the highspeed slide results, and

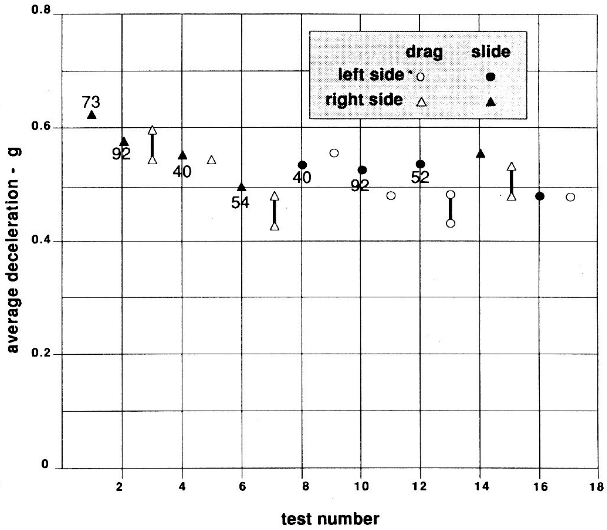

Fig. 9 Towed upright motorcycle: coarse asphaltic concrete wearing-down effects Honda C90

in the great majority of cases were very close to the deceleration achieved in the immediately preceding slide test, being generally within about ±0.05 of that value.

There are four cases where there was a rather greater difference between drag and slide results. In Figure 7 a slide of 0.53g is followed by a drag of 0.42, but here it will be noted that the drag test followed a slide test at 90 km/h—one of the higher speeds—where wearing-down effects may have been significant.

In Figure 11 there are two examples: a slide of .54g is followed by a drag of .37, and later a slide of 0.79g is followed by a drag of 0.61. In the first of these, from only 39 km/h, it was observed that the motorcycle "dug-into" the surface and stopped very sharply; the second was the first on the left side of the machine, where there were several sharp projections normally covered or shielded by a fairing, and again digging-in was observed, also accompanied by a rapid wearing down of the projections. In both these circumstances it is not surprising that the subsequent drag tests gave significantly lower results.

The conclusions drawn from the tests described in this paper are as follows:

1) When a particular motorcycle is dropped gently onto

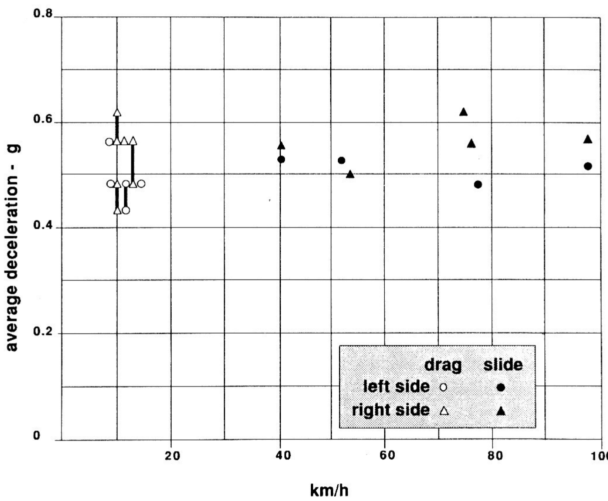

Fig. 10 Towed upright motorcycle: coarse asphaltic concrete speed effects Yamaha TZR125

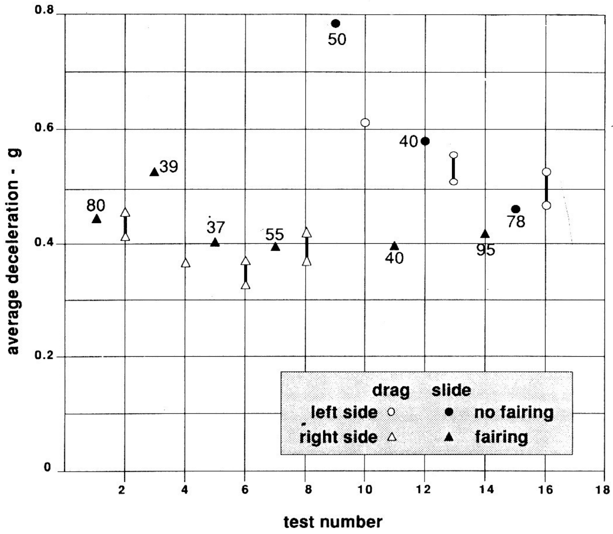

Fig. 11 Towed upright motorcycle: coarse asphaltic concrete wearing-down effects Yamaha TZR125.

a road surface, as in the trailer tests, its average deceleration (or coefficient of friction) as it slides to rest has little or no dependence on speed.

2) When the motorcycle falls to the road from an upright position, there may be some speed dependence, with a higher deceleration being achieved at lower speeds.

3) Drag tests made at a speed of about 10km/h give friction values similar to those found in high-speed slides in either situation, and usually within about ± 0.05g.

4) There is a dependence of the friction on the macrotexture of the surface. This means that general friction values for roads cannot be given without regard for their roughness.

5) As expected, the friction tended to become less in successive tests. However, the decline was not so progressive that one could say that in a drag test made after a slide test, the friction coefficient found would necessarily be less than that which would have been effective during the slide (as Collins has suggested).

6) The scatter of results is in several cases quite wide, but most of this can be attributed to the wearing-down effect.

The first series of tests essentially measured the smoothly-sliding coefficient of friction, and showed that this is what is also measured in the low-speed drag test. In the second series the effects of a more realistic initial impact with the road than in the Becke and Ashton tests have been shown to be less severe than their results would suggest.

In all the tests the motorcycles slid smoothly, but it appears probable that in accidents where the motorcycle tumbles for some of its deceleration distance, the overall deceleration will be higher than if it slides smoothly, and here the drag test will tend to give an underestimate of the rate. It is also clear that an investigator, presented with an accident where a motorcycle has left intermittent scratches and gouges, rather than a continuous set of marks, should not, for the purposes of speed calculation, sum the lengths of the individual sections of marks, but should take the overall distance travelled. He should however note the presence of gaps in the marks and be aware of their meaning. (See also Bratten [8].)

ACKNOWLEDGEMENTS

The author is grateful to members of the Metropolitan Police Accident Investigation Units for their help in setting up and running these experiments; and similarly to Trevor Newbery of the Strathclyde University Forensic Science Unit; also to Dr Steve Ashton for helpful discussions.

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This investigation (which was published in greater detail as SAE Technical Paper 910125) was inspired by the results of some testing circulated by Steve Ashton (reference 7) carried out with Tony Foster and Jim Keenan, then of the Merseyside Police. This showed a speed dependence of the average deceleration of a sliding motorcycle, with it getting lower as the launch speed was increased. It seemed likely that this effect was due to an impulsive loss of speed when the motorcycle first struck the road, after which it would slide to rest at a more-or-less constant rate which should correspond to the friction one would measure in a low speed drag test. Happily this hypothesis was confirmed by the work set out in this paper (where the Chairmanly involvement was maintained by Peter Sippitt, who carried out the rapid photography for me – see Figure 3).

Many other motorcycle slide papers have been published since then, and David Hague wrote a very useful summary in 2004 in the Spring edition of *Impact*. But something I had wanted to do as a follow-up to my testing was to construct a launching method where the motorcycle was held only a very short distance above the ground such that when it was released it was essentially placed straight on the road with no significant speed loss on landing. A device was built but, because of forensic science lab strictures, was never properly tried out. However, quite independently, the same idea was soon after developed by Carter *et al.*, *Measurement of Motorcycle Slide Coefficients*, SAE Technical Paper 961017.

All these researches give us the means to estimate the friction of a sliding motorcycle, but one should not lose sight of the fact that by far the best figure comes from doing an actual drag test at the scene with the actual motorcycle !

Extraction of Pedestrian Crossing Speeds From Collision Evidence

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Abstract:

In fatal pedestrian to vehicle collisions, accident investigators must attempt to reconstruct events that led up to the collision to determine liability in a court of law. In the absence of suitable video footage, the vehicle speed is calculated using particle based throw distance calculators such as the Searle method. Until recently, no methods concentrated on the velocity of the crossing pedestrian, vital for determining responsibility. A new approach, the Pedestrian Crossing Speed Calculator (PCSC), which uses evidence left on the bonnet and windscreen along with pedestrian anthropometry to calculate a pedestrian crossing speed, has been proposed in a previous research, and validated against three real accidents where the pedestrian approach was orthogonal to the vehicle. The range of application of the PCSC theory is investigated in this paper. This study has considered 48 Finite Element simulations to further validate the PCSC against a saloon type and SUV vehicles. In the case of the saloon type, the PCSC theory for a pedestrian crossing approach angle <10°, i.e. a pedestrian crossing trajectory no longer perpendicular to the vehicle trajectory, has been fully vindicated. The study has also confirmed the PCSC hypothesis stating that for saloon vehicles the relationship between and increase in bonnet dent width was caused by an increase in pedestrian gait angle. The study also concluded that the PCSC theory was less conclusive in the case of SUV collisions.

This paper confirms that PCSC is unique and can have an important role in the field of accident reconstruction and for law enforcement; with the potential to determine vehicle speeds from a known pedestrian crossing speed, which will allow the calculation of the vehicle velocity in the absence of physical evidence left on the road surface.

Nomenclature

ECU	Electronic Control Unit. A generic term for any embedded system that controls one or more of the electrical systems or subsystems in a motor vehicle
H	Lateral distance between vehicle dent and windscreen damage
W	Longitudinal distance between vehicle dent and windscreen damage
β	Angle of the actual pedestrian head centre of gravity between the location at initial strike to its location on the windscreen along the vehicle travelling direction
λ	Theoretical angle between the pedestrian velocity and the vehicle velocity
Γ	Head offset to the bumper impact location. It compensates offset by half a pedestrian stride length
θ	Pedestrian gait angle
α	Pedestrian crossing angle relative to the vehicle direction
V_{ped}	Pedestrian crossing velocity
UKPF	UK Police Force
CoG	Centre of Gravity
CI	Confidence Interval

Introduction

1.1 The Pedestrian Crossing Speed Calculator (PCSC) Theory

Pedestrian collisions are often tragic and sometimes even fatal events that happen all around the world. These events are caused by the pedestrian, careless driving or a combination of the two. The Police authorities are then responsible for gathering all the evidence leading to the fatal collision. Evidence can be found in multiple ways, like video footage (either CCTV or dashcam), data from the vehicle ECU, witness statements and physical evidence left on the road, such as skid marks. Pedestrian throw distance calculators such as Searle's method can then be used with physical evidence to estimate the velocity corridor the vehicle was expected to be travelling in, although using this method, the crossing speed of the pedestrian cannot be ascertained.

The Pedestrian Crossing Speed Calculator (PCSC) [1] is a new particle based method of accident reconstruction that uses physical evidence left on the

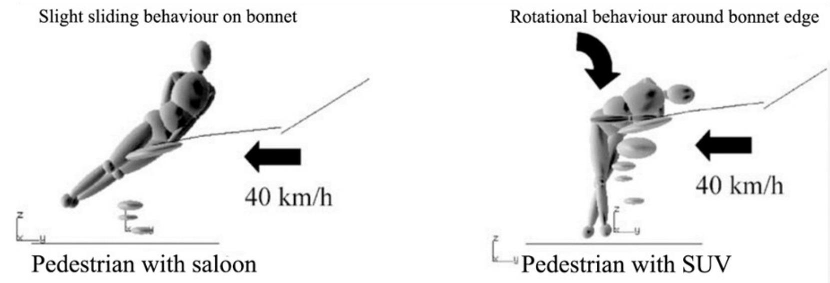


Figure 1 - *Difference in pedestrian kinematics when stuck by vehicles with different front-end geometries [7].*

front end of the vehicle to calculate the crossing speed of the pedestrian. Not only this, but if the pedestrian crossing speed is known, then it can be applied in reverse to find the velocity of the vehicle.

When a pedestrian impacts a vehicle, the first point of contact is between the bumper and knee [2][3]. After initial contact, the pedestrian rotates about the bonnet leading edge and hits the windscreen, the impact of which is offset laterally and longitudinally from first contact [4].

This head contact location is heavily influenced by two factors; the front-end geometry of the vehicle and the height of the pedestrian. A bonnet with a lower height leading edge carries the pedestrian further onto the vehicle [5] and a tall pedestrian is 17% more likely to hit the windscreen [6]. Figure 1 shows an example of the pedestrian kinematics with different front-end geometries, using Madymo a pedestrian multi-body computer model [1].

The Searle method is currently used in UK court proceedings, which is a particle-based mathematical model which uses evidence markers such as skin marks and pedestrian throw distance to calculate a vehicle velocity [8]. It has been shown to compare well to a collection of accident data, predicting vehicle velocities close to the known values [9]. Several deficiencies exist however with this method. A constant friction coefficient of 0.7 is used, which is not representative of a change in road condition, i.e. dry (0.73), wet (0.67), icy (0.30) [10]. Differences in velocities between the pedestrian and vehicle at the moment of impact also require the use of a projection efficiency, which is dependent on vehicle front end geometry.

The Pedestrian Crossing Speed Calculator (PCSC) is a new forensic investigation tool that can be used to calculate the crossing speed of a pedestrian. It assumes the pedestrian to be a particle, and uses vector algebra to determine a directional vector post-impact.

The basic theory of the PCSC is based on the ratio between two angles [1]:

$$\lambda_{generic} = \beta_{generic}$$

Equation 1 – *Basic theory of PCSC*

The first angle, λ, is the absolute angle of the pedestrian-vehicle velocity vector, which can be seen in Figure 2. This vector is measured using two impact locations, the dent left on the leading edge of the bonnet by the pedestrian's leg, and the dent left at the top of the bonnet or windscreen by the pedestrian's head.

Equation 2 shows how λ is calculated.

$$\lambda = \tan^{-1}\left(\frac{V_{ped\_perpendicular}}{V_{vehicle}}\right)$$

Equation 2 - *Absolute angle of the pedestrian-vehicle compound velocity vector.*

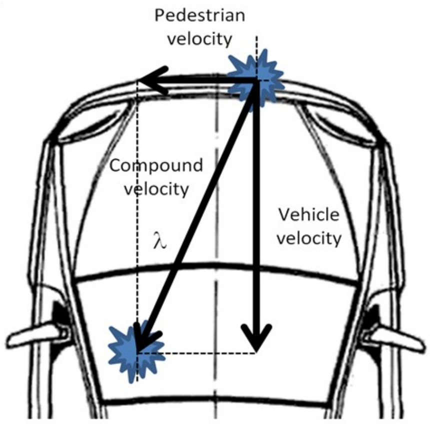


Figure 2 - *Resultant velocity vector generated by the pedestrian and vehicle velocities.*

The angle β, on the other hand, is the pedestrian head approach angle between impacts of the leg on the bumper and the head on the windscreen. The lateral distance between these points is W, and the longitudinal distance between them is H, as observed in Figure 3.

It is assumed in Equation 2 that the pedestrian is travelling on a path perpendicular to the vehicle's

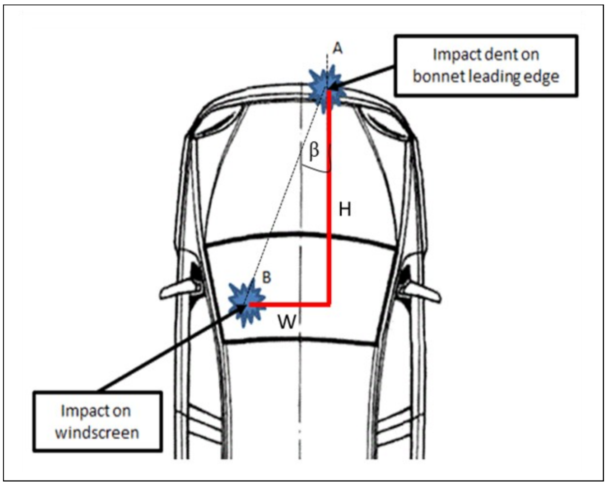


Figure 3 - *Pedestrian impact locations.*

direction of travel. This may not always be the case and so a non-zero approach angle between the pedestrian and vehicle can be observed. This change of angle is included in Equation 3, where α is the approach angle of the pedestrian. Equation 3 reverts to Equation 2 when the approach angle α is zero. The correction value is added to the vehicle velocity if the pedestrian is travelling towards or away from the car.

$$\lambda_{generic} = \tan^{-1}\left(\frac{V_{ped\_perpendicular}}{V_{vehicle} \pm \tan(\alpha) \cdot V_{ped\_perpendicular}}\right)$$

Equation 3- *Absolute angle of the pedestrian-vehicle compound velocity vector with pedestrian approach angle included.*

It should also be noted that there are infinite ratios of vehicle-pedestrian velocities which can fulfil λ. The velocity ratio can be calculated from the impact evidence observable on the vehicle.

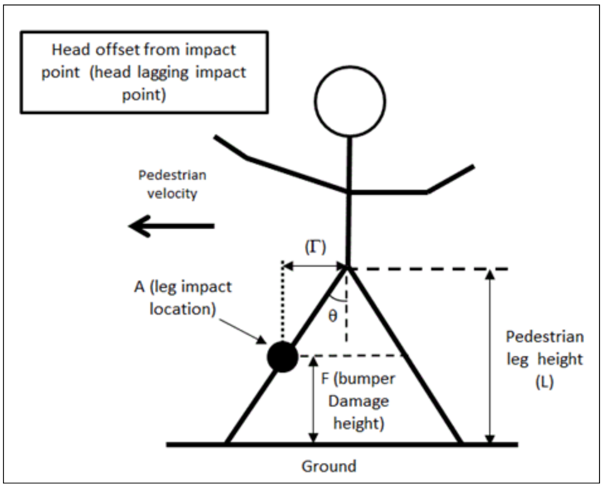
The angle β, on the other hand, is a function of W and H and needs to include the pedestrian's head offset from the leg impact location. This offset is captured in the term $\Gamma_{generic}$ and as such β can be calculated as per Equation 4.

$$\beta_{generic} = \tan^{-1}\left(\frac{W + \Gamma_{generic}}{H}\right)$$

Equation 4 - *Head approach angle of the pedestrian between bumper and windscreen impact points. Γ can be a positive or negative value*

If the pedestrian's head is forward of the bonnet impact point, the head approach angle β will be smaller than λ. If the pedestrian's head is trailing the bonnet impact point, then β will be greater than λ.

Considering α being the angle between the crossing pedestrian and the vehicle, Equation 5 gives an expression for the distance $\Gamma_{generic}$ which depends on the pedestrian's condition pre-impact, i.e. width of pedestrian gait, anthropometrics etc.



$$\Gamma_{generic} = (\pm(L - F)\tan\theta) \cdot (1 - \sin\alpha)$$

Equation 5 - *Head offset from impact point.*

The distance $\Gamma_{generic}$ expressed in Equation 5, is illustrated in Figure 5, where L is the pedestrian leg

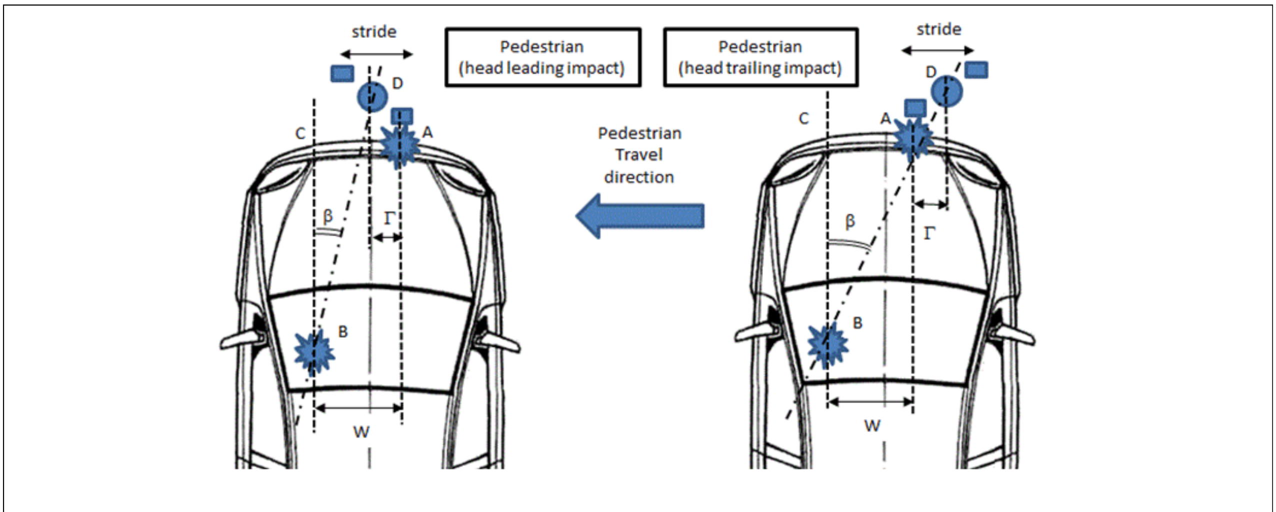


Figure 4 - *Effect of head position relative to the leg impact location.*

length, F is the height of bumper impact and θ is the pedestrian gait width.

Equating $\lambda_{generic}$ (Equation 3) and $\beta_{generic}$ (Equation 4) produces Equation 6, which is the final Pedestrian Crossing Speed Calculator (PCSC) equation:

$$\frac{V_{ped\_perpendicular}}{V_{vehicle} \pm \tan(\alpha) \cdot V_{ped\_perpendicular}} = \frac{W + \Gamma_{generic}}{H}$$

Equation 6 - *Full PCSC equation.*

The head position relative to the leg impact location will be determined by anthropometric factors, such as leg length and the condition of the pedestrian pre -impact. This condition is based on the hip gait angle of the pedestrian, θ. The distance between the bonnet impact location and the pedestrian's head will be larger for a wider pedestrian stance and near zero for a standing stance. Table 1 summarises the maximum hip gait angles for a given stance. It must be noted that this does not divulge the crossing speed. For example, a pedestrian crossing at running speed can have a running gait, as well as a standing or walking gait depending where in their stride they are at impact.

Crossing Speed (m/s)	0 - 0.85	0.85 - 1.4 [11]	1.5 - 3.5 [12]
Type of Crossing	Slow Walk	Brisk Walk	Run
θmax Maximum Hip Gait Angle (deg)	5	20	30

Table 1 - *Pedestrian conditions for different crossing types [1]*

It is proposed to categorise the gait angle as a function of the dent or smear marks left on the bonnet. Indeed, the wider the bonnets dent/ smear, the wider the pedestrian gait (Wide), as the pedestrian body bonnet in-print will be larger. If a standing pedestrian is hit from the side, then their silhouette will be smaller (narrow) and leave a linear print on the bonnet, as illustrated in Table 2. Any intermediate bonnet in-print will be classified as 'Medium'.

In order to further reduce the number of solutions for Equation 6, an additional evidence can be retrieved from the Post Mortem reports (PM), which is to identify the first leg contacted. By looking up in Table 3, it is possible to understand pedestrian's head distance relative to the point of impact visible on the bumper ($\Gamma_{generic}$). A negative sign indicates a head trailing the bumper contact point, while a positive sign suggests leading.

1.2 Physical Validation of the PCSC

An accident case involved a pedestrian collision for which vehicle photographic evidence was provided by the UK Police Force (UKPF). In this instance, the vehicle was fitted with a dashboard camera, which allowed the recording of the pedestrian motion prior and during the collision. Using the camera frames, the vehicle speed was calculated. The vehicle was travelling at 45mph when the driver saw the pedestrian 11.4m from collision. Upon braking, the vehicle velocity reduced to 34mph (15m/s) when the collision took place. The pedestrian was crossing perpendicularly to the road and its speed was calculated at the moment of impact at 3.77 m/s [1]. The vehicle evidence, as well as the pedestrian's anthropometric information, are input in Equation 6 and overlaid in Table 4, which represents a vehicle speed – pedestrian crossing speed domain.

Table 4 (overleaf) is showing in red the vehicle/ pedestrian speeds for which the PCSC requirements are respected and in green the PCSC value, which should have been obtained for an impact speed of 15m/s and a crossing speed of 3.77m/s. The PCSC flags in red a solution for 15m/s, highlighting the value 14.9m/s, which in return relates to a pedestrian crossing speed at the time of impact of 4.0m/s, representing a difference of 6% in pedestrian crossing speed estimation. This discrepency is likely influenced by the measures taken from the blueprint. As the values observed in real-life were accurately recorded and are true values, it can be concluded that the proposed PSCS methodology predictions are believable and valid [1].

1.3 Proposed investigation in this paper

The PCSC has been verified with two further collisions, using data provided by the UKPF [1]. These collisions all occurred with an approach angle α of 0° and has been highlighted by the authors as a limitation of this verification.

Gait type	Narrow	Medium	Wide
θ hip angle gait (deg.)	5	20	30
Bonnet in-print example	Minor damage		

Table 2: Imprint classification as a function photographic evidence

Car colliding pedestrian from	Left			Right		
Leg contacting bumper (PM or video)	Left	Left	Right	Right	Right	Left
Location of windscreen impact head contact (PM)	Frontal	Occipital	Occipital	Frontal	Occipital	Occipital
Caused by	Front of head hits wind-screen	Back of head hits wind-screen	Back of head hits wind-screen	Front of head hits wind-screen	Back of head hits wind-screen	Back of head hits wind-screen
Head COG position prior to contact	Head forward of leg con-tact	Head rearward of leg contact	Head forward of leg contact	Head forward of leg con-tact	Head rearward of leg contact	Head forward of leg contact
Gait to consider	Rear Leg Hit	Front leg hit	Rear Leg Hit	Rear Leg Hit	Front leg hit	Rear Leg Hit
$\Gamma_{generic}$ (sign)	Negative	Positive	Negative	Negative	Positive	Negative

Table 3 : *Gait selection from impact side and head injury location based on computer kinematics [3]*

PEDESTRIAN CROSSING SPEED (m/s)	VEHICLE SPEED (m/s)																				
	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.1
2.0	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1
2.1	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4
2.2	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8
2.3	9.3	9.2	9.1	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1
2.4	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.5
2.5	10.1	10.0	9.9	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8
2.6	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2
2.7	10.8	10.8	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.8	9.7	9.6	9.6	9.5
2.8	11.2	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.9
2.9	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2
3.0	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11.1	11.0	11.0	10.9	10.8	10.8	10.7	10.6	10.6
3.1	12.4	12.3	12.2	12.1	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11.1	11.0	11.0	10.9
3.2	12.8	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.0	12.0	11.9	11.8	11.7	11.7	11.6	11.5	11.4	11.4	11.3	11.2
3.3	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.2	12.2	12.1	12.0	11.9	11.9	11.8	11.7	11.7	11.6
3.4	13.6	13.5	13.4	13.3	13.2	13.1	13.0	12.9	12.9	12.8	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.1	12.0	11.9
3.5	13.9	13.8	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.1	13.1	13.0	12.9	12.8	12.7	12.6	12.6	12.5	12.4	12.3	12.3
3.6	14.3	14.2	14.1	14.0	13.9	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.2	13.1	13.0	12.9	12.8	12.8	12.7	12.6
3.7	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9
3.8	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.9	13.8	13.7	13.6	13.5	13.4	13.4	13.3
3.9	15.5	15.4	15.3	15.2	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	14.0	13.9	13.8	13.7	13.6
4.0	15.8	15.7	15.6	15.5	15.4	15.3	15.2	15.1	15.0	14.9	14.8	14.7	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	14.0

Table 4 : *PCSC search for the pedestrian accident case*

This paper will attempt to further validate the PCSC by running FE simulations using the THUMS4.01 human body model and assess the extent of usefulness on the PCSC theory. The latest computer human body technologies involve finite element model (THUMS and GHBMC [13]). These models are designed to replicate the physical properties of the human body, and are based on the results of many studies and CT scans. It has been proven that THUMS can predict the dynamic impact and response compared to a PMHS to within ±15% [14] [15]. THUMS has also been validated for post impact kinematics, producing results consistent with the Searle method at speeds up-to 40km/h [15].

The study will investigate changes in pedestrian crossing speed, pedestrian approach angle, pedestrian gait angle and different vehicles class (standard saloon and SUV), with the purpose of testing the validity of PCSC by creating more accident samples, albeit numerical. The hypothesis that an increase in dent width leads to an increase in pedestrian gait angle will also be questioned, as this is important for forensic investigators in a real-world collision.

2.0 Methodology

In order to test the PCSC theory, pedestrian-vehicle collisions were simulated using the THUMS model and a Toyota Yaris (saloon) and RAV-4 (SUV), as illustrated in Figure 6. The ultimate aim was to compare the computer model pedestrian response against the PCSC theoretical predictions.

Figure 6 - *Vehicles used for simulations: Toyota Yaris (left) Toyota RAV-4 (right).*

Pedestrian crossing speeds of 0.0, 1.4 and 3.0m/s were arbitrary used, representing standing, walking and running respectively whilst covering a wide range of crossing speeds. Three pedestrian gaits were also considered, with the THUMS model posture being modified to 0°, 20° and 30° representing a standing, walking and running gait respectively. The positioning of the pedestrians is shown in Figure 7. It should be noted that for the running gait pedestrian the struck leg is forward of the head centre of gravity, unlike the standing and walking gaits. This was done to test the PCSC in both scenarios, and was observed that the pedestrian will fall on their side/ front with a standing/walking gait and on their side/ back with a running gait.

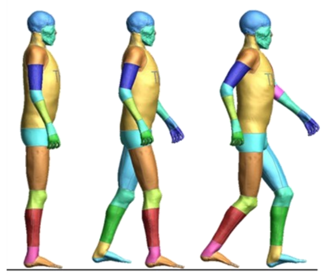


Figure 7 - *Different pedestrian gait angles : standing gait 0° (left), walking gait 20° (centre), running 30° (right).*

For a standing gait, the pedestrian can be crossing at standing, walking or running speeds. Yet for a running gait the pedestrian can only be crossing at running speed. The possible crossing speeds to pedestrian gait permutations are shown in Table 2.
Each of these permutations was also run for an approach angle α of 0°, 10°, 20° and 30°.

Crossing Speed (m/s)	Standing Gait	Walking Gait	Running Gait
0	Y	N	N
1.4	Y	Y	N
3	Y	Y	Y

Table 2 - *Possible pedestrian crossing speeds depending on gait.*

A total of 48 simulations, 24 simulations for each vehicle – 12 standing, 8 walking and 4 running were computed. These simulations were set to an end time of 0.3s, which was an adequate time to capture pedestrian head to windscreen contact.

For each simulation, the variables W and H were measured on the vehicle, using D3PLOT[16] as a post-processor interface. An example measurement is illustrated in Figure 8. The distance between the centre of the dents is taken, and then the appropriate X and Y measurements recorded, as per the PCSC equation requirements.

The leg length of the THUMS AM50 human model is measured to be 867mm (from hip joint to foot).

Figure 8 - *Taking W and H measurements.*

The bumper damage height is generally consistent to each vehicle for every simulation. This is because the directional vector begins at the point of rotation. As the plastic bumper is relatively soft, it deforms under the impact from the pedestrian. This does not cause the pedestrian to begin rotating towards the bonnet. The stiffer metal bumper beam is the component that changes the pedestrian's directional vector, with the contact height for this being consistent across the simulations. For the Toyota Yaris, this was 517mm, and for the Toyota RAV-4 it was 687mm from the ground. The height at which the point of rotation occurred was checked in every simulation and most of the simulations were the same heights, with a variance of ±30mm.

3.0 Dent Width Investigation

During a collision, a pedestrian could rotate after the initial contact with the vehicle. This rotation can be influenced by the offset between the pedestrian's centre of gravity situated in the navel area and the area of the leg contacting the vehicle. When the approach angle is zero and the pedestrian has a small gait, for saloon vehicles, a narrow dent will be observed on the bonnet; this was proposed as an important assumption for the PCSC equation derivation. This is because no rotation of the pedestrian will occur so they fall onto their side. As the hip gait angle increases, the offset between the leg contact and head CoG also increases which will rotate the pedestrian onto their front or back. It has therefore been hypothesised that an increased pedestrian gait

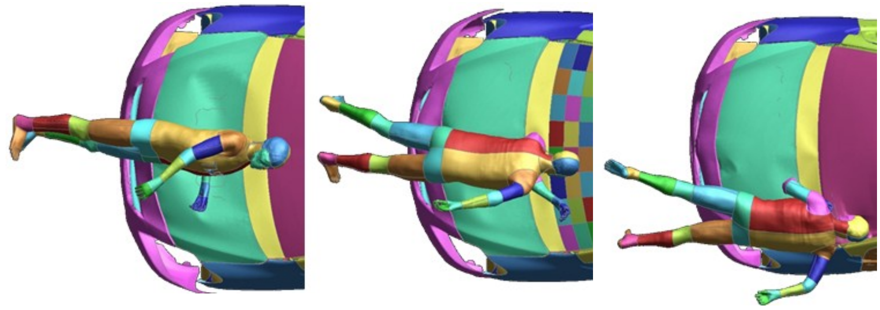


Figure 9 - *Effect of an increase in gait angle 0° (Left), 20° (centre), 30° (right).*

will create a wider dent in the bonnet, as illustrated in Figure 9.

Using the simulations, the width of the bonnet dent left by the pedestrian is measured. In a real-world accident, the evidence is not limited to just the bonnet damage. It is possible that during a collision with a low enough velocity, the elastic limit of the bonnet may not be overcome and no dent is left. The spring back of the bonnet must also be considered, which would make the measured dent created by the pedestrian contact narrower. However, smear marks left on the bonnet, such as dirt, may be used to suggest the width of the pedestrian in contact with the bonnet. Therefore, it is more suitable to measure the contact width of the pedestrian.

The simulation animation is stopped when the pedestrian is in full contact with the bonnet. A parallel cut section to the bonnet is then made and translated in the local z-direction until a profile representative of the bonnet dent width is observed in the post-processor. The width of the torso is then measured in line with the deepest deformation of the dent, as seen in Figure 10.

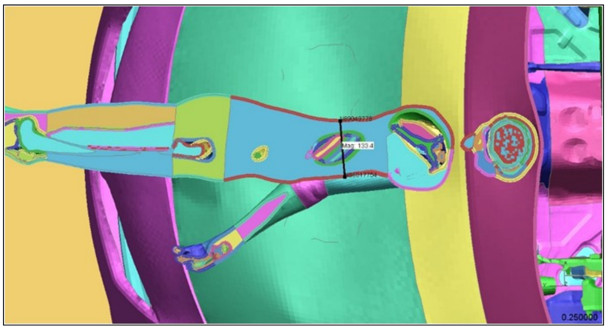


Figure 10 - *Measuring torso contact.*

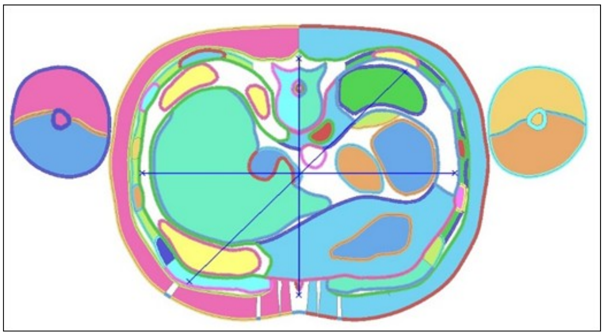


Figure 11 - *Measuring mean maximum torso width.*

To relate these measurements to the pedestrian rotation, the measured torso contact is divided by the mean maximum torso width of THUMS at rest. This measurement can be seen in Figure 11, and for a real-world case can be measured by a post-mortem. The THUMS model gives an average torso with of 303mm. This gives a 'torso ratio', which returns a value of '1' when the pedestrian has landed square on their front or back. Values over '1' can be obtained, as the thorax can compress during impact, increasing the contact seen on the bonnet.

All dent width measurements can be found in tabulated form in Appendix A. Figure 12 shows the

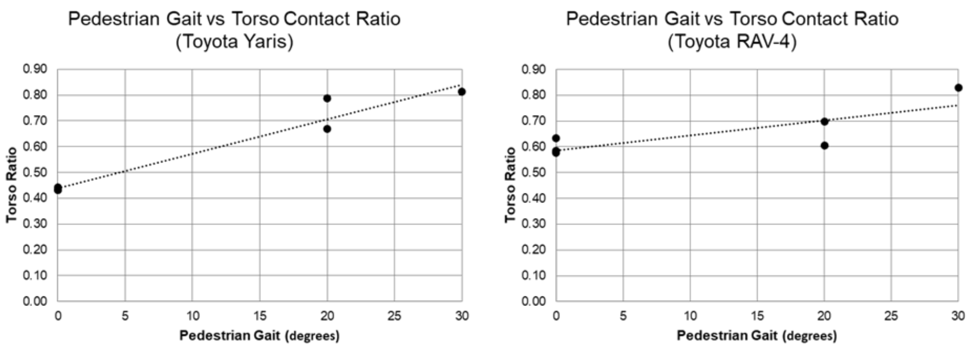


Figure 12 - *Torso contact ratio with increasing pedestrian gait angle, (left) Toyota Yaris (right) Toyota RAV-4.*

measurement results for the Toyota Yaris and RAV-4 respectively when the approach angle α is 0.

It can be observed that the hypothesis holds true for the Toyota Yaris, where an increase in pedestrian gait angle produces a visible increase in torso ratio. However, the same conclusion cannot be drawn for the Toyota RAV-4, as the torso ratios only slightly increase with a change in approach angle. This would lead to inconclusive evidence being collected at the scene of the accident, and could not provide objective information on the pedestrian gait angle at impact.

It is also important to investigate whether or not this hypothesis is true when the pedestrian-vehicle approach angle is not orthogonal, or a non-zero angle. As discussed in section 3, simulations between 0-30° were run and the measurements were also collected from these simulations. Figure 13 shows the results of these measurements, plotted as approach angle against torso ratio, with different markers used to distinguish different pedestrian approach angles.

The results of the Toyota Yaris show that for an approach angle above 0°, the pedestrian gait width cannot be distinguished from the dent width alone. If this were to be possible, the measured dent widths would need to be sequential, starting with the smallest gait (standing) producing the smallest dent, and the largest gait (running) producing the largest dent. This does not occur for approach angles above 0°.

The Toyota RAV-4 could not provide distinguishable contact ratios at 0°, and the trend continues in to higher approach angles. It can therefore be concluded that the dent width cannot be used to distinguish the pedestrian gait angle for an SUV.

4.0 Comparison between theoretical and numerical PCSC predictions

$$C.I. = V_{ped}(Actual) \pm \left(1.96 \times \left(\frac{\sigma}{\sqrt{N}}\right)\right)$$

Equation 7 - *Calculating confidence intervals [17].*

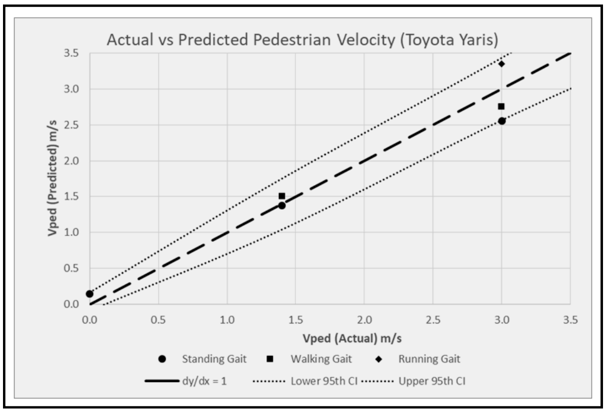


Figure 14 - PCSC results from simulations with a Toyota Yaris, with an approach angle of 0°.

All graphs contain a 'true' gradient line, where the predicted pedestrian velocity is equal to the known pedestrian velocity from the simulation, as per the PCSC Equation 6. Upper and lower bounds are 95th percentile confidence intervals (CI) of the data sets. It can be observed that some samples have fewer dataset points, consequently the CI is smaller, nevertheless it can be observed that the datasets generated are close enough to land within the 95th percent confident interval, hence voiding the need for further computation. For each pedestrian velocity, the standard deviation is calculated, and the upper and lower bounds are evaluated as per Equation 7 [17]. The results of simulations for the Toyota Yaris with an approach angle of 0° are illustrated in Figure 14, and the same for the Toyota RAV-4 in Figure 15. Tabulated results of all simulations are provided in Appendix B.

The results for the Toyota Yaris show that the PCSC can accurately return a pedestrian crossing velocity within a

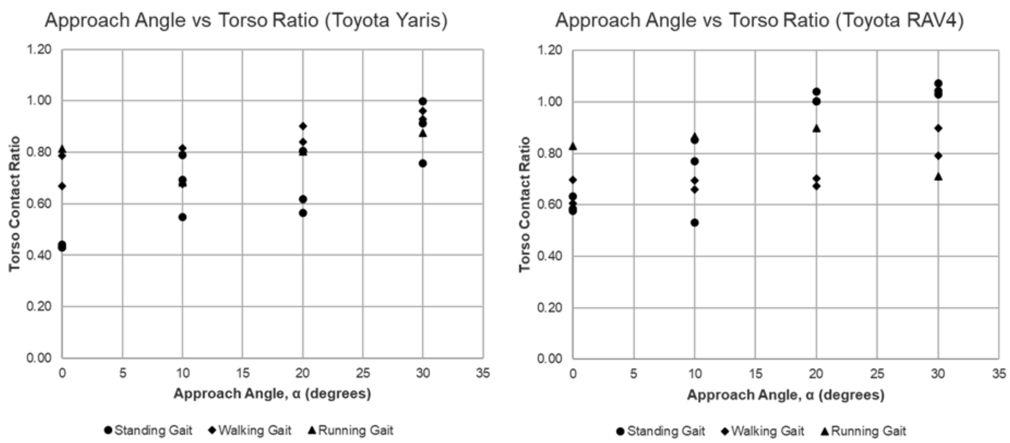


Figure 13 - *Torso contact ratio with increasing approach angle, (left) Toyota Yaris (right) Toyota RAV-4.*

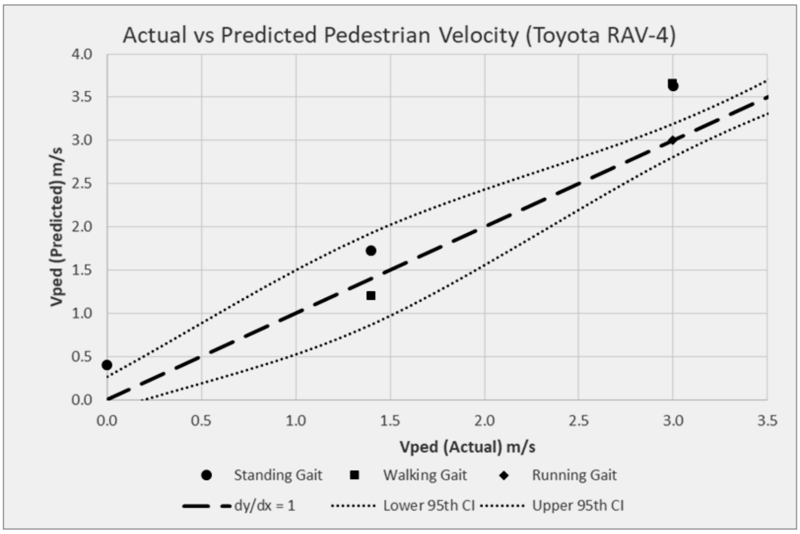


Figure 15 - *PCSC results from simulations with a Toyota RAV-4, with an approach angle of 0°.*

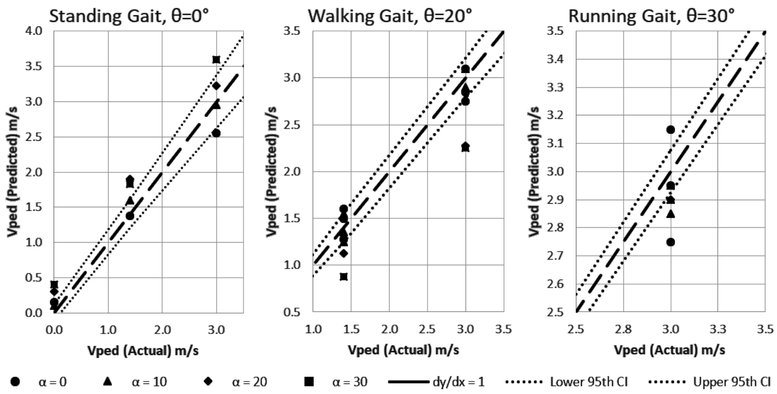


Figure 16 - *PCSC results from simulations with a Toyota Yaris, with an approach angle of 0-30°.*

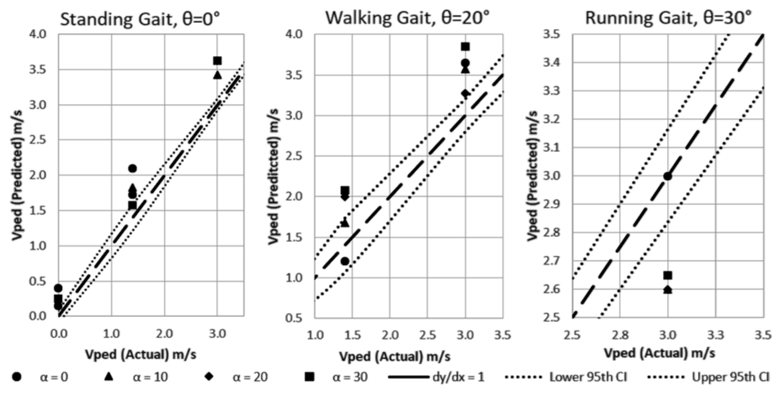


Figure 17 - *PCSC results from simulations with a Toyota RAV-4, with an approach angle of 0-30°.*

95% confidence interval for a = 0°. The results of the Toyota RAV-4 are less conclusive, tending to overestimate the crossing velocity of the pedestrian. The reasons for this will be discussed later. However, the RAV-4 for a running gait at running speed the calculator returned a value of 3.0m/s, identical to the known pedestrian crossing velocity.

The results of a change in approach angle are illustrated in Figure 16 and Figure 17.

For a change in approach angle with the Toyota Yaris, for both the standing and walking gaits above 10°, the predicted velocity falls outside of the confidence intervals. For the running gait, the confidence interval is very narrow, causing the results to also fall outside. However, this still gives a good indication of the general crossing speed of the pedestrian at the time of impact.

The change in approach angle with the Toyota RAV-4 in Figure 17 shows the results of an SUV type vehicle are not suitable for the PCSC. The standing and walking gaits overestimate the predicted velocity, and the results with a running gait are underestimated.

4.0 Discussion

The PCSC was previously validated against three real world cases, where the vehicles had low leading bonnet edges and pedestrian approach angles of 0° [1]. The results of the simulations with the Toyota

Yaris further validate the theory when a = 0-10°. However, when the same simulations are computed with a Toyota RAV-4 the results fall out of the 95th confidence interval bounds. In these scenarios, the standing gaits and walking gaits are overestimated, and the results of the running gait are underestimated. This would suggest a consistent factor is causing miscalculation. The obvious differentiator between the two vehicles is the difference in front end geometry, as the Toyota RAV-4 has a significantly flatter and higher front end than the Toyota Yaris. The increased height of the bonnet leading edge of the Toyota RAV-4 means that the pedestrian spends a greater amount of time attached to the front of the vehicle. This directly affects the two variables that produce the directional vector, W and H. A decrease in H causes the predicted velocity to rise. The increase in frontal wrap causes the pedestrian to fold over the bonnet leading edge, as opposed to being deflected over this edge with the Toyota Yaris. This is unavoidable, and is due to the location of the pedestrian's CoG relative to the height of the bonnet leading edge. This factor is then exaggerated by the reduced velocity of the H component caused by an increase in contact time on the front end of the vehicle. Combined, this causes a shorter H distance between the two dents, creating a more acute angle of the directional vector. This in turn returns a higher predicted pedestrian velocity. This is illustrated in Figure 18, where stills of the simulation show the different pedestrian wraps.

For the Toyota RAV-4, the standing and walking gaits results are consistently above the true pedestrian velocity as per the reason above. However, this is reversed with the running gait results, where the pedestrian velocity is underestimated. This is hypothesised as being due to the position of the pedestrian's leg relative to the CoG of their head. For the standing and running gaits, the struck leg is forward of the head, and the opposite is true for the running gaits. This causes the pedestrian to land on their front (leg forward of head CoG) or on their back (leg rearward of head CoG). The same wrapping phenomenon is observed with the pedestrian's leg rearward of the CoG. For the standing/walking gaits, the wrap causes a shortening of H. For the running pedestrian, this also happens, but due to the algebra of the PCSC causes a decrease in predicted pedestrian velocity. Therefore, for all gaits there is potential for a correction factor to be utilised if the pedestrian collides with an SUV. Whether or not this 'constant' would be the same for all SUVs would require further simulations, with vehicles of different front-end geometries and bonnet leading edge heights. The THUM's anthropometry would also need considering, as this will also affect the amount of 'stick' time on the front of the SUV. All these factors can then be combined to find the magnitude of the correction factor/s needed.

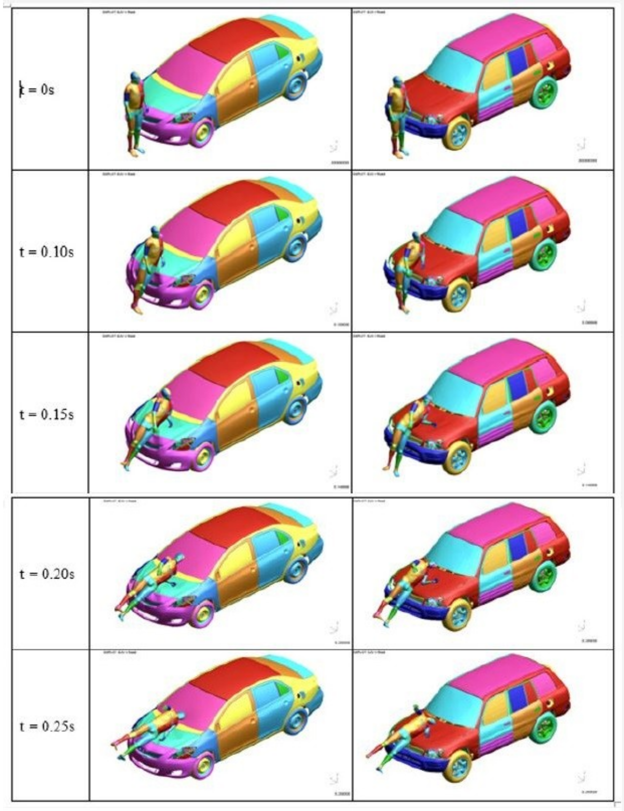


Figure 18: *Differences in pedestrian wrapping for the Toyota Yaris (left) and Toyota RAV-4 (right) at different time.*

When the approach angle is '0', the effect of the pedestrian gait on the dent width observed on the bonnet of the Toyota Yaris and further validates the PCSC base assumption that gait and dent are linked for crossing perpendicularly to the road. A smaller pedestrian gait produces a narrower dent, with dent size increasing with pedestrian gait angle. The increase between the walking and running dent width was small compared to the difference between the standing and walking gait. This could partly be attributed to the difference in gait angles between the three stances chosen, with a standing gait of 0°, a walking gait of 20° and a running gait of 30°. It is therefore unsurprising that the absolute difference between the walking and running gaits is small. When $\alpha = 0°$ with the Toyota RAV-4, the increase in dent width for a standing gait is likely due to increased rotation of the pedestrian during contact with the front end. The Toyota RAV-4 cannot validate the theory on increased gait width causing an increase in dent width. The increased dent widths at standing gait makes it difficult to distinguish the difference between standing and walking gaits.

In the Toyota RAV-4 case, when the approach angle increases, it becomes more difficult to distinguish an increase in dent width with an increase in pedestrian gait angle. For any approach angle above 0°, with a collision with the Toyota Yaris, the pedestrian gait angle cannot be determined from the dent width alone. For the Toyota RAV-4, it is further shown that the dent width cannot be estimated from any approach angle of the pedestrian. This can be again attributed to the extended time the pedestrian spends on the front of the vehicle. Yet, the difference in dent width for a pedestrian with a walking gait with an approach angle of 0-20° remains constant, only rising at 30°. The extended contact time does not seem to rotate the pedestrian with a walking gait until a more extreme approach angle is observed.

It must also be noted that the method of measuring these dent widths is not the most robust, and can be greatly influenced by the computer user measuring these widths. Care was taken to make these measurements accurate and repeatable, however there is undoubtedly some variance in measurement. The position of the arm during the collision also seems to influence the pedestrian kinematics; it has been observed that the arm can change the vector of the pedestrian on impact, although it is unknown how much difference this makes to the impact location of the head. When measuring dent widths, the arm can be the body part that leads the human into the bonnet. This makes the dent relative to the arm and not the torso, which will make it difficult to measure reliably in a real collision incident if the gait width is being estimated from the dent width.

5.0 Conclusions

The range of application of the PCSC theory was evaluated and confirmed that the PCSC equations predicted accurately the pedestrian crossing velocity for low approach angles against a saloon vehicle. This PCSC validation was conducted using 24 computer simulations, which confirmed the crossing velocity within a 95% CI for approach angles less than 10°. At approach angles exceeding 10°, it is still possible to distinguish the approximate condition of the pedestrian before contact, i.e. whether they are walking or running, albeit the velocity magnitudes are less accurate.

The same process was also carried out on a Toyota RAV-4, however the pedestrian crossing speed predictions did not compare with the PCSC expectations. The results of the RAV-4 simulations suggest that an overestimation of predicted velocity occurs for standing and walking gait angles, with running gait angles being underestimated. Several reasons for this based on observations of the results and simulation animations have been suggested.

An investigation into the hypothesis that an increase in pedestrian gait angle leads to an increased dent width was carried out. It was found that for the Toyota Yaris, at $\alpha = 0°$ the dent, or dirt bonnet smearing, width could be used to estimate pedestrian gait angle, but beyond 0° this was not possible. For the Toyota RAV-4, at no approach angle can a dent width be used to conclusively validate the pedestrian gait angle at impact.

If can be concluded that the range of application of the PCSC theory are now better understood and that in specific cases, this method could be a candidate as a forensic tool to compute the vehicle impact speed in hit-and-run cases

6.0 Recommendations for Further Work

A larger study on how the PCSC reacts to vehicle with a high leading bonnet edge, such as SUVs should be carried out. If enough data is gathered, a correction factor can be suggested for SUVs which is hypothesised will allow the PCSC to return a predicted velocity closer to the true value, and within an acceptable bound.

7.0 Acknowledgement

The authors would like to thank the Road Safety Trust [19] for their support in this research. This work was completed as part of project Road Safety Trust (RST 65 _3_2017) "Reducing Road Traffic Casualties Through Improved Forensic Techniques and Vehicle Design (RoaD)". The authors would also like to thank the UK Coroner and the UK Police forces for their support and expertise on pedestrian accident reconstruction and traumatology.

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See also 'ppendices 'A' and 'B' on pages 38 - 40

Impact

Submissions invited

Next Edition Summer 2021

As ever, the Editor would be very pleased to hear from members, non-members or subscribers, who have produced material that they feel would be of interest to readers of *'Impact'.* Details of research projects or relevant collision investigation testing would be particularly welcome. Attracting sufficient numbers of articles for publication in the Institute's journal remains a difficulty ! Whilst the Editor is delighted to receive papers from overseas contributors, a greater supply of 'home grown' material would also be very welcome.

If you have any questions regarding the publication of an article / paper, or simply wish to discuss the possibility of preparing a piece for the journal, please contact Steve Cash, at **editor@itai.org**

Appendix A : Tabulated Dent Width Results

Toyota Yaris, $\alpha = 0$

Pedestrian Gait	Vped (m/s)	Gait Angle (deg)	Dent Width (mm)	Torso Ratio
Standing	0.0	0.0	133.4	0.44
Standing	1.4	0.0	130.3	0.43
Standing	3.0	0.0	130.3	0.43
Walking	1.4	20.0	201.9	0.67
Walking	3.0	20.0	238.0	0.79
Running	3.0	30.0	245.6	0.81

Toyota RAV-4, $\alpha = 0$

Pedestrian Gait	Vped (m/s)	Gait Angle (deg)	Dent Width (mm)	Torso Ratio
Standing	0.0	0.0	176.4	0.58
Standing	1.4	0.0	174.4	0.58
Standing	3.0	0.0	191.5	0.63
Walking	1.4	20.0	182.9	0.61
Walking	3.0	20.0	210.8	0.70
Running	3.0	30.0	250.7	0.83

Toyota Yaris, $\alpha = 0\text{-}30°$

Pedestrian Gait	Vped (m/s)	Approach Angle (deg)	Dent Width (mm)	Torso Ratio
Standing	0.0	0.0	133.4	0.44
Standing	1.4	0.0	130.3	0.43
Standing	3.0	0.0	130.3	0.43
Standing	0.0	10.0	209.1	0.69
Standing	1.4	10.0	238.3	0.79
Standing	3.0	10.0	165.7	0.55
Standing	0.0	20.0	170.5	0.56
Standing	1.4	20.0	186.9	0.62
Standing	3.0	20.0	243.3	0.81
Standing	0.0	30.0	229.0	0.76
Standing	1.4	30.0	276.1	0.91
Standing	3.0	30.0	301.9	1.00
Walking	1.4	0.0	201.9	0.67
Walking	3.0	0.0	238.0	0.79
Walking	1.4	10.0	204.7	0.68
Walking	3.0	10.0	247.0	0.82
Walking	1.4	20.0	254.3	0.84
Walking	3.0	20.0	272.5	0.90
Walking	1.4	30.0	280.6	0.93
Walking	3.0	30.0	290.0	0.96
Running	3.0	0.0	245.6	0.81
Running	3.0	10.0	205.8	0.68
Running	3.0	20.0	242.7	0.80
Running	3.0	30.0	264.2	0.87

Appendix 'A' (continued)
Tabulated Dent Width Results

Toyota RAV-4, **α = 0-30°**

Pedestrian Gait	Vped (m/s)	Approach Angle (deg)	Dent Width (mm)	Torso Ratio
Standing	0.0	0	176.4	0.58
Standing	1.4	0	174.4	0.58
Standing	3.0	0	191.5	0.63
Standing	0.0	10	160.8	0.53
Standing	1.4	10	257.9	0.85
Standing	3.0	10	232.6	0.77
Standing	0.0	20	303.2	1.00
Standing	1.4	20	302.7	1.00
Standing	3.0	20	314.6	1.04
Standing	0.0	30	310.9	1.03
Standing	1.4	30	315.4	1.04
Standing	3.0	30	323.6	1.07
Walking	1.4	0	182.9	0.61
Walking	3.0	0	210.8	0.70
Walking	1.4	10	209.8	0.69
Walking	3.0	10	199.5	0.66
Walking	1.4	20	203.7	0.67
Walking	3.0	20	212.4	0.70
Walking	1.4	30	238.9	0.79
Walking	3.0	30	271.5	0.90
Running	3.0	0	250.7	0.83
Running	3.0	10	261.3	0.86
Running	3.0	20	271.7	0.90
Running	3.0	30	214.7	0.71

Continued overleaf …………

Appendix B

Tabulated simulation results.

Toyota Yaris

Pedestrian Gait	α (deg)	Vped Actual (m/s)	Vped Predicted (m/s)	Error (Abs)	Error (%)	Result Time (s)
Standing	0	0.0	0.15	0.15	100	0.50
Standing	0	1.4	1.38	-0.02	-1.81	0.50
Standing	0	3.0	2.55	-0.45	-17.65	0.50
Standing	10	0.0	0.10	0.10	100	0.40
Standing	10	1.4	1.60	0.20	12.50	0.40
Standing	10	3.0	2.95	-0.05	-1.69	0.50
Standing	20	0.0	0.30	0.30	100	0.40
Standing	20	1.4	1.90	0.50	26.32	0.40
Standing	20	3.0	3.22	0.22	6.83	0.50
Standing	30	0.0	0.40	0.40	100	0.40
Standing	30	1.4	1.83	0.43	23.29	0.50
Standing	30	3.0	3.60	0.60	16.67	0.50
Walking	0	1.4	1.50	0.10	6.67	0.40
Walking	0	3.0	2.75	-0.25	-9.10	0.50
Walking	10	1.4	1.25	-0.15	-12.00	0.50
Walking	10	3.0	2.78	-0.22	-7.91	0.25
Walking	20	1.4	1.13	-0.28	-24.44	0.50
Walking	20	3.0	2.28	-0.73	-31.87	0.40
Walking	30	1.4	0.88	-0.53	-60.00	0.50
Walking	30	3.0	2.25	-0.75	-33.33	0.50
Running	0	3.0	3.15	0.15	4.76	0.45
Running	10	3.0	2.95	-0.05	-1.69	0.45
Running	20	3.0	2.90	-0.10	-3.45	0.50
Running	30	3.0	2.85	-0.15	-5.26	0.50

Toyota RAV-4

Pedestrian Gait	α (deg)	Vped Actual (m/s)	Vped Predicted (m/s)	Error (Abs)	Error (%)	Result Time (s)
Standing	0	0.0	0.40	0.40	100	0.50
Standing	0	1.4	1.73	0.33	18.84	0.50
Standing	0	3.0	3.63	0.63	17.24	0.50
Standing	10	0.0	0.25	0.25	100	0.40
Standing	10	1.4	1.83	0.43	23.29	0.40
Standing	10	3.0	3.43	0.43	12.41	0.50
Standing	20	0.0	0.15	0.15	100	0.40
Standing	20	1.4	2.10	0.70	33.33	0.40
Standing	20	3.0	3.63	0.63	17.24	0.50
Standing	30	0.0	0.25	0.25	100	0.40
Standing	30	1.4	1.58	0.18	11.11	0.50
Standing	30	3.0	3.63	0.63	17.24	0.50
Walking	0	1.4	1.20	-0.20	-16.67	0.40
Walking	0	3.0	3.65	0.65	17.81	0.50
Walking	10	1.4	1.68	0.28	16.42	0.50
Walking	10	3.0	3.58	0.58	16.08	0.25
Walking	20	1.4	2.00	0.60	30.00	0.50
Walking	20	3.0	3.28	0.28	8.40	0.40
Walking	30	1.4	2.08	0.68	32.53	0.50
Walking	30	3.0	3.85	0.85	22.08	0.50
Running	0	3.0	3.00	0.00	0.00	0.45
Running	10	3.0	2.60	-0.40	-15.38	0.45
Running	20	3.0	2.60	-0.40	-15.38	0.50
Running	30	3.0	2.65	-0.35	-13.21	0.5

Brake : 'Forgotten Victims' Report

Mary Williams OBE : Chief Executive of Brake

Editor's Note : Limits on column space in *'Impact'* mean that it is not possible to reprint the whole of the Forgotten Victims Report produced by the road victims' charity 'Brake'. The Preface (by Mary Williams OBE - Chief Executive of 'Brake') together with Conclusions, Recommendations and a Summary of the Report are here reprinted by kind permission of the charity.

The full report can be found online at -

https://www.brake.org.uk/files/downloads/Reports/Victim-support-reports/Brake-report-Forgotten-victims.pdf

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Preface

25 years ago, people affected by road death and serious injury in the UK were unlikely to be offered any level of emotional support or help with practical or procedural issues. Police forces did their best in trying circumstances, producing leaflets for road crash victims about grief (that were, at police forces' own admission, inadequate) that they handed out when delivering the "knock on the door". Many well-meaning police officers tried to deliver emotional support themselves, with no training in helping people bereaved or injured in such horrific circumstances, and with no support for their own welfare.

When Brake was founded in 1995, the charity quickly recognised the need for standardised, care for every bereaved family (and those suffering a life-changing injury too), regardless of where they lived, and in partnership with the police. We considered what could be provided as quickly as possible, but to a high standard, to help as much as possible, with little funding.

A decision was taken by the charity to consult widely within criminal justice agencies, bereavement specialists and fellow NGOs to prepare a pack of information, objectively written, using plain English, that would give families the information needed at this terrible time and signpost them to sources of further help. This information was presented in a resilient, hard-bound ring binder that gave the pack, and the tragedy itself, deserving status and covered all issues ranging from coping with shock reactions to claiming compensation.

Police immediately welcomed what become widely known as "the Brake support pack", and the charity, thanks to corporate donations, was able to produce versions for all countries in the UK, and ensure that police family liaison officers received stocks. We were also able to start taking calls from families wanting support and further information.

The quality and value of the service, and its standardised national impact, was immediately recognised by the Home Office which began to fund the charity's provision of the support pack and down the line support alongside corporate support.

From there, the charity was able to grow and develop the National Road Victim Service. The support pack continues to be delivered immediately to all families in all cases involving a fatality. Combined with down-the-line support, by phone or in other ways, the service provides accredited national help, giving vital support and advocacy to families (and professionals working alongside them), delivered by named and trained case workers. This service works to protocoled standards and delivers support in many of the UK's most devastating crashes. We also assist UK citizens affected by a crash outside the UK thanks to funding from the Foreign, Commonwealth and Development Office.

The charity also provides a professional engagement programme for police 'family liaison officers' including training, an annual conference and an awards programme. The charity has launched an online learning hub for family liaison officers and other online tools as part of our pandemic response.

For the past five years, the charity has been working to retain our small levels of England and Wales statutory funding from the Ministry of Justice (which took over funding from the Home Office), which part-funded the National Road Victim Service. Funding for "victims of crime" has now been devolved to Police and Crime Commissioners but funding for road crash victims by PCCs requires us to liaise with every force across the UK, which is a timely effort, and also battle the wrong-minded perspective that our victim group does not deserve priority support through police funding because not all road crashes involve a crime (despite all road deaths resulting in a criminal investigation and being equally as horrific as homicide). Road deaths often involve a crime, and always involve a criminal investigation.

Despite this fundamental problem, around half PCCs are now contributing a small amount each to the cost of operating Brake's National Road Victim

Service, demonstrating commitment to our service; but these are small grants and donations that are insufficient to sustain or develop the service to be even more effective locally. Funding must be obtained at higher levels either centrally or locally or both.

Meanwhile funding from statutory agencies for our work in Scotland (Scottish Government), our work in Northern Ireland (Police Service Northern Ireland) and our work supporting UK citizens bereaved abroad (Foreign, Commonwealth and Development Office) continues, for which the charity is most grateful, along with additional corporate funding.

In early 2020 the Department for Transport stepped in and provided emergency top up funding of the service in England and Wales for a year. The goal now is to ensure sustainable statutory funding for this vital service providing national, standardised coverage for people across the UK and developing the service appropriately in ways explained in our strategy, which requires higher levels of funding.

Brake has an ambitious but necessary strategy of strengthening the National Road Victim Service and its impact. We want our quality, standardised support service to: reach more bereaved and seriously injured people, more easily, across all regions; enhance our service through more, and closer, partnerships with community providers of complementary care services; and, importantly, more comprehensively evaluate the effectiveness of our service against wellbeing outcomes for users. Only a small minority of police force areas in the UK have additional, locally-run support services for road crash victims.

Perhaps the most pertinent point made in this report is the levels of funding provided, centrally, by the Ministry of Justice to victims of homicide. People bereaved by road death are as devastated as people bereaved by murder. Yet funds given by the Ministry of Justice for care of road crash victims were only 1.3% of the amount given to care for homicide victims. The reasons why this funding for homicide victims was provided (to ensure a consistently high standard of care for people bereaved in one of the worst ways possible) equally apply to road crash victims.

I urge government, corporate funders and grant aiders to read this report, which outlines the current situation in detail, and support, through funding, the further development of the National Road Victim Service. We will happily put you in touch with families and police family liaison officers across the length and breadth of the UK who will tell you the life-saving value of what we do.

Further strengthening our understanding of the needs of road crash victims, it is important to also understand that, as a pandemic response, Brake has hosted the development of Sudden, a service for anyone bereaved suddenly in any way, inclusive of COVID-19 victims. Sudden has received start-up funding from government and other grants to develop an early intervention care service, specifically for the first ten weeks after a sudden or 'too-soon' death, either through illness, injury or suicide. This service's development, which is funded for the financial year 2020/21 but as yet not significantly beyond, strengthens our understanding of the needs of road crash victims for a national service that is sustainable, and how best to help. The two services complement and inform the development of the other.

This report is produced for a simple reason; to raise awareness and funding for the National Road Victim Service. Thank you for reading on and then helping.

Conclusions

1. The National Road Victim Service provided by Brake is an acclaimed and accredited service valued by victims and professionals, offering a standardised approach, and helps the well-being of road crash victims across all regions of the UK. With sustained and additional funding it could help further, at levels comparative to the Homicide Service.

2. The National Road Victim Service is particularly valued by its main professional partner; the police.

3. Initial calculations by Brake estimate that the National Road Victim Service in its current format provides an annual saving to police of £2.2m (in time saved caring for road crash victims) against a basic cost of the down-the-line National Road Victim Service caseworker service and pack provision of £440,000 for 2020. Other professionals in the criminal justice system and care professions - for example GPs - will benefit from additional savings.

4. Funding for the National Road Victim Service to date has been woefully inadequate compared with the Homicide Service, has had to be annually fought for in recent years, and for the financial year 2021/22 and beyond is inadequately secure to cover basic costs as outlined in 3 above, nor service development to reach more victims with a further enhanced service.

5. The development of Brake's National Road Victim Service strategy (summer 2020), to meet more comprehensively the grave needs of road crash victims, will require funding in excess of £440,000. The cost of funding the Homicide Service demonstrates the cost of caring for people who are suddenly bereaved by a violent event involving a criminal investigation; and road crash victims bereaved and suffering life-changing injury exceed numbers of homicide victims.

6. There is no government department in England and Wales currently taking lead responsibility for national strategy nor providing access to sustainable funding to provide support for people bereaved and suffering life-changing injury in road crashes. (The roads policing review, ongoing by the Department for Transport has the potential to progress and resolve work in this space.)

Recommendations

1. Central government for England and Wales takes responsibility for the strategic necessity of victim care for road crash victims in England and Wales. This is assigned to one departmental minister to take responsibility for it, with cross-department involvement and agreement of the necessity of need; involving, importantly, the Association of Police and Crime Commissioners and other stakeholders, notably Brake. Given the consistent failure of the Ministry of Justice to take sustained responsibility, an appropriate alternate department could be the Department for Transport, given the UN pillar of post-crash care, and given the department's increasing interest and involvement in road policing.

2. The long-standing, acclaimed and accredited Brake-developed National Road Victim Service in England and Wales, and its further strategic development appropriate to victim need, is considered, by the chosen lead department. A plan is arranged to provide sustainable funding at a level agreed to assist road crash victims, for a multi-year duration that is sustainable, either through central funding or through Association of Police and Crime Commissioner-led direction to PCCs to each fund to a particular level. Within that plan, funding is assured for continuation of the National Road Victim Service and its development, sustaining and building upon its wealth of knowledge and credibility of service provision.

Mary Williams OBE - CEO of Brake

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See also 'Appendix 'A' overleaf

Appendix 1: The police perspective: a valued service offering value for money (summary report)

In December 2019, Brake surveyed Family Liaison Officers (FLOs) regarding the value provided by its National Road Victim Service.

FLOs value Brake's National Road Victim Service (NRVS), rating its importance to their work as 9 out of 10. Brake's bereavement literature is rated as a 10 in importance.[19]

Family Liaison Co-ordinators tell us that the NRVS significantly reduces FLO workload and improves outcomes for victims. Without it FLOs would need to keep their phones on all the time, and victims would become frustrated if they couldn't get hold of their FLO. They say it is likely that outcomes for victims would be worse without the support from Brake, increasing pressure on the police.

"*Brake is an integral part of the jigsaw in moving family/friends or next of kin forward to closure, healing or getting on with their lives.*"[20]

The FLOs and their coordinators tell us they do not have the expertise nor capacity to meet all the support needs of people bereaved victims of crashes, and it is not within their remit to do so. They rely on Brake to provide that expertise; and FLOs also access support and guidance directly from Brake.

"*The FLO's are not trained nor able to provide the pastoral care and support families need but it is crucial to their role that they have a* ***reliable*** *resource available to them to which they can direct them.*"[21]

The NRVS means FLOs can manage victims' support expectations by providing high quality information in the form of the Brake pack and direct victims to the helpline where they have questions or require support.

The National Road Victim Service saves statutory services money.

The NRVS's early intervention and lasting care is focussed on reducing the suffering of road crash victims and increasing their ability to cope with their situation. This frees up police time, resources and training costs. It increases victims' chance of recovery, reducing pressure (and cost) on statutory services such as health services, education and benefits.

Based on feedback from police colleagues, Brake estimates that the average saving to police services for each victim that uses the Brake helpline is a minimum of £3,000 and a total annual saving of over £2.2m.[22]

Like FLOs, many **Police and Crime Commissioners** believe there is a need for a dedicated national road crash victim support service, in comparison to generic victim support. The main reasons given are that it provides consistency, specialism and independent support. One PCC said they "*rely on support provided by Brake.*"[23]

There are significant concerns amongst PCCs at the potential loss of funding for Brake's NRVS service. Many believe there would be a gap in services without centralised, national funding for the Brake service, and value the quality of Brake's work.

"*We would see a significant gap if national funding were to be removed.*"[24]

Even in the small number of areas where alternative support arrangements are at least partially in place, PCCs had concerns about victims who have a crash in one area but live in another.

"*A national helpline is able to ensure there is full interoperability for individuals out of their police force area.*"

Moreover, generalised crime victim services are not in a position to provide support unless it is clear a crime has been committed.

The Institute of Traffic Accident Investigators

Will provide a training course in the subject of occupant kinematics entitled :

Biomechanics in Accident Reconstruction

Presented by: Greg Sullenberger & Jeffrey Pike

To be held

14th to 18th June 2021

Online via the ‘ Zoom’ platform
Running between 10:00am & 6:00pm (BST)

This five-day training course on biomechanics and crash injury analysis in accident reconstruction will include training in various topics including:

Background anatomy and terminology;

Contact, non-contact and contrecoup injuries;

Forensic examination of vehicles;

Newton’s laws applied to vehicle inspection;

Newton’s laws, occupant trajectory and occupant injury;

Calculating and applying Delta V and PDOF to determine seating location;

Case studies including actual collisions.

Injury biomechanics;

Counter-intuitive injury mechanisms;

Matching vehicle damage and injuries;

Rollovers;

Crash reconstruction information from medical and autopsy reports;

Deployable and non-deployable occupant protection systems;

FURTHER DETAILS INCLUDING BOOKING AND INVOICING INFORMATION ON THE ITAI WEBSITE AT
https://www.itai.org/event-registration/?action=evrplusegister&event_id=6

The students will receive five full days’ training and their knowledge will be tested at the end of the course. Students will be accredited with their attendance and the course will attract a minimum of 30 hours CPD.

The cost for members (Student, Affiliate, Associate & Member) to attend this workshop will be:

ITAI Members - £350.00 - Non-Members - £425.00

All enquiries, including if you need to pay via an issued invoice, should be made via e-mail to: gensec@itai.org : or call: +44 (0)8456 21 20 66

Collision Investigation training to degree level

In partnership with De Montfort University, AiTS offers a full range of collision investigation qualifications from entry level to full BSc (Hons). The programmes are designed to be studied part-time (60 credits per year) using a range of delivery methods including classroom and distance learning.

The entry level UCPD in Forensic Road Collision Investigation is designed for those new to the profession. The course covers maths, physics and additional collision investigation tools to enable you to reconstruct collisions. Complete a further 60 credits at Level 4 to gain a CertHE in Forensic Collision Investigation.

Further knowledge can be gained via a range of professional qualifications, progressing through to the full degree. Once you have completed your UCPD, you may wish to : -

- Accrue a further 120 credits at Level 5 to gain the Foundation Degree (FdSc) in Forensic Road Collision Investigation
- Top up with 120 credits at Level 6 to gain a full BSc (Hons) degree in Forensic Road Collision Investigation

Courses are open to UK and overseas students. Access to HE programmes can be by similar / equivalent qualifications to the UCPD. The top up BSc (Hons) is open to students with other HE science-based qualifications. Contact us for further details.

During the current pandemic most modules run in distance learning mode with minimal contact time. Field days are run directly from the airfield when permitted.

For further information

Visit the Collision Investigation pages at **www.aitsuk.com**
or contact Anna Howe at **ahowe@aitsuk.com**

AiTS, Unit A5, Lakeside Business Park, South Cerney
Gloucestershire GL7 5XL. Tel +44(0)1285 864650

DE MONTFORT UNIVERSITY

aits training

AiTS Training courses for 2021

AiTS are pleased to present their residential programme for 2021

During the current pandemic, most modules are running in distance learning mode with minimal contact time. Field days are currently suspended due to Government Legislation. Our IMI short course programme for Vehicle Examination is also suspended.

Entry level qualification

UCPD in Forensic Collision Investigation - Starting 24th May 2021
This course will run in distance mode – spaces still available.

UCPD in Forensic Collision Investigation - Starting 27th September 2021
This course will run in block release mode. – spaces still available.

NB. From September 2021 the entry requirements and the way in which we deliver the UCPD will change. For further details please visit the collision investigation pages at www.aitsuk.com.

Higher education qualifications
CertHE, FdSc and BSc(Hons) starting 27th September 2021

Go to **www.aitsuk.com/calendar** for information about further courses

For further information, visit **www.aitsuk.com** or contact Anna Howe at **ahowe@aitsuk.com**

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aits training

Bringing everything into focus

CAMERACAL

Professional Camera & Lens Calibration, Servicing, Sensor Cleaning & Training

Courses commencing 1st May 2021

HONESTAS ET INTEGRITAS

Digital Photography for Forensic Collision Investigators

A camera is possibly one of the most important pieces of equipment a Collision Investigator has available to them, when capturing evidence, but it is also one of the most overlooked, when it comes to training. A view not shared by the Forensic Science Regulator or us! It is apparent that Collision Investigators need to be able demonstrate that they have been trained to use equipment and that they are competent, understand the technology and are compliant with guidance and regulations in the field and for many, ISO compliance is now a necessity. Our newly revamped course for Forensic Collision Investigators, features comprehensive and detailed training, assessments and examinations, backed up by training staff with over 30 years experience in the photographic industry, 30 years experience in Collision Investigation, plus our own studio, equipped with computers, lighting, photographic equipment and outside areas for practical sessions. Its also a valuable source of CPD and recognised by ITAI. Certificate issued upon successful completion of examinations and assignments.

What does it cover? We're glad you asked!

- Full frame, APS-C and Mirrorless camera systems
- Lens systems, Sensors, IBIS and VR systems
- Day, night, macro and flash photography
- Audit trails, ITAI Good Practice and ISO compliance
- Storage media and battery maintenance
- Auxiliary lighting systems (flash, off camera systems), tripods and supports
- Camera modes (Program, Shutter, Aperture and Manual - and how, why and when to use them)
- Focussing systems, focal lengths and depth of field
- Exposure, metering, white balance, ISO, and EV Compensation
- RAW vs jpeg
- Histograms, exif data and how to read it, examining images to determine settings used and editing undertaken, Bracketing, Focus stacking and HDR
- How to - photograph scenes, views, vehicles, damage and components
- How to back up and use images in reports
- Basic editing in Photoshop

Plus equipment maintenance and as the country's leading camera / lens calibration and sensor cleaning service we think we know a thing or two about this!

Courses are available both as on-line, or conditions permitting, face to face - or we can come to you!

Costs - On-line for ITAI members - £595 per person (12 week duration including assignments). Face to face for ITAI members - £625 per person (1 week classroom plus 6 weeks for assignments). (Non-ITAI members £695 and £725 respectively)

For more information or to discuss your specific needs, please contact us on - Email: training@cameracal.uk

or call us on 01798 306599, and you can visit our website at www.cameracal.co.uk

WREX 2023 April 17 – 21, Orlando, Florida

Larger and Better Than WREX 2016

The next World Reconstruction Exposition, WREX 2023, will be held on April 17 – 21, 2023 at the Rosen Shingle Creek Hotel in Orlando, Florida. WREX 2016 was the largest crash conference ever hosted and many attendees said that it was the best they had ever attended. WREX 2023 is expected to be larger and even better than WREX 2016.

International Planning

WREX 2023 will be hosted by a large group of international associations. Representatives from 24 groups are hard at work planning for, and refining, the next event. WREX 2023 will feature many of the top international speakers in the ever-expanding field of collision reconstruction. Crash Test Day at WREX 2023 will utilize multiple crash test teams to provide numerous high speed crash tests with minimal down time. The new off-site crash test location will facilitate easy access between staged collision events and provide for a better attendee experience. The Interactive Field-Testing Day (aka "Reconstruction Midway") at WREX 2023 will be held at a larger venue on site at the host hotel to accommodate even more exhibitors. High quality sit-down lunches will be served each day of the conference and are included as a part of your event registration fee. For those intent on getting the most bang for their training buck, evening presentations, including poster presentations of select collision reconstruction topics, will be available at WREX 2023.

Assist the Organisers by Pre-Registering Now

The WREX 2023 planning staff can do a better job coordinating this event with your cooperation. The staff asks you to visit the conference website - www.wrex.org and add your name to the list of attendees ASAP. There is no cost to "pre-register" and no penalty for removing your name. An approximate count of conference attendees will help the staff develop the best possible plan for the event. As a bonus for helping the staff by "pre-registering", two of the "pre-registered" attendees, whose names have been added to the list by September 30, 2021, will receive free admission to WREX 2023. Please help us to make this the best conference you have ever attended. Remember the attendee room block at the host hotel sold out in 2016. The WREX 2023 planning staff encourages you to reserve your hotel room ASAP to ensure your ability to stay on site while attending this sureto-be spectacular event.

If you were unable attend WREX 2016, speak to someone who did. We will see you at WREX 2023.

Pre-register now at : www.wrex.org