AN APPROACH TO THE STANDARDISATION OF ACCIDENT AND INJURY REGISTRATION SYSTEMS (STAIRS) IN EUROPE

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ABSTRACT

STAIRS is a European Commission funded study whose aim is to produce a set of guidelines for a harmonised, crash injury database.

The need to evaluate the effectiveness of the forthcoming European Union front and side impact directives has emphasised the need for real world crash injury data-sets that can be representative of the crash population throughout Europe. STAIRS will provide a methodology to achieve this. The ultimate aim of STAIRS is to produce a set of data collection tools which will aid decision making on vehicle crashworthiness as well as providing a means to evaluate the effectiveness of safety regulations. This paper will disseminate the up-to-date findings of the group as they try to harmonise their methods.

The stage has been reached where studies into the diverse methods of the UK, French and German systems of crash injury investigation have been undertaken. An assessment has already been made of the relationships between the three current systems in order to define the areas of agreement and divergence. The conclusions reached stated that there were many areas that are already closely related and that the differences were only at the detailed level.

With the emphasis on secondary safety and injury causation, core data sets were decided upon, taking into account: Vehicle description, collision configuration, structural response of vehicles, restraint and airbag performance, child restraint performance, Euro NCAP, Pedestrian and vehicle occupant kinematics, injury description and causation. Each variable was studied objectively, the important elements isolated and developed into a form that all partners were agreeable on. A glossary of terms is being developed as the project progresses which includes ISO standards and other definitions from the associated CAREPLUS project, which addresses the comparability of national data sets.

A major consideration of the group was the data collection method to be employed. The strengths and weaknesses of each study were investigated to obtain a clear idea of which aspects offered the best way forward. The quality of this information and transference into a common format, as well as the necessary error checking systems to be employed have just been completed and are described.

In tandem with this area of study the problem of the statistical relationship of each sample to the national population is also being investigated. The study proposes a mechanism to use a sample of crash injury data to represent the national and international crash injury population.

INTRODUCTION:

Researchers, manufacturers, insurers and regulatory bodies all have a role to play in the area of vehicle crashworthiness. Each has an individual approach to this area and uses similar information as a base for their judgements. However, none of the parties has the benefit of all the information that could be available. Three separate levels of collection systems are currently in place in several EU countries.

The first represents the National crash injury population - the accidents that occur throughout a country that meet certain criteria for inclusion. These criteria are different for each country and are not necessarily comparable. The second level forms a specialist database; insurance companies are the largest of this group and can include data from more than one country. However, a lot of the information is self reported and the quality of the information, including injuries, may not be of the required standard. The final level is derived from In-depth investigation systems. These include a high degree of detail, but consequently they may be more limited in number of cases. They also are derived from a set of inclusion criteria initially based on the crash notification process, plus other additional sampling variables (e.g. the presence of an injury).

It would obviously be preferable if all these systems were in some way compatible so that a better view of the overall situation could be observed. The aim of STAIRS is to give help and guidance at the in-depth level and to produce a set of data collection tools for:

- Research based vehicle safety policy-making,
- Measuring the effectiveness of vehicle safety regulations,
- Measuring the effectiveness of new safety systems,
- Identifying the need for new/revised vehicle safety regulations,
- Identifying areas requiring further research.

In order to progress this task, three of the largest in-depth investigation studies in Europe are being used: The Medical University of Hannover (Germany), The Co-operative Crash Injury Study (UK), and INRETS (France). Two areas of study were identified. The first concerns the actual data collection process; the second is the statistical problem of linking the in-depth sample to the national dataset.

The first work package has seven tasks to complete (See Figure 1), and deals with the collection process. Initially the three different systems of each country were assessed in order to find the strengths and weakness present, as well as looking at the initial level of compatibility that already existed between them. Following this, a nucleus of data had to be identified along with the collection methodology to be used. Relevant, practical quality checks were then identified concerning the accuracy of the data. A small pilot database was then collected in order to validate the previous steps, and finally the handling of sensitive data within the confines of each country's data protection laws was developed.

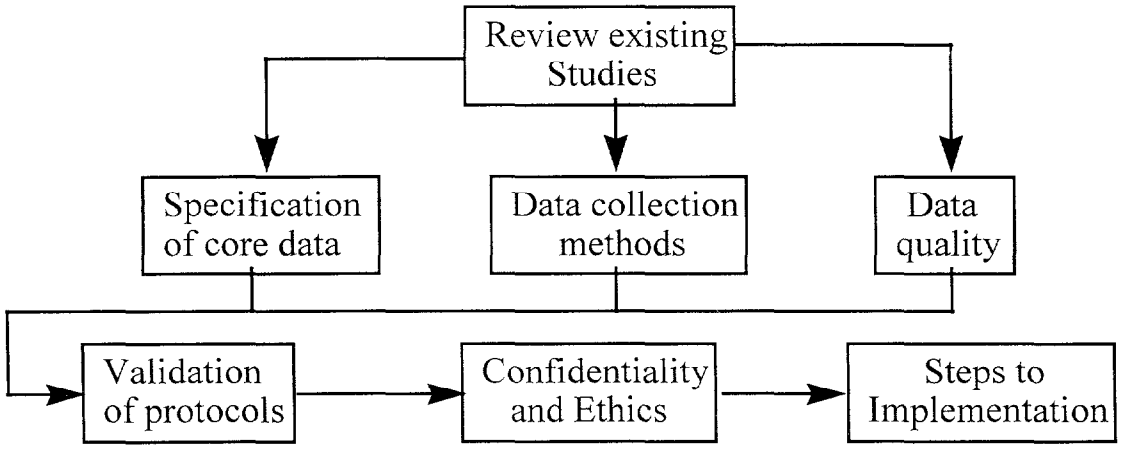

Figure 1. Work package one flowchart.

The second work package is designed to draw up a protocol so that a generalisation of the results from in-depth investigations can be related to the National database. The same three studies are being used to formulate this linkage. The tasks to complete in this work package are:

- Sampling and case selection,
- Comparability of data
- Correct usage of the databases.

The initial problems to overcome is the statistical relationship between the in-depth, local and national databases. A methodology is to be devised to take into account the biases between each of these databases so that a link can be made to national level, the limit of STAIRS.

There will be, within the overall strategy of this package, a connection to the CAREPLUS system so that a link between the National and International databases will be feasible.

WORK PACKAGE ONE.

Work Package 1.1 - Review of existing In-depth studies:

Germany has the longest running, consistent, single programme having commenced in 1973, collecting full 'in-depth' data from1985. The collection area is bound by the common border of Hannover, approximately 2,289km^2. It has a population of 1.2 million and is fairly representative of the national population in terms of its percentage of urban to rural areas. The study uses an on-scene, in-time collection methodology and has specialists in the injury, vehicle mechanics and road environment fields to collect the data.

The UK study CCIS (The Co-operative Crash Injury Study), began in 1983 although previous in-depth studies had been in existence since the sixties. There are two main collection teams based at Loughborough University (The Vehicle Safcty Research Centre), and Birmingham University (Birmingham Accidcnt Research Unit). There are a series of six smaller groups, the Vehicle Inspectorate, in other areas around the country. The project is managed by the Transport Research Laboratory (TRL). All information is collected in the same manner retrospectively. This entails going to investigate the vehicle at a recovery yard some days after the crash and taking all the necessary measures. This information is then collated with the injury information from the hospitals.

France has had different collection systems in place ever since the sixties. However the current large scale project only began in 1993. It consists of four teams. Two belong to The Institut National de Recherche des Transports et de leur Sécurité (INRETS), at Salon-de-Provence, and Lyon., the other two belong to the Centre Européen de Sécurité et d'Analyse des Risques (CEESAR), and are located in Amiens and Evreux. All the teams collected their data in the same way until recently. The methodology used is on-scene, in-time and includes a strong Primary Safety element with information on driver behaviour collected by a psychologist. Recently, the centre at Lyon has begun to collect its data retrospectively, although the information collected is similar. The impact of this change has yet to be assessed.

All three studies have common objectives, in particular, regarding the assistance given to policy makers and industry. This includes assessing the need for new regulations as well as the efficiency of the current laws. Each of the separate databases are also used to monitor new safety mechanisms, such as airbags or side impact bars, to see if they have affected the injuries sustained in different types of crashes. However, each study does have its own individual aims and objectives. The German study concentrates on the injury pattern and considers the efficiency of the emergency services in handling injuries and their outcome, while the French have a deep interest in the drivers psychological behaviour, and the UK study focuses on secondary safety and injury causation.

Although there are these divergent areas of interest, there is immense potential for convergence as collecting detailed descriptions of deformations and injuries and other main methods are entirely compatible, with the differences being in the detail. This is due to the individual aims of each study and need not be compromised to achieve compatibility. A series of variables are common throughout the studies, but the interpretation of the exact meaning is slightly different. If a glossary of terms could be agreed as well as the method of collection, then there are no reasons why steps cannot be made towards compatible systems within each country.

Work Package 1.2 - Variables and values:

This work package seeks to define a group of variables, upon which all partners agree, and which are essential for a detailed accident database. The data is a minimum set and it is expected that groups will add extra details or extra variables to reflect particular interests. However it should be possible to reduce any enhanced dataset down to the STAIRS level without ambiguity.

Initially each partner put forward a list of the variables they deemed necessary for the above. Discussion took place until there was consent as to the exact interpretation of the variables meaning. This has, on certain occasions, necessitated the variable to develop into a new form that none of the current systems collect, but with the ability to be compatible with the old formats in each of the databases. If an international standard was already in place then it was, if possible, adopted and integrated into the lists. The intent is not to re-invent the current collection systems, but to provide the opportunity of developing a new one.

The document is set out in a logical manner beginning with: accident configuration, followed by the vehicle description, pre- and post-crash measurements, seats (including child restraints), intrusion, pedestrians, casualty and finally the injury section (See Table 1)

VARIABLE	VARIABLE
Accident Details	Number of Vehicles
Number of People	Vehicle Description
Pre-crash Measurements	Post-crash Measurements
Doors	Seats
Restraint Details	Airbag
Child Restraint Evaluation	Measurement of Intrusion
Pedestrian	Casualty
Occupant and Injury Details	Single Injury Description

Table 1 Document Variable Headings

The collision partner list includes a wide range of vehicles, most of which are not covered in the body of the work.

It is envisaged that the variables used are transferable and can be enhanced to suit whatever area of interest is being investigated. Similarly, the list is seen as modular, with headings to be omitted or new ones added or enhanced as the user requires. The list will also develop with time, and is not to be taken as a rigorous, defined system. New areas are being added all the time, and the current list includes Euro NCAP variables and other current EU-Commission research projects such as CREST, COST 327.

Variables have been added in the 'accident configuration' section which relate to those collected at national level. This is to enable a link between the in-depth investigations and the national databases. Many variables that are extremely helpful in defining collision types could not be used as there was no comparable equal across the participating countries. An example is that of 'type of road'. The definitions within each country were based on completely different lines, from traffic flow to whether the road lies within a town boundary or not. These disparities were too great to overcome, but work is being done within the CAREPLUS programme that may help in this area in the future.

The Collision Partner Configuration table (See figure 2) was developed to enable a quick reference to the type of vehicles involved. This idea of using a grid or matrix to refer to certain pieces of information which may include a number of variables has been used throughout the work package; from an intrusion 'matrix' to the locating of pedestrian contacts on the exterior of a vehicle's bonnet.

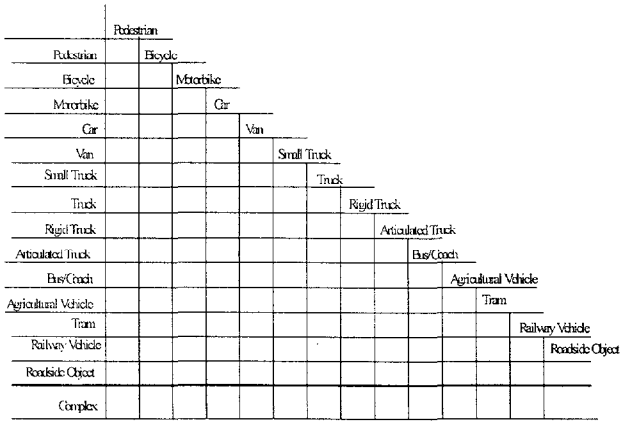

Figure 2 Collision Partner Configuration Table

Many areas which are currently very contentious were examined with a view to developing a new paradigm. However, it was accepted that some areas, such as refined methods to estimate collision speed, were too large a subject for the STAIRS project to cover and outside of its remit. In other areas the current practice was developed and extended to produce a hybrid. The extra digits in the collision deformation measurements and in the AIS injury descriptions are examples of this. Others, such as intrusion, were developed to a lesser degree but do give a starting point to work from.

Essentially STAIRS is concerned with secondary safety, and as such deals mainly with investigating the crashworthiness of the vehicle. Particular emphasis was placed on the presence of safety components and their effectiveness. This has necessitated taking into account current and proposed standards. Euro NCAP variables are included throughout the document and consideration was given to the new side impact tests when the collision deformation measurements were discussed. Details of child restraints were also included as this was deemed an area that will require more investigation in the future.

The body of the document is laid out with the variable on the left, followed by the attendant values, and finally by a notes section (See figure 3). The notes section is intended to clarify the meaning of either the variable or the value or explain the protocols to be used when collecting the data. This is particularly relevant within the new systems detailed for intrusion, injuries and pedestrian contact location.

There is a copy of the complete document on the World Wide Web at the URL www.ice.co.uk/stairs.

Variable	Value	Notes
Post-crash measurements: Collision condition		
Number of collisions	Number	Total number of collisions for the considered vehicle in the crash
Chronological collision number	Number	Collision number in the chronological series of the collision sustained by the vehicle
Collision number (by severity)	Number	The ordering is dependant on the severity, 1 being the most severe (in terms of deformation).
Collision partner		See previous list in section.
Mass of collision partner		In Kilograms
Overlap	In percent (%)	Percentage of the area of the concerned vehicle in contact with the obstacle in the crash
Collision angle	In hours	Angle formed by the longitudinal axes of the vehicle and the obstacle at the time of collision. Longitudinal axis to the front refers to 12 o'clock. See figure 6.
Direction of force	In hours	Give the direction of the main force sustained by the vehicle. Longitudinal axis to the front refers to 12 o'clock.
Rollover	Yes/No	In case of 4-wheeled vehicle including overturning to the side
Under-run	Yes/No	Main impact is to the upper area of the vehicle where it is mostly glazing .
Final position	On wheels	This is the vehicle position after the crash
	Left side	
	Right side	
	Roof	

Figure 3 Example of a page from the Variables and values document

WORK PACKAGE TWO.

Combining the datasets from several countries is complex. If the analysis of the data were just used for linking injury outcome with vehicle performance, then sampling methods would not be a problem. However, STAIRS is to be used as a tool for a better understanding of the European crash population. In order to achieve this the case selection process must produce representative data. To link in-depth data to a subset of the local accident population, and from there link to a subset of the national population, will involve using weighting factors through a two stage process.

Currently only working documents have been produced, but the following is a synopsis of the current situation. Both France and the UK are planning the linkage between their respective in-depth databases and the appropriate local/national databases by use of common variables (see figure 4). In Germany the linkage to the local accident database is possible, but it may not be possible to represent the national accident database due to the special features of the local sample area.

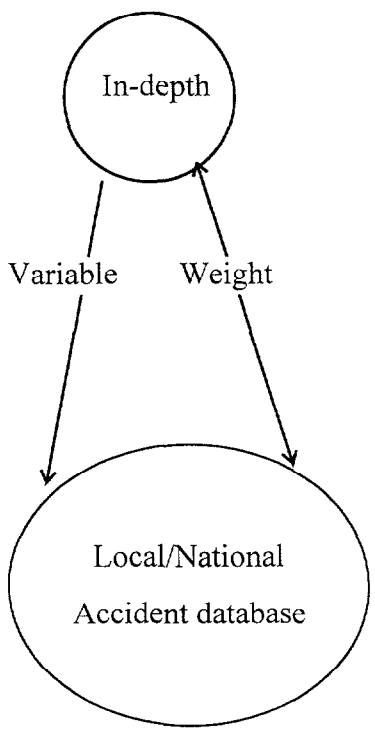

Figure 4 Linking in-depth to local/national databases.

If a variable of interest is only collected within the in-depth database and an estimation of its' distribution is required at national level, the in-depth distribution will be weighted by one (or more) variables which will scale the distribution to estimate the local and then the national distribution. The weighting variable(s) must be in common with the in-depth and local/national databases. Further, the weighting variable will reduce the sampling biases which may be in the in-depth database. A check at each level of the process should be made using a known outcome from a closely related variable to ensure accuracy of the estimate.

The following assumptions are made:

- In-depth database accidents are included within the local/national database.
- The local database may be a biased sample of the national database.
- The in-depth database may be a biased sample of the local database.

The question is then:

- Is there any weighting variable (wi) to reduce the bias from the in-depth to local database.
- Is there any weighting variable (wj) to reduce the bias from the local to the national database.
- Is the weighting variable the same in each case? (wi) = (wj).

We expect w_i and w_j to be functionally related to the variable of interest. The problem is to identify those weighting variables which are required for the variable of interest and to demonstrate that their use reduces bias.

The following points arise:

- The need to identify key variables for weighting purposes.
- To identify types of variables which would use the same set(s) of weighting variables.
- To use substitute weighting variables when necessary, e.g. δV is not a linking variable so one could use speed limit instead as the best available.
- To accept that there may not be suitable weighting variables and/or data in the in-depth database to provide an estimate.
- It is essential to estimate the confidence interval on any estimate.
- Weighting from a small in-depth database to a national estimate may be imprecise

OTHER WORK PACKAGES.

Further work in other areas is occurring simultaneously but have not yet reached their conclusions. **Work Package 1.4** deals with **data quality** and covers the areas of: Data collection, compilation of data, initial processing of electronic data, and comparison of data from several sources. The emphasis of the quality aspect in this package is to ensure accuracy of data and does not mean that the data is necessarily available to answer certain questions.

There are three levels within the data quality process:

- Collection of the data.
- Coding of the collected data into an accepted format.
- Analysis of the data

A set of flow diagrams have been produced that relay the primary principals explored within these three categories(See example figure 5).

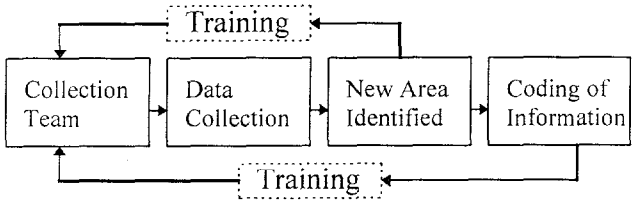

Figure 5 The Collection Loop

These diagrams relate to an established group and identify the feedback loop necessary to ensure that the changing environment of vehicle design and safety systems are identified at an early stage. From this the appropriate training can be given to the investigators. This includes any changes that may occur within the coding systems.

The accuracy of data is the most important at the collection phase. Crash investigators should be proficient in the areas of impact kinematics, biomechanics and vehicle examination. They should also understand fully all the tools at their disposal, and the circumstances in which each one is the most practical, efficient and accurate. The advent of electronic forms of collection will help in this area, but only insofar as the time taken and there will be fewer transposition errors. The physical collection process and its' inherent quality problems will not be solved by the use of computers.

Concentration of the quality management procedures should be directed at the collection end of the process to ensure the least degradation of information. In order to ensure that this happens the following recommendations should be applied:

- A balanced team should be selected, with the appropriate specialists in place.
- Training and a constant updating of skills necessary to ensure the high quality of information collection should be a main priority.
- A similar process for the coding of the information should occur.
- A glossary of terms, updated as necessary, should be in place with a clear, precise understanding of the terminology and conventions used.
- An objective method of recording data, such as photography, should be used either as the primary or secondary tool for investigation.
- Putting the case together should have at least two stages:
    1. The initial methodology of bringing together all the separate parts; vehicle information, injury details etc., and which should include a manual logic check for self consistency throughout.
    2. A second, more objective check made by personnel not directly associated with the collection process.
- Checks should be used to ensure that the data is transferred into an electronic format correctly.
- A check for self-consistency within the coding of the electronic data should occur.
- There should be a management check.

Data also has to have a certain level of 'user quality'; that is the ability to answer questions that may be asked of it. This area of quality is determined by the prevalent areas of investigation at the time, which is in turn dictated by the overall aims of the funding body concerned. In order to be of use, a common database must have datasets from its contributors that cover all the relevant areas of interest, both political and social, to such a level that it can provide useful information on any query that may arise. To ensure that this happens in a controlled manner rather than in a haphazard fashion, regular reviews of the core datasets should occur.

Work package 1.6 - Confidentiality and Ethics, is now at the stage whereby all the necessary information concerning the working practices in each country have been identified. Each country has its own set of laws at local and national levels, dealing with this type of data. European legislation does exist and has been used as the foundation for this work package. There is however, broad consensus as to the handling of the sensitive information collected. The transfer and storage of confidential data is subject to strict guidelines concerning the availability, access and confidentiality of the information. All partners provide for the secure storage of the written data. Electronic data has to be anonymous and each system has in place a means of removing direct references to the persons involves in the crash and the vehicles they occupied.

From this a set of protocols can now be developed to set down best practise within this area; but with the flexibility to allow for the local differences that are present.

A workshop is being organised for **Work Package 1.5** in order to validate the protocols established and receive feedback from other interested parties. The date will be within the week commencing 15th June 1998 at the European Commission buildings in Brussels.

Work Package 3 involves the dissemination of the information from the STAIRS project as a whole. This has been achieved by the development of a wide ranging database of companies, institutes, working groups and research establishments that have an interest in the field of vehicle safety. The deliverables from the work packages are distributed amongst these groups and feedback requested. Replies from this diverse section will give an excellent range of replies as to the practicality of the proposals and help in the further development of them.

As any list will never be totally comprehensive, especially in such a large area as vehicle safety, an avenue of contact has been provided in the shape of a world wide web site at:

http://www.ice.co.uk/stairs

This site is intended to hold all the up-to-date information on STAIRS and also the points of contact in each relevant country.

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