EUROPEAN ACCIDENT CAUSATION SURVEY (EACS) METHODOLOGY

Bernard Chenisbest
CEESAR
Norbert Jähn
ACEA
Jean-Yves Le Coz
LAB PSA Peugeot Citroën - RENAULT
France
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ABSTRACT

The emphasis of accident research is in general placed in the field of passive safety, so that consideration is devoted to measures, which reduce the consequences of an accident. Persuaded that accident avoidance is also needed to save more crash victims than new progress in passive safety, the **European Automobile Manufacturers Association (ACEA)** has taken the initiative in launching a " **European Accident Causation Survey** " with the support of the **European Commission** and under the aegis of the **European Road Safety Federation (ERSF)**.
Thus, five partners from European countries (Germany, Italy, Finland, France) have been collaborating since March 1996 and are building up a data bank on the causes of accident based on a scientific in-depth investigation of the pre-crash phase.

Although retrospective data collection will also feature in the work, it is thought that a " prospective study " based on a common questionnaire, prepared by these accident investigation experts, will provide more complete data about human, road, environment and traffic factors responsible for causing accidents.
It is only through such a scientific accident investigation of the pre-crash phase, combining detailed technical aspects and driver behavior data that it can be understood how and why accidents happen, and the effectiveness of solutions can be assessed in conjunction with full scale experiments and simulations.
This paper will describe the harmonized approach and methodology followed in this study to secure a reliable quantitative and qualitative understanding of the different phases of the crash.

INTRODUCTION

Many authorities in Europe refuse to accept the current toll of road accidents and request that improvements are made in the field of road safety. The prevention of accidents is therefore a major stake in this field. It clearly appears today that passive safety has limits and that other complementary means will have to be implemented to continue to reduce the number of road fatalities and casualties.

In the early 70's, teams were created in Europe [: **University of Birmingham** (United Kingdom), **ICE*-University of Loughborough** (United Kingdom), **ARU-Medical University Hannover** (Germany), **VALT**** (Finland), **INRETS***** (France), **LAB****** (France)] to investigate the consequences of road crashes by in-depth case-by-case analysis involving engineers and medical doctors, or even psychologists. In fact, in-depth road accident investigations give a more detailed knowledge about different factors on the course of events behind accidents and their consequences than can be obtained from records based on forms from police, hospital or insurance one's.

These teams are still at work following the evolution and the progress for new generations of cars and working to solve new priority problems regarding long-term disability, the vulnerable population such as older car occupants and children, or structural compatibility between vehicles.

It is impossible to prevent every injury in a large number of accidents, and for complete freedom from injury, crash avoidance systems would also have to be completely successful. The existing technological possibilities for crash avoidance have to be selected and better defined taking into account the true needs of the drivers involved in pre-crash situations.

* ICE : Institute for Consumer Ergonomics.
** VALT : Finnish Motor Insurers' Centre - Traffic Safety Committee of Insurance Companies.
*** INRETS : National Institute for Research on Transports and Road Safety.
**** LAB : Laboratory of Accidentology and Biomechanic, PSA Peugeot Citroën - RENAULT.

Sufficient information on the causes of accidents is still lacking, although it is well known that more than 90 % are related to human errors [1]. It is only through a scientific accident investigation of the Pre-crash phase, combining detailed technical aspects and driver behaviour data that it can be understood how and why accidents happen, and that more effective solutions can be developed in conjunction with full scale experiments and simulation. Although retrospective data collection feature also in this work, it is thought that the " prospective study " based on a common questionnaire provide more complete data about the responsibility for causing accidents of human, road and environmental factors as well as traffic conditions.

So, after a retrospective pilot study based on one hundred German automobile accident reports conducted by **DEKRA** experts in 1993-1994, **European Automobile Manufacturers Association (ACEA)** decided to support a "***European Accident Causation Survey***" (**EACS**) with the following objectives :

- several countries involved ;
- focus on the pre-crash phase ;
- prospective study, so that most of the parameters to be collected are previously defined ;
- accident investigations, starting on the scene very soon after the accident, to increase the chance of collecting traces on the road, true final position of the cars, better description of the environmental conditions and driver interviews ;
- enlarged sample of accidents ;
- in-depth analysis of the interaction between vehicle, driver and road environment aspects according to this system safety approach :

		SUB-SYSTEM		
		Drivers	Vehicles	Infrastructures
SITUATIONS	Pre-conflict - Design/Training - Wear/Life	Psychological Sensorial Cognitive Motor	Ergonomic Dynamic Interactions	Geometry Grip Signing Visibility Equipment
	Conflict	Perception Processing Action	Space-time Interactions	Dynamic

- use of a common questionnaire to allow a common data base ;
- accidents studied will reflect the statistical distribution of cases observed in each particular country ;
- experienced European investigation teams currently at work and able to carry out accurate accident reconstructions.

It was expected that a sample of at least two thousand fully documented pre-crash accident cases will be available before the beginning of the new millennium. This will allow the acquisition of a technical understanding of pre-crash processes, determination of typical accident scenarios and analysis of countermeasure efficiencies for an enhanced car safety contribution within a traffic system.

KICK-OFF HISTORY

Over a period of about three years, **ACEA** contacted several institutions and universities in Finland, France, Germany, Italy, and United Kingdom who have a recognised expertise in accident investigation field. All expressed their interest in an active participation in such an important common research project. But some possible partners did not succeed in gathering all the necessary means and agreements to realise their aims.

So, on the initiative of the **ACEA**, under the aegis of the **European Road Safety Federation (ERSF)**, five accidentological partners :

- the **University of OULU**
  in co-operation with **VALT** (Finland),
- **INRETS** (France),
- **CEESAR** (France),
- **DEKRA** (Germany),
- **ELASIS** (Italy),

started working on the project ***"European Accident Causation Survey"*** (**EACS**) for the development of a European data bank on accident causation. It was defined as a First phase (from March 1996 until December 1997).

ACEA entrusted **CEESAR** to co-ordinate the work of the different partners.

This project constitutes the first European Accident Causation Data Bank. Moreover, beside this main focus on the causation, data related to the mechanisms of the accident (pre-crash steps) will be collected.

The project is supported by the **European Commission** (part of EC Contract n°B3-B96-B27020-SIN2806) to collect, through co-ordinated efforts and on the basis of a common and harmonised methodology, more accurate information on the causes of traffic accidents in Europe.

A sixth team joined the EACS partners in April 1997 : **Accident Research Unit - Medical University Hannover** (Germany) for just 10 accident cases to be collected.

EACS ORGANISATION

General

CEESAR was entrusted by **ACEA** to co-ordinate the work provided by EACS partners. **CEESAR** was responsible for the collection of these data from its partners and organised the exchange of relevant information that was needed.

Every quarter, **CEESAR** presented a status report of the work carried out to the Pilot of the **ACEA**-EACS Task Force.

CEESAR arranged and chaired meetings, especially :

- a one-week workshop in March 1996 with the teams of experts at the EACS-Phase I kick-off,
- a one-day meeting (June 18th 1997) with teams representatives, Task Force members, **and European Commission DG VII** representatives.

The persons who assumed scientific responsibility for this study are :

- for **CEESAR :** Mr B.CHENISBEST
- for **ACEA :** Dr. C.TARRIERE till June 1997, Dr. J-Y.LE COZ after this date,

as pilot of the **EACS** Task Force.

EACS Partners

UNIVERSITY OF OULU / VALT

The investigation of road accident factors by teams of specialists from several fields started in Finland in 1968. The team members included traffic police officers and vehicle and road engineers. This operation provided new ideas and in-depth information for road safety work.

The operation is conducted and financed by the Traffic Safety Committee of Insurance Companies (**VALT**), a committee for safer road traffic in the Finnish Motor Insurers' Bureau. The other bodies involved in the activity are government departments and they contribute to cover costs by permitting their respective representatives in the teams to participate in the investigation work as if it were a part of their normal duties.

At present, there are a total of 13 investigation teams, one in each province and one in the city of Helsinki. The original members are included, supplemented by physicians, psychologists, and experts in railway traffic. Generally, the members are government officials or experts. The total number of team members is nearly 200.

University of OULU is one of the 13 investigation teams. At the beginning of 1996, Mr. Lasse HANTULA [2], **VALT** Secretary General Road Safety Director, designated it to **ACEA** as an **EACS** project partner.

Professor Timo ERNVALL is the project manager. In the Department of Civil Engineering, he is the head of the Traffic Engineering and Transports Laboratory. He was assisted in this project by Mr. Jani HUTTULA, senior researcher.

The investigation area covers the city of Oulu and the district approach 50 kilometres southwards, 50 kilometres northwards and 50 kilometres eastwards from Oulu. Mr. Kari PURANEN, Mobile Police Chief superintendent, Northern Finland Department, conducts the investigation group. It consists of :

- 2 police inspectors ;
- 2 medical members (: 1 orthopaedic surgeon, 1 psychiatrist) ;
- 3 vehicle inspectors ;
- 5 road technical members : Professor Timo ERNVALL, 3 research engineers, 1 laboratory technician.

Every month, in their investigation group, they discuss the collected accident files and their problems. They continuously improve their methodology. Mr. Pekka SULANDER made the reconstructions in VALT office in Helsinki.

INRETS means " Institut National de Recherche et d'Etudes sur les Transports et leur Sécurité ". It is the French public research institute devoted to road transport.

Present in-depth accident studies form a part of the national " Vehicles and Safety on the Road (**VSR**) [3] " programme, they are aimed at improving knowledge of traffic accident causation. This programme, started in 1993, is carried out in close collaboration by **INRETS** and car manufacturers (**PSA Peugeot Citroën - RENAULT**).

Their work was to build up an in-depth accident database to :

- examine in-depth researches both in pre-crash and crash safety fields ;
- determine dysfunctions in the driver-vehicle-environment system ;
- identify specific countermeasures ;
- follow up and evaluate the various measures.

On EACS project, just worked for **INRETS** the " Accident Mechanisms " department located in Salon-de-Provence (south-east of France) - on responsibility of Mr. Francis FERRANDEZ [4] -.

Mr Yves GIRARD is the project manager ; he was helped on this project by Mr. Christophe PERRIN, researcher. The investigation area covers the rescue services' intervention area of Salon-de-Provence, which represents 15 kilometres around this city. The investigation team consists of three experts :

- 1 specialist who investigates on vehicle and road infrastructure ;
- 1 psychologist ;
- 1 researcher who collects medical informations.

A mechanics engineer helps them for reconstruction.

CEESAR stands for " Centre Européen d'Etudes de Sécurité et d'Analyses des Risques " (in English : " European Centre for Safety Studies and Risk Analysis "). It's a non-profit making association, bringing together automobile manufacturers, component manufacturers, technical universities, insurance companies, and individual acknowledged French medical and technical specialists.

Its aims are :

- establish relationship and information exchanges between its members in order to identify the role played by the human and technologic parameters in the traffic accidents and to estimate their economic impact.
- to promote researches, tests, surveys able to reduce the risk of accidents in collaboration with all concerned partners : research laboratories, medical people or universities, industry (particularly cars) insurance companies, teaching profession ...
- to develop education methods in order to put in place specialists able to overcome the synthesis between socio-economics and accidentology.

Mr Bernard CHENISBEST is the project manager. For collecting accident data, two groups of three persons each are acting jointly. The investigation area covers :

- for the first group, the city of Evreux and the district approach 16 kilometres southwards, 25 kilometres westwards, 7 kilometres northwards and 7 kilometres eastwards from Evreux.
- for the second, the city of Amiens and the district approach 15 to 20 kilometres around Amiens.

Each investigation group consists of :

- 1 vehicle expert, he also collects medical informations ;
- 1 psychologist ;
- 1 road infrastructure and reconstruction expert.

Moreover :

- for reconstruction studies, 1 researcher works with them ;
- for accident involving trucks or buses, two experts can join these groups.

DEKRA AG is an organisation of experts offering reports and analyses throughout Germany, with some 6000 employees including roughly 3200 engineers.

One of the activities of **DEKRA** is the compilation of technical expert reports in the motor vehicle field. Traffic accident reports focus on the reconstruction of road traffic accidents and the technical investigation of vehicles involved with regard to technical defects responsible for causing accidents.

Furthermore, expert reports serve to illustrate the central themes of the experts' activities which, for example, are of particular interest for training courses and regular technical test programmes.

Mr. Walter NIEWÖHNER is the project manager ; he was assisted on this project by Mr. Frank SCHMIDTS, engineer. The investigation area covers all Germany. About one hundred experts worked on this project by collecting informations. A copy of all written reports is sent to **DEKRA** headquarters, Accident Research department, in Stuttgart, where they were checked, codified and added to the EACS database.

Accident Research Unit - Medical University of Hannover (ARU-MHH) joined the EACS partners in April 1997.

Mr. Dietmar OTTE is the project manager. The investigation area extends from the urban to the rural regions of Hannover with a radius of approximately 60 kilometres. Engineers, medical experts, project assistants and students from the department undertake case investigations.

ELASIS is a consortium of companies of the **FIAT** Group, which was established in October 1988 with the aim of creating a scientific and technical " network " located in the south of Italy to support product innovation in the **FIAT** plants.

Since 1994, one department copes with investigations oriented towards a scientific and objective understanding of the accidents. At the beginning, **ELASIS** received a training in France by the **LAB-CEESAR** and exchanged information with **INRETS**.

Mr Vito CARRARA is the project manager. The investigation area is an approximately circular with a radius of about 30 kilometres and the operational headquarters in Pomigliano d'Arco (near Naples) is at the centre.

The investigation team consists of ten people :

- 3 vehicle experts ;
- 2 road infrastructure experts ;
- 2 reconstruction expert ;
- 2 doctors (2nd Medical University of Naples) to collect the medical information ;
- 1 psychologist to characterise the driver behaviour.

On the site of the accident, at least two experts are present.

DATA COLLECTION

Accident study - Statistical Distribution

The sample of accidents will include accidents with injuries involving at least one car (light vehicle < 3.5t). The distribution of accidents per type will have to be as close as possible to the statistical pattern of accidents found for each country (types of road, types of vehicle, types of driver).

However, because drivers must be able to explain the precise circumstances of their accidents by interviews, it will be necessary to give priority to cases without serious brain injuries.

Number of Accident cases Collected and Coded

Organisation (Country)		Number of cases to collect Initially (March 1996)	and to code Finally (December 1997)
University of OULU / VALT	(Finland)	85	43
INRETS	(France)	85	85
CEESAR	(France)	30	40
DEKRA	(Germany)	700	720
ARU.MUH	(Germany)	0	10
ELASIS	(Italy)	100	115
	TOTAL	1000	1013

The accident collection finally breaks down as follows :

- Single car accident : 196
- Car(s)-to-Car(s) * : 405
- Car(s)-to-Truck(s)/Bus(es) * : 89
- Car(s)-to-Two-wheeler(s) * : 162
- Car(s)-to-Pedestrian(s) * : 157
- Others : 4

* These vehicles had or not a trailer.

Mathematical Reconstruction

In the Reconstruction domain, when it's possible, the main objective was to obtain a quantification of the pre-crash phase in terms of vehicle kinematics and driver behaviours. For a quantitative and qualitative understanding of the different phases of the crash, experts filled a pre-collision table [5], where interpretation that the driver has on the situation (Safety State, Risk State or Danger State) as well as the (possible) reaction (braking, swerving, etc.,...) are linked to time,

Vehicle kinematics are based on data collected on the site, like traces, skidmarks, collision point on the road and post-crash position of vehicles. An evaluation of the energy dissipated into vehicle deformations (so called *"Equivalent Energy Speed") is* estimated by experts.

Several computer programmes of accident reconstruction were used by the different teams involved. However, basic physic laws are of course the same.

QUESTIONNAIRE

Setting-up

A first (English version) questionnaire has been drafted on October 1994 by **CEESAR** on the basis of questionnaires used by **DEKRA** (**ACEA** Pilot study), **ARU - MHH, VALT** and **LAB-CEESAR/INRETS.**

On February-March 1996, high level discussions took place between European partners and **CEESAR** and **ACEA** members. Then, **CEESAR** has reviewed the questionnaire's structure, improved it, and suggested to EACS partners the specific codification.

For the homogeneity of the work between the five teams, answers of each question and their codification have been discussed during a one-week seminar organised by **CEESAR** in Paris (end of March 1996), and agreed by experts.

On August 1996, **CEESAR** organised an opinion pool : it sent a list of new possible improving changes, and required from all project's partners their agreement. Changes have been taken into account when all five partners' majority agreed.

The EACS questionnaire codification last update is thus September 3rd 1996.

Questionnaire Hierarchy

The common questionnaire is composed of several parts which -if there is need to do so- can be used once or more. It consists of six main parts some of them divided in optional sub-parts (see Table 1) and of two additional one's which are only indirectly related to the accident causation :

- Secondary safety parameters (included in the other forms),
- Witness information (used to complete the available information).

Table 1.
EACS questionnaire Chapters

Main Part	Optional Sub-Part	Number of questions
Accident Generalities	-	45
Road Infrastructure	-	92
Vehicle	For the whole vehicle	12
	For motor vehicles, except two-wheelers.	77
	For Cars and Light Trucks	57
	For Trucks and Buses	108
	For Trailers	103
	For Two-wheelers	23
Vehicle Occupant	For each occupant (including the driver or the rider)	33
	For the driver or the rider only	103
Pedestrian	-	85
Reconstruction	For the accident	3
	For each vehicle	68
	Pre-Collision Table	12
	TOTAL	821

One accident may involve several Roads, Vehicles, Vehicle Occupants and/or Pedestrians. So it is necessary to fill in several forms of the same kind.

Specific rules have been established. Thus, normally, for an accident case, experts need to complete :

- one Accident General Form per accident,
- one Road Infrastructure Form per vehicle,
- one Vehicle Form per vehicle type involved,
- one Vehicle Occupant Form per occupant in concerned vehicle,
- one Pedestrian Form per pedestrian,
- one Reconstruction Form per vehicle.

A complete listing of the different subjects per chapter is included in the appendix.

How does it work ?

For example, if we consider a car-to-truck (with trailer) accident - two persons are in the car -, accident investigators must fill :

EACS Forms		For the Car	For the Truck + Trailer
Accident Generalities	-	1	
Road Infrastructure	-	1	1
Vehicle	For the whole vehicle	1	1
	For motor vehicles, except two-wheelers.	1	1
	For Cars and Light Trucks	1	0
	For Trucks and Buses	0	1
	For Trailers	0	1
Vehicle Occupant	For each occupant (including the driver or the rider)	2	1
	For the driver or the rider only	1	1
Reconstruction	For the accident	1	
	For each vehicle	1	1
	Pre-Collision Table	1	1

that means to put answers for about 1215 items.

MANUAL FOR CODING

During the study, a complementary document was written : it's the **Manual for coding the EACS's questionnaire**, which describes in detail how to use the questionnaire, the different definitions or arrangements to be used, how information should be interpreted into the coded format.

Contrary to the EACS's common questionnaire, its editorial content changed, according to the questions asked to **CEESAR** by its partners. Answers are provided by **CEESAR** after taking into account and having all teams' agreement.

This manual contains in addition articles or references to documents allowing thus a better and common understanding to themes and variables used in this project.

DATABASE

The **EACS** database was structured like the questionnaire to obtain the most effective data processing : each form represents one table. The data bank system (DBS) was selected at **CEESAR** workshop (end March 1996). The way the data have to be filed in the DBS and communicated to the parties involved in the project met the requirements of the expert teams and **ACEA**.

To ensure the easy handling of data input, **CEESAR** developed, and distributed to its partners and **ACEA**, a data capture software tool, where input masks are oriented to the structure of the **EACS**'s associated

questionnaire forms. Moreover, in each input masks, to display background information, for each **EACS**'s variable (or question), a label is used for the coded answer.

CEESAR took care the DBS could be run with the number of data which is expected to be collected from 2000 accidents cases, and with sufficient computational time.

EXCHANGES

During the two-years program, following a fixed timetable, **CEESAR** collected the computerised data from its partners, adding new data and any modifications to the **EACS** data bank.

CEESAR organised the coding process and especially the complete storage to share the **EACS** database to **ACEA** members. All collected results have been made available to **ACEA** in the format of the selected DBS and in ASCII format.

At the end of Phase I, possible copying of accident files can be asked to **EACS** partners by **ACEA** members.

CEESAR checked that information was coded according to the common care of specifications to ensure that a same understanding of the common procedure is reached. Every quarter, **CEESAR** presented to the Pilot of the Task Force **EACS** a status of the work carried out.

CONCLUSION

- **EACS - Phase I (1996-1997)** can be considered as a success. Objectives are decently reached.

- The first sample of 1 000 accident cases will show the potential of this Survey. Nevertheless, to be useful to manufacturers and road safety, it is essential to increase the databank's size till at least 2000 cases.

- We could also think in the future - with a sufficient budget - to make available, with the **EACS** data bank, computer files of :
  - pictures of the road infrastructures and vehicle damages ;
  - a comprehensive sketch of the accident scene facts i.e. pre-crash, crash and post-crash areas (including road measurements, obstacles, skidmarks, impact location, final position of vehicles) ;
  - a sketch of the reconstruction, giving vehicles paths and locations, at each pre-crash phase.

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Appendix 1 : EACS QUESTIONNAIRE SUBJECTS.

Accident General Form
- Location.
- Date and Time.
- Weather conditions.
- Common Infrastructure description :Junction.
- Accident Type.
- Accident Severity.
- Prometheus.

Road Infrastructure Form
- Road type.
- Road restrictions.
- Road geometry.
- Road surface.
- Road equipment.
- Traffic.
- Difference between the approaching zone and the accident zone.

Vehicle Form - Part I
- Accident severity.
- General information.

Vehicle Form - Part II
- General information (Technical and administrative).
- Design specifications (Performance, technical design, driving aids).
- General technical state.
- Load during the trip.
- Defects (Braking, steering, suspensions,lights).
- State at the time of the accident.

Vehicle Form - Part III
- General information.
- Defects on tyres and wheels.
- Load during the trip.

Vehicle Form - Part IV
- General information.
- Defects on tyres and wheels.
- Load during the trip.

Vehicle Form - Part V
- General information.
- Design specifications.
- General technical state.
- Load during the trip.
- Defects on tyres and wheels.

Vehicle Form - Part VI
- Technical information.
- Defects.

Vehicle Occupant Form - Part I
- Personal status.
- 4-wheeler vehicle occupant report.
- Child restraint data complement.
- 2-wheeler occupant conspicuity and passive protection.
- Injury report.

Vehicle Occupant Form - Part II
- Personal status.
- Driving experience.
- Intoxication level.
- Trip in progress.
- Accident and emergency situations.

Pedestrian Form
- Personal status.
- Past accidents.
- Intoxication level.
- Pedestrian conspicuity.
- Trip in progress.
- Accident and emergency situations.
- Collision.
- Injury report.

Reconstruction Form - Part I
- General information.

Reconstruction Form - Part II
- Vehicle parameters.
- Aspects recorded at accident site.
- Pre-crash phases (vehicle behaviour, key events).
- Pre-collision table.
- Impacts and vehicle (Running-in impact speed, type of impact, EES, ...)
- CDC/TDC codification.
- Accident causation.