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D 5.5

'Analyzing Human Factors in road accidents'
TRACE WP5 Summary Report

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Abstract:
The main objectives of TRACE WP5 'Human factors' deliverables are:
. To support a better standardization of accident analysis in Europe on a scientific background,
. To provide operational models and methodological classification grids dealing with 'human factors' aspects involved in road accidents,
. To promote a comprehensive analysis of the involvement of human beings, going further than the usual 'user-orientated causal analysis' often limited at establishing the driver 'at fault' and without searching for the background reasons of the problems met par road users.

Such objectives involve analyzing accidents as the symptom of the difficulties met by drivers in certain driving situations, and as a revelatory of their needs in help. Two questions have to be asked in order to progress in the understanding of accident causation: 1) What are precisely and operationally the human failures in accidents? But also: 2) What are the reasons for these human failures? Keeping in mind that these reasons are of multiple natures and combine most of the time to produce the final event. By so doing, the definition of typical scenarios of 'human error' production can open to the definition of more appropriate countermeasures, well fitted to human needs.

Keyword list: Human error – Human Factors - Functional failure - Accident situations - Accident factors - Accident aggregation – Social factors

Table of Contents

1 Executive Summary

1.1 TRACE project: TRaffic Accident Causation in Europe

The European TRACE project (2006-2008) has been defined to go further in the understanding of the overall driving system unsafety by the use of different methodologies: statistical studies, in-depth accident investigations and risk analysis. As a matter of fact, road safety is still one of the main societal concerns today, in spite of countless amounts of research and development. This shows the necessity to go on progressing on the way, and maybe the need to promote new views about accident production and the means to fight against it. It is a concern for the European Commission, for National Governments, and also for the vehicle industry, insurance companies, driving schools, non-governmental organisations and more generally for every single road user.

It is essential nevertheless to acknowledge and keep in mind the massive and efficient work done those last decades toward safety by all participants of the driving system. But the more we gain, the more efforts we need to progress. For example, car manufacturers have made strong labours which have dramatically improved passive safety of their vehicle for the past 15 years; however, current road safety research has shown that an asymptote is about to be reached on this aspect in most countries and many experts agree that preventive (prevention of accidents) and active safety (recovery of an emergency situation) should now, particularly, be brought forward. Such a trend might only be a success if road users' characteristics are permanently kept into the loop of safety research and development. It is, at least, the claim of the deliverables put forward in the frame of WP5 of TRACE.

TRACE project has 2 major objectives. The first one addresses the determination and the continuous up-dating of the aetiology (i.e. analysis of the causes) of road accidents and injuries, and the definition of the real needs of the road users as they are deduced from accident and driver behaviour analyses. The second one aims at identifying and assessing, among possible technology-based safety functions, the most promising solutions that can assist the driver or any other road users in a normal road situation or in an emergency situation.

So the purpose is first to bring a comprehensive and understandable definition of accident causation which goes further and deeper than the usual statements. It is also to provide the scientific community, the stakeholders, the suppliers, the vehicle industry and the other Integrated Safety program participants with a global overview of the road accident causation issues in Europe and promising solutions based on technology.

1.2 The WP5 'Human Factors' and its deliverables

In order to gain new knowledge on accident causation, several Methodological Work Packages have been defined in the structure of TRACE with the purpose to give a support to the analyses conducted into the Operational Work Packages of the project.

As part of these methodological frames, WP5 has been developed to improve the multidisciplinary methodologies which allow the analysis of the role of 'human factors' (in the widest meaning) in road accident production.

Many accident causation systems currently focus much of their attention on the road user and their 'human errors' which resulted in the accident occurring. By so doing, these 'errors' or failures are treated as the main cause of accidents, while the reasons behind them (i.e. the 'factors' of human failures) are often given little consideration. Also, 'factors' are often confused with their resultant 'failures' in the analysis of accidents.

In brief, WP5 is oriented toward: 1) the diagnosis of the difficulties met by road users which lead them to an accident, 2) the identification of the contexts in which they take place, and 3) the definition of the origins of these difficulties whether they are relating to the layout to the vehicles, or to human characteristics (physical, cognitive, motivational, but also sociological and cultural). The methods developed aim to standardise accident analysis in order to bring validated and comparable results from one study to the other, while keeping the scientific and academic background required for a comprehensive and efficient research work.

Four tasks compose this Work Package. The first three ones are oriented toward the elaboration of an operational model permitting a comprehensive analysis and classification of 'human error' generating processes. The fourth one is devoted to a further and wider view on the influence of the social and societal context on accident occurrence.

- Task 5.1 A model for human functional failure analysis

The objective of this first task is to define and characterize the different types of human errors, violations and difficulties which are involved in the accident generating process. Such modelling work is based both on scientific literature dealing with human error analysis, and on truly in-depth accident data. The purpose is to build an operational grid for human functional failures, consistent with cognitive ergonomics concepts and specifically adapted to the driving task difficulties. These conceptions are developed in TRACE deliverable D5.1: '*Analysing human functional failures in road accidents*' (Van Elslande & Fouquet, 2007a).

- Task 5.2 A comprehensive grid of factors and situations for human functional failure

Human failures are explained by factors characterizing the state of system, i.e. the defects of its components and of their interactions. These factors are then considered as the explanatory elements of the road users' lack of capacity to adapt to the situation in hand. A grid of all the relevant elements contributing to human failures has been compiled, and differentiates those factors coming from the 'human' part of the system, from those coming from the layout, the traffic interaction and the vehicle. To put further forward the context in which accident occur, a second grid proposes an operational typology of the driving situations (or 'pre-accident situations) in which the drivers were engaged when they found a difficulty. These grids are presented in TRACE deliverable D5.2: '*Which factors and situations for human functional failures? Developing grids for accident causation analysis*' (Naing, Bayer, Van Elslande & Fouquet, 2007).

- Task 5.3 Typical failure-generating scenarios

The purpose of this third task is to combine the results from T5.1 and T5.2 in order to build a methodological frame allowing the aggregation of accident data under the form of generic accidental processes, viewed as an integration of the parameters characterizing the accident generation: which situation and context, which human failure, which explicative elements, which consequence, etc. They will allow putting forward the typical specificities of the difficulties encounters by different types of road users, in different types of situations. The method for building such scenarios is defined in TRACE deliverable D5.3: '*Typical human functional failure-generating scenarios: a way of aggregation*'. (Van Elslande & Fouquet, 2007b).

- Task 5.4 Social and cultural aspects of human factors

This last task is more prospective. Its purpose is to enlarge the scope of Human Factors by analyzing the socio-economic/socio-cultural dimension of human activity, and its interaction with the driving system. Practically speaking it is turned toward the building of a framework of analysis aimed at completing the accident analysis framework proposed in the other Tasks of the WP by putting forward broader 'upstream' factors of their role in the production of accident process. The sociological dimensions potentially acting on individual behaviour are presented, in TRACE deliverable D5.4 '*Social and cultural factors*' (Engel, 2007) with an opening toward an operational grid of analysis of these variables under the form of 'social spheres'.

1.3 Conclusion

The present deliverable D5.5 'Analyzing Human factors in road accidents' gives a synthetic view of the methodological results put forward in the framework of TRACE WP5. It can be seen as an overall introduction regarding the necessity to put forward new advances in the framework of human factors involved in road accidents, the more operational aspects of which being found in each WP5 deliverable mentioned above. The conceptions developed will hopefully be useful to push forward scientific research and development efficiently towards human difficulties encountered while driving, notably in Europe.

2 Introduction

TRACE Work Package 5 has been dedicated to the analysis of 'Human Factors' in the field of accident causation analysis. It is aimed at contributing to a deeper comprehension of the complexity of the human aspects involved in driving activity by promoting human centred methodological tools. The analytical models and classification grids proposed in TRACE WP5 deliverables try to go further than the usual 'user-orientated causal analysis' by enlarging the investigation toward searching for the causes upstream human failures. Such a procedure is claimed to be essential if efficient solutions –i.e. adapted to human functioning- are to be expected for a safety improvement of the driving system as a whole.

The role played by the human component in the traffic system can be regarded as a hardcore among road safety problems to investigate. So it is the case in the frame of an European project such as TRACE. In line with this view, this WP5 is devoted to a transversal work aimed at providing operational models and methodological support to the other Work Packages of TRACE project, concerning the 'human factors' aspects involved in driving and in road accidents resulting from this activity. This question is to be studied in detail in order to provide comprehensive results and not only general ones as it is commonly the case when dealing with human aspects involved in accidents. In this purpose, all the disciplines of psychology that are relevant for driving behaviour are screened: research in human perception, attention, cognition, personality, social, etc.

In the frame of this Summary Report, the term 'human factors' will be understood under the general meaning of 'human aspects involved in driving activity', both in their positive and negative facets. This definition is aimed at discarding from any tautological view of the human being considered as the main cause of accidents, leading to a pessimistic view as regard as the capacity to improve road safety (as far as human is difficult to change and to put apart of the driving system). Its purpose is to allow putting forward the very different forms that take these human aspects in the accident processing; not forgetting that most of the time the human is the principal factor of the driving system efficiency – by compensating for most of the system drawbacks , even if can be subject to failures. These failures are then to be taken as object of study, searching for theirs causes and reasons, as many variables on which appropriate measures can be undertaken.

The main objectives of the WP5 deliverables which are synthesized in the present report are:

1. To promote a new view on the involvement of road users in the systemic accident production process, going further than the usual 'causal analysis'. This view regards road accidents as the symptom of the difficulties met by drivers in certain driving situations, and as a revelator of their needs in help.
2. To help clarifying the distinction to put forward between 'errors' and 'factors' (whereas human or not) in accidents, the latter producing the former.
3. To provide the other TRACE Work Packages with operational models and methodological support dealing with 'human factors' aspects involved in road accidents.
4. To give some cues about factors acting further upstream in the causal process that end up with an accident.

The following sessions first situate the human factors work package inside the TRACE system functioning, and then explain the necessity felt to go further than the usual -more or less implicit- views on 'human factor' or 'human behavior' in accident studies, focusing the analysis only at the sharp end of the accident process.

Subsequently, will be presented the main results of each of the tasks constituting TRACE WP5:

- Task 5.1 - A model for human functional failure analysis

- Task 5.2 - Comprehensive grids of factors and situations explaining human functional failure
- Task 5.3 - Typical human functional failure-generating scenarios
- Task 5.4 - Social and cultural aspects of human factors

2.1 WP5 inside TRACE project

WP5 is part of the methodological Work Packages which have been defined to both feed the operational work packages (WP1, WP2 and WP3) and the evaluation Work Package (WP4) with adapted methodologies (see Figure 1).

The WP5 methodological results are thus devoted to better understanding the influence of human aspects under play regarding: 1- characteristics of the road users involved (type of vehicle used, age, gender), 2- types of situation which provoke specific road users' difficulties (intersection, bend, overtaking, etc.) and 3- types of risk factors which affect specifically such or such human failure (alcohol, vigilance, layout defects, etc). And the human aspects will be of course at the core of the assessment of the capacity of technological safety functions to compensate for drivers needs in help (for example, cf. TRACE deliverable D4.1.5).

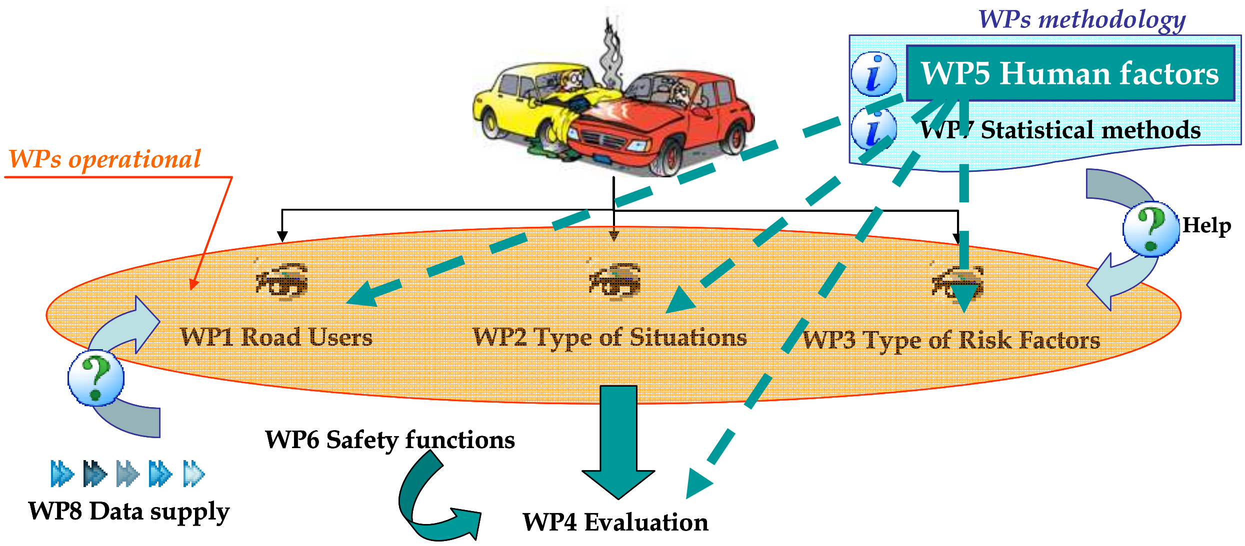

Figure 1- WP5 inside TRACE project

The models and grids provided in WP5 aim at supporting improvement and standardization in the overall analysis of accident production, and specifically regarding the role of human factors in the driving system malfunction processes. A block diagram illustrating the links between the deliverables put forward is presented on Figure 2.

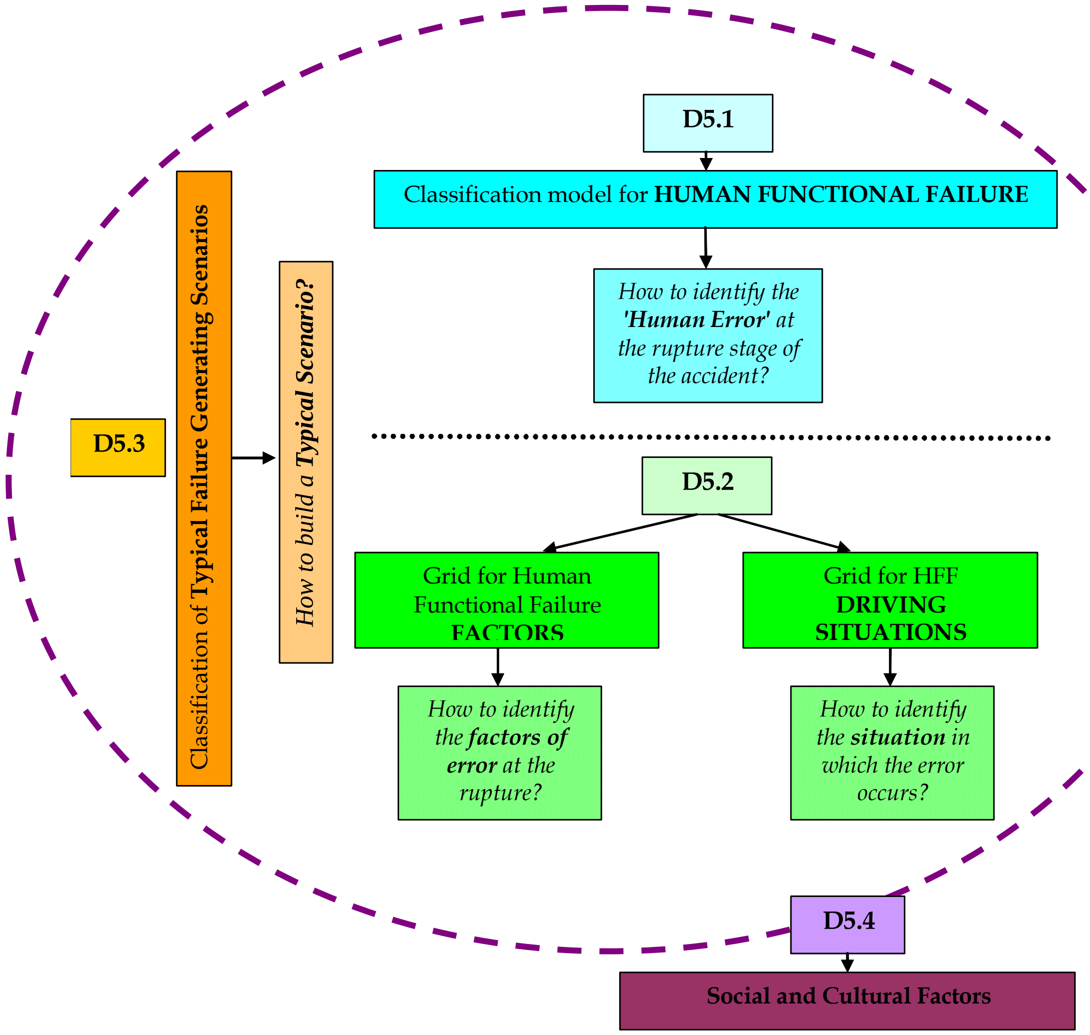

Figure 2- Links between TRACE WP5 Deliverables

2.2 Reasons for methodological improvements regarding human factors

In the field of road safety, it is most often taken for granted that 'human factors', 'human errors' and/or 'human behaviour' –these terms being nearly considered as one and the same- are the main cause of accidents. The problem behind such a statement is that it is not only subject to question but also leads to very few chances of positive amelioration. Apart from changing the human part or discarding it from the driving system, both of these solutions not being so easy, otherwise they would have been applied a long time ago. This overall statement against human nature is thus poorly productive in view of finding solutions to enhance road safety and a wider analysis is thought to be useful in line with this objective. Rather than putting the blame on the driver, this wider analysis would consider far more useful to search for the needs to fulfil in a way that these drivers are performing more efficiently in a more adapted environment with a more adapted vehicle. Such a wider view must at least clearly clarify what is understood behind the concepts used so as to avoid mixing things. It is the specifically the case for the so-called 'human factors' and 'human errors'.

- Human factors of driving

The term 'human factors' in the ergonomic literature generally stands for all the human aspects involved in any activity, would they be positive or negative. This is a catch-all term that covers notably the science of understanding the properties of human capability[1]. This conception is well represented by the international 'Human Factors' Journal. And when analyzing road accidents, it is worth remembering that the driving system is relying a lot on the capacity of human beings to adapt to situations which are often complex, variable and insufficiently defined where no other devices than human factors are able to operate and to adapt efficiently, even if this adaptation capacity is subject to limits. The problem behind such a label is that it is too often confused with its homonymous qualifying the human contributing causes of accidents, figuring only the negative aspects of human factors.

- Human factors of accidents

Accidents are explained by multi causal factors characterizing the wrong state of a system, i.e. the defects of its components (would they be human or other such as technical defects) and the defects in the interactions between these components. Accident factors correspond to the main parameters of the driving context (relating to the road, the driver, other users, the conditions in which the task is performed) that contributed to the user's inability to adapt to a road situation he had to negotiate and of its particular demands. And it has to be borne in mind that in the majority of cases it is at the interface between the human component and the other components of the system that the problem is found to originate. Thus, human factors of accidents refers to the inadequacy of the variables characterizing the human component (such as level of experience, of fatigue, of attention, etc.), and which combine with the inadequacy of the variables characterizing the other components (road layout, vehicle, environment, traffic) to produce 'human errors'.

- Human errors

In its common sense definition, human error is most often considered as the main -and more or less fatalistic- cause of the problem considered: Human is by nature subject to errors, and it is the reason why problems occur. Another implicit aspect of this common sense is that 'error' is confused with and taken as synonymous of 'fault'. In such a way that each time a human error is noticeable in a process, it becomes the fault of the human being involved in this process. And as being a fault, the only way to fight against it is the punishment of its author. This implicit common sense becomes misleading when applied to the scientific analysis of a phenomenon such as road accidents, leading analysts to confuse human errors and human factors of accident. The problem with such confusion is that it looses any potentiality of solution, apart from fatalism and punishing. A scientific analysis of accidents needs a precise characterization of these 'human errors', clearly differentiated from the factors that produce them, would they be human, environmental, vehicular, etc. Such a differentiation can open to more efficient solutions directed toward preventing efficiently well understood human errors by acting on their well identified causes, and by promoting a better ergonomics of the driving system in accordance with human capacities and weaknesses.

2.3 WP5 deliverables overview

Four deliverables have been resulting from the work done, each corresponding to one of the 4 tasks forming the TRACE WP5.

The first one -D5.1: '*Analysing human functional failures in road accidents*' (Van Elslande & Fouquet, 2007a)- defines model and classification grid for analysis of 'human functional failure' (HFF). These model and grid have been built on the background of literature dealing with human error analysis, in combination with the detailed analysis of human difficulties found in in-depth accident data. The purpose was to build an operational method both consistent with cognitive ergonomics concepts and specifically adapted to the driving task and its particular malfunctions. The report D5.1 begins with setting the way how to consider HFF in such a way as to promote operational measures being able at compensating for these driving malfunctions. It then defines and characterizes the different types of human failures: errors, violations and capacity exceeding which are involved in the accident

[1] Human Factors (also called Ergonomics) is the '*scientific discipline concerned with designing according to the human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance*' (definition adopted by the International Ergonomics Association in 2000)

generating process and which need to be clearly identified if efficient solutions are thought to be put forward (Figure 6).

The second deliverable -D5.2: '*Which factors and situations for human functional failures? Developing grids for accident causation analysis*' (Naing, Bayer, Van Elslande & Fouquet, 2007)- has been shaped so as to be complementary to D5.1. It presents methodological grids helping to define the causes of HFF and the situations which produce them. The factors of human errors correspond to the defective states of the driving system, i.e. the deficiency of its components and of their interactions. These factors consist in the explanatory elements of the road users' incapacity to adapt to the situation in hand. A grid of all the relevant elements contributing to human failures has been compiled, and differentiates those factors coming from the 'human' part of the system, from those coming from the layout, the traffic interaction and the vehicle. A second methodological grid put further forward the context in which these HFF occur via an operational typology of the driving situations (or so-called 'pre-accident situations') in which the drivers were engaged when they found a difficulty (Figure 8).

The third deliverable -D5.3: '*Typical human functional failure-generating scenarios: a way of aggregation*'. (Van Elslande & Fouquet, 2007b)- proposes a step further toward the integrative analysis of accident production regarding human factors. It combines the input from D5.1 and D5.2 in order to build a methodological frame allowing bringing together similar accident processes under the form of generic accidental patterns. These patterns are viewed as an integration of the parameters characterizing the accident generation: which situation and context, which human failure, which explicative elements, which consequence, etc. They will allow putting forward the most typical processes of production of human failures, i.e. the recurring difficulties encounters by different types of road users, in different types of situations, due to such or such combination of factors (Figure 10).

The fourth and last WP5 deliverable -D5.4 '*Social and cultural factors*' (Engel, 2007)- is enlarging the scope of human factors by taking into account variables which are acting further upstream the accident scene. The prospective analysis proposed expands the accident causation view by considering the socio-economic/socio-cultural dimension of human activity. Practically speaking D5.4 is turned toward the building of a framework of analysis aimed at completing the accident analysis framework proposed in the other deliverables of the WP by putting forward broader 'upstream' factors of their role in the production of accident process. The most important sociological dimensions potentially acting on individual behaviour are presented in view of an operational grid of analysis of these variables under the form of 'social spheres' (Figure 15).

The problematic and methodological results described in these 4 deliverables are synthesized in the following chapters, giving an overall view on the way to improve accident analysis by developing a more scientific regard on 'human factors' than it is usually the case in the frame of road safety.

3 A model for Human Function Failure analysis in road accident studies (TRACE report D5.1)

A large majority of safety studies conducted in the frame of road safety tends to come to the conclusion that human error is the main cause of accidents. Nevertheless, such a conclusion has not proved to be efficient in its capacity to offer adequate means to fight again these so-called 'errors'. For the purpose of better qualifying accident causation in the frame of TRACE, the role of 'human factors' in driving task performance and failures has been analyzed from literature review and in-depth accident data with the aim of going further than such a simple and reductive statement.

The TRACE deliverable D5.1 is investigating the different types of 'errors' with the help of a classification model formalizing typical 'Human Functional Failures' (HFF) involved in road accidents. These functional failures are not seen as the primary causes of road accidents, but as the result of further upstream malfunctions characterizing the different components in interaction. So HFF are the result of users/road/vehicle bad states and of their defective interactions (unfitness of an element with another). Such a view tries to extend 'accident causation' analysis toward understanding, not only the resulting 'causes', but also the background processes involved in the accident production. The purpose is to go further than establishing the facts, toward making a diagnosis on their production process. The usefulness of this diagnosis is to help at defining countermeasures suited to the malfunction processes in question, not focalizing only on the last link of this process: the human failure to compensate for the difficulty encountered.

3.1 Driving and accidents as interaction processes

As stated by numerous authors, the term 'human error' can be misleading, giving the impression that an accident is only the result of the last action performed in its sequential course, which is an oversimplified conception of how events occur. From the perspective of TRACE WP5, this term have been enlarged and conceptually systematized under the notion of Human Functional Failure, insisting on the fact that such failures represent the limits in the human functions which otherwise (and most of the time) allow the road user to adapt to the difficulties of the driving task. Differentiating from the common sense acceptation of 'human error', HFF viewed from an ergonomic meaning will not be considered as the origin of the accident, but as the result of factors which involve the different components of the system: drivers, vehicles, layout, etc. (cf. § 4).

Every study needs a theory as a frame to interpret data and lead them to 'results'. Without a clearly defined theory every analysis is subject to biases by implicitly referring to naïve theories. In the absence of well defined model of reference, analyses of accidents indeed tend to produce typologies which mix up very disjoined phenomena, putting for example on the same level: maneuvers, processes, factors, consequences, types of collision, etc. Thus, to understand accident data we need to rely on an accident production theory, even more when thinking to integrate the complex human component in this analysis. The most fruitful -and shared among the community of safety researchers- approach appears to be the so-called 'systemic approach'. This approach assumes that the components that comprise the transport system include: the users, the transport tools and the infrastructures used. These components operate by interacting with one another and the smooth running of the system implies that all three components have been adjusted correctly. Seen from this point of view, an accident is the result of an incorrectly adjusted interaction between the system components. So the cause of accident should not be searched into one or another of these components taken separately, but in the defective inter-component interactions (Figure 3).

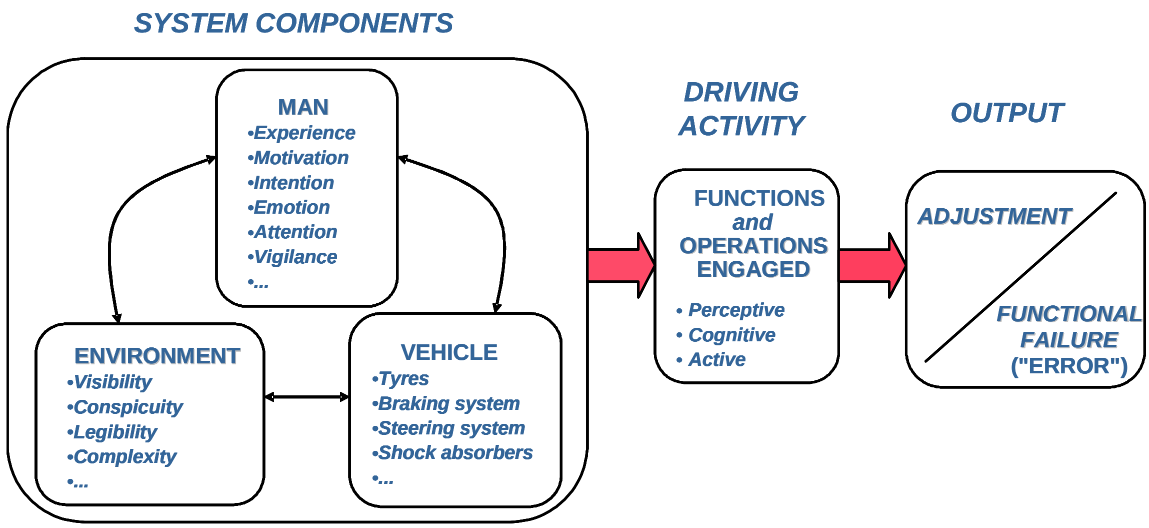

Figure 3: Interactions within the elementary Human-Vehicle-Environment system

It is important to recognize the specific role of the human element in the traffic system: it is both a **component** and the principal **actor** of its functioning.

As a component, the driver is characterized by a certain number of internal variables (e.g. Experience, Motivation, Vigilance, Attention, etc.) which are in a certain state, more or less favourable to driving task performance. In the same way, the other components of the system are also described by variables in a more or less degraded state. The interaction between these components forms the driving system and the factors of accidents are to be found inside these human, vehicular and environmental states of this system.

But the driver is also the element that *drives* the system. It is his or her task to regulate his activity and adjust it to the problems arising from the interactions between the different components, including him. To negotiate those difficulties, he performs a number of functions, especially cognitive ones. And we shouldn't forget that most of the time the use of these functions allows road users to succeed in compensating from driving system drawbacks. These human functions are at the basis of the (efficient) driving system functioning. But the same functions that usually enable the driver to regulate his activity may fail if he encounters major malfunctions within the system that prevent those functions from attaining their regulating objective. It results as an output in a functional failure (related to detection, cognition and action), which is commonly called 'human error'.

While it may appear artificial, this distinction between human as component of the system and human as actor is nevertheless important insofar as it enables us to differentiate between what are factors - attributable to the three components of the system - and what corresponds to the resulting difficulties in the operator's activity. However much one tries to highlight factors of errors, one thus has to focus on man as a component of the system like any other, rather than on his role as an actor who attempts to adapt to the difficulties arising from those components.

To conclude, it is essential not to make the recurring common sense amalgam between 'human error' and 'human factor'. For example we shouldn't confuse a detection failure and the different types of factors of detection failure (e.g. inattention, visibility obstacle, atypical acceleration from another driver, visual acuity, etc.). The detection failure is not the cause of the accident. It is just a link flowing from the upstream factors, some being human and other being external. And if concluding that the detection failure is the cause of the accident we lose the possibility to find an appropriate solution against it, a solution which will differ according to the different causes. The 'error', or in other words, the non recovered error[2], corresponds to a momentary failure of the one or other of these sensory,

[2] The negative consequences of the non recovered errors are far from being turned out (Amalberti, 2001).

cognitive and driving functions that the man usually operates to fit his activity to the difficulties of his task, where he mostly has success. Such a functional failure figures a limit in the functions capacity as a consequence of an integrated set of causal elements. It is therefore necessary to identify the failures to understand the specificity of the difficulties met by the users in their regulation attempts. But it is also indispensable to analyze correctly the combinations of elements involved in the genesis of these failures to be able to define appropriate solutions to well identified problems.

3.2 Driving and accident as sequential processes

Driving activity has often been defined as a complex and sequential task. As part of its malfunction output, every crash is also the result of a complex and temporal process. Its complexity and sequentiality are necessary to consider so as to be able to replace each single intervening element in the overall process and, by such, to clarify the role it plays in this process. If considering only the last step of the process, i.e. the crash situation, to understand the accident production, the risk is important to mix causes and consequences and to provide useless analysis both on a scientific and operational angle. Of course the resulting crash situation is essential to analyse in a secondary safety purpose, but the earlier steps of the accident generation must also be taken in a primary safety perspective. This basic consideration is nevertheless surprisingly not systematically taken into account in accident studies, in spite of the clear methodological work completed in the frame of OECD (1988).

The first stage of analysis consists of drawing up the accident scenario in terms of the sequence of events and, in particular, describing the initial system status, identifying the triggering event and reconstructing the emergency manoeuvre. The second stage is to identify the mechanisms that contribute to the production of this sequence of events: these mechanisms are found in the system component interaction. To achieve this, the scenario is divided into four phases, connected one to the others (Figure 4).

Driving phase	Rupture phase	Emergency phase	Impact phase
↓	↓	↓	↓
Behaviour on approaching the place	Meeting an unexpected event	Avoidance manoeuvres and dynamic demands	Nature of impact

Figure 4: Major steps to consider in a sequential analysis of accidents

- The driving phase

The driving situation can be described as the one in which the user is before a problem arises. It is the 'normal' situation, which is characterised for the driver by the performance of a specific task in a given context, with certain objectives, certain expectations, and so on. It is 'normal' because no unexpected demands are made upon him. The driver can adapt effectively, the events unfold in line with his predictions, expectations and anticipations. He is not overloaded with information. He controls his speed and course; he is 'master of his vehicle'. In more general terms, this means that there is a balance between the demands and ability of the system components to respond one to another: alignment, skid-resistance, sight distance, tyre wear and pressure, condition of shock absorbers, speed, degree of driver awareness, etc.

It should be noted that 'normality' in this case refers to effectiveness, but not necessarily to compliance with traffic regulations.

The advantage of the study of this situation is to reveal what the driver considers to be both desirable and feasible in a particular place, and in a particular context.

- The rupture phase

The 'rupture' is an unexpected event that interrupts the driving situation by upsetting its balance and thus endangering the system. That event could be an unforeseen presence or manoeuvre by another user, the advent of an infrastructure configuration which takes the driver by surprise, or provokes a sudden high workload, and so on. The effect of the rupture situation is to switch the system components from a bearable level of demand to a suddenly excessive demand in terms of ability to respond.

It should be noted that an 'unexpected event' does not necessarily mean 'unpredictable'. Which raises the question of to what extent it really was unpredictable, and if not, why it was unexpected. Information gained on the driving situation is of considerable use when seeking this explanation.

- The emergency phase

It is the period during which the driver tries to return to the normal situation by carrying out an emergency manoeuvre. A particular feature of this stage is that the driver faces very severe constraints (both temporal and dynamic) as regards the options open to him.

The emergency phase covers the space and time between rupture and impact. If the rupture situation gives a statement of the problem in hand, the emergency situation defines the space-time 'credit' available in which to solve it. This 'credit' is, by definition, extremely limited.

The emergency situation can be determined in relation to the driving situation by the sudden excessive demand level imposed on the system components. The driver must solve, within a given time, a problem that is, in principle, entirely new to him. The range of solutions depends on the environment in terms of hostile obstacles or the space available for evasive action. The capacity of the vehicle to perform the required manoeuvre depends not only on its design and state of repair but also, when referring to vehicle-ground liaison, on the state of the infrastructure. The emergency situation reveals the insufficiencies or defects in one or another of the system components, weaknesses that remain tolerable when faced with normally moderate driving situation demands. Of course, this phase may not be manifested when the driver keeps unaware of the danger until the impact.

The emergency manoeuvre is an attempt to find a solution to a problem. It sometimes succeeds, but in accident databases this manoeuvre has failed. So the emergency situation is followed by the crash phase.

- The crash or impact phase

The crash phase comprises the crash and its consequences. It determines the severity of the accident in terms of material damage and bodily injury. Once again, the situational circumstances depend on what has occurred previously and the interaction between the three components: thus an elderly person is more vulnerable to injury, modern vehicles are better designed to crashworthiness, a protection rail prevents impact with a hostile obstacle, etc.

From a safe-system model point of view, each of these phases should be considered specifically with the purpose of not generating hazards for the driver. So the driving system shouldn't generate ruptures, should be forgiving (i.e. giving the possibility to recuperate) in emergency phase, and protecting in impact phase.

The identification of these phases (or 'situations') enables the different sequential stages of the accident to be reconstituted in a homogeneous manner, which makes it possible not only to analyse each case from the viewpoint of the process that engenders it, but also to set up horizontal studies of several accidents by comparing the successive stages in their development.

We are particularly interested in the analysis that follows in the so-called 'accident' or 'rupture' situation, which is a key stage that pitches the driver from a normal driving situation into an impaired one. That transitional phase is a good place for comparing accidents, to the extent that it marks the start of a malfunction process. In the sequence of failures that follows the accidental impact, we thus identify those which characterize this moment of rupture and explain the fact that the driver suddenly finds himself in a critical situation. This rupture phase is the transitional step between a controlled and an impaired situation. It forms the pivotal moment of the accident generation and the human functional failure at this moment will be essential to consider in a purpose of primary safety development.

3.3 Classification Model for Human Functional Failures in accidents

The objective of the classification model is to help defining in what consist the different types of Human Functional Failures and how they can be characterized in an operational way. Such a modeling work had to be based both on scientific literature dealing with human error analysis, and on truly in-depth accident data.

3.3.1 Definition of human functional failure

As stated above, and in the lineage of recent literature works (e.g. Reason, 1995, 2000; Leplat, 1999, Simon *et al.*, 2005), 'human error' will not be analyzed as the first cause of the degradation of the situations, but as the symptom and the vector of the system malfunctions (Van Elslande, 2003). We will report it mostly afterward with the label of 'functional failure'[3]. That is for three reasons. At first, to distance itself from ambiguities of the notion of error in its common sense, often synonymic of the word 'fault'. Then, to target the analysis at the non retrieved errors, which are by definition those studied from accidents data. Finally, to include in this analysis the phenomena connected to capacities, notably physiological, of the individuals. In other words, this notion of function failure features the impairment of one (at least) of the cognitive, sensori-motor or psycho-physiological functions that usually allow the operator to adapt to the difficulties he meets when fulfilling his task. The notion of functional failure is thus useful to report the many levels of human dysfunctions: the error, the violation, the inaptitude.

'Error' is by definition not deliberated. We do not make any mistake on purpose (or it is not really an error anymore). This question of intentionality led Reason (1990) to distinguish what concerns 'error' and what corresponds to deliberate unsafe acts. There would be an error only when the subject does not reach the purpose aimed during the execution of a strategic sequence of mental or physical activities, and when these failures cannot be attributed to the intervention of fate only. The notion of error does not thus cover all the forms of contribution of the human beings to the accidents. Unsafe acts, which are deliberately operated, are identified by this author as 'violations'.

'Violation' is defined as the deliberated infringement (but not necessarily hostile, nor inevitably reprehensible from a legal point of view) of an established behaviour code or socially admitted to assure the safe functioning of a potentially dangerous system (Parker and al., 1995). In this explanatory system, it is also a question for extreme -even if they are rarer- deliberately criminal behaviours and those which have the will to damage: they are qualified as 'sabotages' by these authors. They match on the road those acts named delinquent, and which are different from the more 'classic' road insecurity: Car chases, search for revenge, etc., which characterize certain atypical accidents.

The notion of failure also allows to integrate more diffuse problems which are connected to the more or less durable inaptitude of the individual to realize his task and which can be a determinant link in the accident process: falling asleep, an illness, a impairment or an exceeding of the sensori-motor and cognitive capacities.

3.3.2 Delineation of Human Functional Failure

To make things easier, failures found in accident cases are delineated below in a 'Classification model for human functional failures in road accidents' following a sequential information processing chain of human functions involved in information gathering, processing, decision and action (Figure 5). It doesn't imply at all that drivers effectively function in a linear way. In the common functioning of the individual, there are numerous feedbacks between the various modules, and the data processing is

[3] A glossary is presented at the end of the report.

strongly looped. But involving accidents as in the analysis which follows, we stop this functional buckle in the stage of rupture in the progress of the driver, as he is confronted with an unexpected difficulty which is going to lead him to lose the control of the situation which was more or less suitably regulated so far. It is thus a grid of analysis of the dysfunctions and not a model of functioning or dysfunction of the operator.

At a general stage, the classification model allows distinguishing Failures at the information detection stage, Failures at the diagnostic stage, Failures at the prognostic stage, Failures at the decision stage on the execution of a specific manoeuvre, Failures at the psychomotor stage of taking action, and Overall failures dealing with the psycho-physiological capacities of the driver. At a more defined level (Figure 6), it shows the specificities of the types of failures found in in-depth accident data. 20 precise HFF are so defined which gives an innovative view on the difficulties met by drivers on the road, notably in that it opens up the possibility of defining drivers needs in aid, where classical work on 'human errors' tends to finally conclude in the destiny of accidents simply due to 'human nature'.

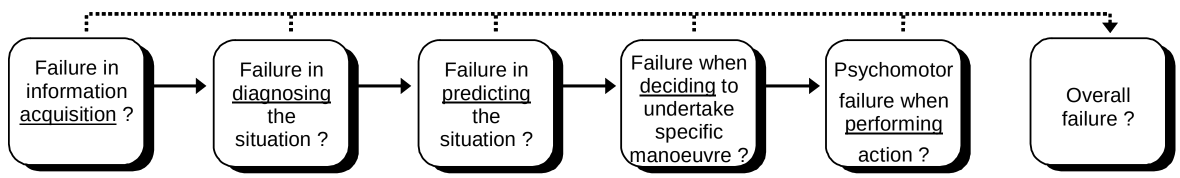

Figure 5: General stages of human malfunction chain potentially involved in accidents

By examining in detail In-depth data collected on accident scenes, the following types of functional failures can be defined with each of these categories. These failures are described, stage by stage, in the following pages.

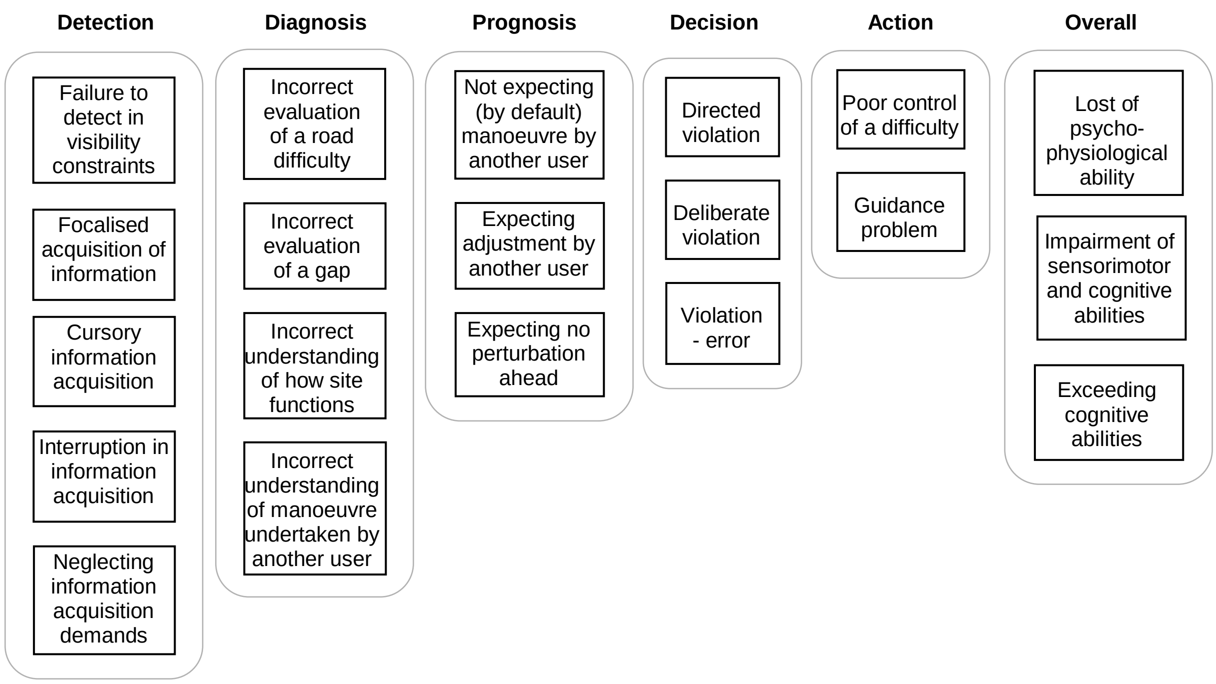

Figure 6: Delineation of functional failures found from In-depth accident analysis

Failures at the information detection stage

Perception (P) failures – Failures where, for some reason, the road user fails to detect another road user/hazard and therefore proceeds with manoeuvre, which leads to the impact.

The safe performance of a task in a given driving situation depends in the first place on early detection of all the relevant data required for that task to be performed. If there is a failure in perception (?), this first human function will interrupt the good process of the entire human functional chain. For drivers in that situation, accidents are directly attributable to the non-detection (or belated detection) of certain essential parameters of the situation, such as a change in the way the site functions or the presence of another user on a potential collision course. These detection failures can occur following different types of mechanisms which go far further than strictly sensorial mechanisms. They can refer to problems relating to information conspicuity, a deficient organisation of information acquisition, or a failure to search actively for information.

- *P1 failure - Non-detection in visibility constraints conditions*
- *P2 failure - Information acquisition focused on a partial component of the situation*
- *P3 failure - Cursory or hurried information acquisition.*
- *P4 failure - Momentary interruption in information acquisition activity*
- *P5 failure - Neglecting the need to search for information*

Failures at the diagnostic stage (information processing stage 1)

Diagnosis Failures – Evaluating and understanding the situation. Once the detection stage is correctly performed, the road user will then need to process the information they encounter in a situation.

Following a sequential logic of analysis for malfunctions, once the detection stage is correctly performed, a second functional stage involved in driving entails processing information acquired in the situations encountered. This processing activity should essentially enable the driver to:

- On the one hand, *evaluate* the physical parameters (space, time, speed, acceleration, etc.) identified at the previous stage in order to assess the feasibility of undertaking his planned manoeuvre and,

- On the other hand, *understand* the information acquired concerning the type of situation with which he is confronted.

- *T[4]1 failure - Erroneous evaluation of a passing road difficulty*
- *T2 failure - Erroneous evaluation of the size of a gap*
- *T3 failure - Mistaken understanding of how a site functions*
- *T4 failure - Mistaken understanding of another user's manoeuvre*

Failures at the prognostic stage (information processing stage 2)

Prognosis Failures – Expectations of the road user.

Given that it is an activity with a dynamic component, a second stage in the processing of the information acquired involves making a prognosis of its probable evolution (Hoc, 1996). At this stage, the driver has two tasks: on the one hand ensuring he correctly *anticipates* the potential changes in the currently encountered situations and; on the other *making a prevision* on the possibilities of a not yet visible event potentially occurring in situation to come. We will remind that beyond its direct intervention in the accident mechanisms such as they are analysed here, the prognosis function has an over determining influence on other functions, and by so, conditions more or less implicitly the whole process involved in a dynamic activity such as driving. To support this idea, Hollnagel (1991) describes prognosis function as a 'genotype' of many problems which will express itself in at the end of the functional chain by many different 'phenotypes'.

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[4] 'T' accounts for 'Treatment of the situation', all failures of which involve Information Processing functions.

Three types of prognosis failures can be identified within the realisation of driving activity in accidental situations. The two first deal with the anticipation process: the wrong expectation that another user won't move, and the wrong expectation that another user will regulate the situation. The third failure refers to the prevision process: the wrong prediction that no 'obstacle' will be met.

- *T5 failure - Expecting another user not to perform a manoeuvre.*
- *T6 failure - Actively expecting another user to take regulating action.*
- *T7 failure - Expecting no perturbation ahead.*

Failures at the stage of deciding on the execution of a specific manoeuvre

Decision (D) failures – After undertaking the detection and information processing stages correctly, the failure occurs at the decision stage of the process. The road user makes an 'incorrect' decision.

Still following sequentially the grid of analysis of human functional failures, the functional stage resulting from the detection and processing of the event encountered consists of the decision-making processes that come into play. Since the driver gathered the right information items, since he has correctly interpreted the situation and anticipated its short termed evolution, he still has to 'select' amongst the driving strategies that are feasible in that situation the one that seems to him best suited to the event and its safety requirements. To the extent that the present analysis is focused on the problems that can put the driver into a situation of impeded progress, the failures outlined below relate to decisions to undertake a specific manoeuvre and not to the broader decisional factors related to the circumstances in which the journey is being made (alcohol intake, journey for recreational purposes, and so on), parameters which will be analysed as explicative elements for different types of failures.

Contrary to the failures analysed until now, the malfunctions revealed in this type of process have more to do with the notion of 'violation' (Reason, 1990) than the notion of 'error' in information processing terms. As already stated, 'violation' in this context doesn't refer to the law, but to the informal driving norms socially shared. Such 'violations' can be viewed as a deviation from the behaviours which could be expected from the majority of road users. Several types of failure in this decision-making function can be distinguished, according to the degree of intent involved in the violation committed:

- *D1 failure - Violation directed by the characteristics of the situation.*
- *D2 failure - Deliberate violation of a safety rule.*
- *D3 failure - Violation-error.*

Failures at the psychomotor stage of taking action

Execution (E) failures when taking 'Action' - When the previous stages are all undertaken correctly, a failure could still occur at the psychomotor stage. The road user loses their ability to control their vehicle due to either external factors or being distracted by undertaking another task.

The last link in the functional chain involved in driving activity is the driver's manipulation of the controls of his vehicle to ensure it continues along his chosen trajectory. This category only includes accidents in which a problem of vehicle control is the direct cause of the emergence of an accident situation, meaning that they occur after the driver has successfully negotiated the other stages. Note that these failures do not refer to the emergency stage but, as for other failures declined here, are analysed at the rupture stage.

Two types of problems distinguish as the handling failure features an external element which comes to perturb the controllability of the manoeuvre (E1), or only the conditions of attention allocated to the task of trajectory regulation (E2).

- *E1 failure - Poor control of an external disruption.*
- *E2 failure - Guidance problem.*

Overall failures

Overall or 'General' (G) failures - These failures involve several stages of the driving process, and the outcome will be that the road user will lose the capacity to fully control their vehicle.

Until now we studied the failures corresponding to one or the other of the functional stages involved in the driving activity. However there are cases for which the problem does not settle anymore in terms of functions failure but in terms of capacities. It recovers the notion of 'overall failure which corresponds to a degradation of the whole functional chain, the outcome of which is a loss of control of the situation. These include those cases where the whole of the functions needed to drive seem to have been deficient in the mechanism leading to an accident.

It is thus at the level of the general capacity of the individual to manage the situation encountered, as much from the point of view of the information to be collected, treatments to be operated, decisions to set, actions to undertake, that the problem is situated. Hence, the problem is located at the key level of the individual's general ability to handle the situations he encounters, with regard to not only information acquisition and processing but also the decisions to be made and the action to be taken. The origin of this overall failure is to be found in the parameters (factors) indicating the psycho-physiological and cognitive state of the drivers scarcely compatible with the functional demands required by the general activity of driving. These factors can refer to different things such as fatigue, alcohol or other drugs intake, fitness to drive, and so on.

Three types of driving capacities degradation are listed in this category: the loss of psycho-physiological capacities, the alteration of the sensori-motor and cognitive capacities, the overstretching of the cognitive capacities.

- *G1 failure - Loss of psycho-physiological capacities.*
- *G2 failure - Alteration of sensorimotor and cognitive capacities.*
- *G3 failure - Overstretching cognitive capacities.*

Such a classification, based upon in-depth analysis of the real difficulties encountered by drivers in accident histories, allows being well operational when trying to diagnose malfunctions in the purpose of promoting a safe driving system.

To conclude with this analysis of HFF, it has to be well kept in mind that the clear finding of the human failure involves of course relying upon quality data collected by specialists in accident analysis, and notably involving verbal data collected by psychologists following a predefined protocol. This point seems problematic when conducting extensive in-depth data collection, sometimes more oriented to statistical purpose than really intensive research of the mechanisms involved. As a result, making use of data collected by non specialists in human factors (for example policemen records) will require a level of inference which does not guaranty the validity of the conclusions and, by so, their likeness depending on the analyst. For this reason, will be presented in Chapter 5 a more generic method allowing, not to precisely diagnose the failures and their factors, but to recognise the whole process of HFF generation by assimilation of the data to already defined typical HFF generating scenarios. This recognition method will be useful when working on large sample of accident cases put poorly documented on human factors aspects.

3.4 Degree of the driver's involvement in the degradation process

Complementarily to the diagnosis put on the functional failure, the variable 'Degree of the driver's involvement' defines the role played by each driver in the genesis of the accident. Close to the notion of 'responsibility', it differs nevertheless from this latter by the reference not to a legal code but to a strictly behavioural reference. An ergonomic approach of accidents, differentiating from the insurance and judicial perspectives, does not search for punishing but to preventing. It is not its role to attribute the guilt (which is underlined in the notions of 'responsible' or 'at fault' drivers); but to clarify the respective degree of participation of the various users involved in the same accident, from the viewpoint of the degradation of the situations. This will help defining whose drivers have to be helped and in which manner. Four modalities are so defined below which show in a decreasing way the degree to which the driver participates, through his behaviour, to the fact that the critical situation he met turned into an accident:

- Primary contributing (trigger)

This modality designates the drivers who 'provoke the disturbance', but not on purpose. They have a determining functional involvement in the genesis of the accident: they are directly at the origin of the destabilization of the situation. Following the functional failure, the drivers provoke for themselves or for the other interfering users in the system, a critical situation in which the accident is going to take place. Examples include: a manoeuvre bringing the driver toward a trajectory of collision with the other, generating an unpredictable disturbance for the other users, provoking a loss of control, etc. In certain extreme situations, we can isolate two primary contributing drivers in the same accident, when they are both causative in the destabilisation of the situation (for example: when two drivers decide to overtake face to face on the third way).

- Secondary contributing (contributor)

These drivers are not at the origin of the disturbance which precipitates the conflict, but they are however part of the genesis of the accident by not trying to resolve this conflict. We cannot attribute them a direct functional implication in the destabilization of the situation but they participate in the non-resolution of the problem by a wrong anticipation of the events evolution. In situation of pre-accident, they did not envisage a possible degradation of the events, although this degradation was theoretically detectable according to more or less alarming cues they had at their disposal. Potentially able to anticipate whereas they do not, they thus contribute to the genesis of the accident by the absence of adapted preventive strategies. Examples include: absence of behavioural adaptation because they expect an adjustment from the other user, no anticipation of a possible conflicting pathway with others although alarming indications, etc.

- No contributing (but potentially reactive)

These drivers are confronted with an atypical manoeuvre of others that is hardly predictable, whether it is or not in contradiction with the legislation. As a general rule, the human functional failure (HFF) observed among these drivers doesn't feature any endogenous (human) explanatory element. They are not considered as 'active' in the degradation because the information they had did not enable them to prevent the failure of others (contrary to the secondary contributing). They were not able to anticipate, due to this lack of information, the degradation of the situation, while the avoidance of the accident would have been possible in theory if this information had been supplied to them in time. But we differentiate them from 'only present' users, for whom no information would *a priori* have allowed to avoid the collision. Examples of 'no contributing' include: drivers confronted with visibility constraints, drivers that must face an atypical manoeuvre of others and who do not have warning cues at disposal, etc.

- Neutral (only present)

These drivers are not involved in the destabilization of the situation even if they are nevertheless an integral part of the system. Their only role consists in being present and they cannot be considered as an engaging part in the disturbance. No measure may a priori be beneficial to them, except to act on the other driver. That is why in an ergonomic purpose they are differentiated from 'No contributing' drivers. Examples include: drivers who are collided with when stopped at a traffic light or on a parking spot, drivers confronted with stone falls, etc.

3.5 Conclusion

Application of the classification model to in-depth accident data allows well précising the weak points in the driving functional chain where drivers can be subject to functional failures. Defining the degree of involvement from a behavioural (and not a legal) point of view allows going further in the understanding of the contribution to each protagonist in the accident production. Once the failure in the human functions allowing driving has been diagnosed, and once the level of contribution of each road user in the overall accident process has been defined, still have to be searched the reasons why the driver didn't succeed in compensating for the difficulties encountered. The definition of the factors of human failures which is presented in the following chapter will permit to find what has to be fought against in order to avoid human failure production, and by such avoid accidents to occur.

4 Classification grids of factors and situations for HFF (TRACE report D5.2)

TRACE Report D5.2 describes the work undertaken for TRACE Work Package 5 Task 2, which aims to both determine the types and variations of potential factors which lead to the human functional failures that occur in road accidents, and also outline the types of pre-accident driving situations in which the road user is exposed to these factors. This work has been combined elsewhere with the work in the Work Package 5, to develop analytical tools for analysing human functional failures and typical failure generating scenarios in real-world accidents.

It is generally acknowledged from a scientific view that the majority of road accidents are caused by not just one factor, but by the interaction of many different factors intervening at different levels, the one facilitating the other. Since the 1970’s, accident causation has become an increasing concern and many newly developed data collection systems and their databases now include accident causation variables, including factors which contributed to the accident occurring. But many accident causation systems currently focus much of their attention on the road user and their 'failures' which resulted in the accident occurring. By so doing, these 'errors' or failures are treated as the main cause of accidents, while the reasons behind them (i.e. the 'factors' of human failures) are often given little consideration. Also, 'factors' are often confused with their resultant 'failures' in the analysis of accidents. A review of literature and current accident studies confirmed that the problem with many accident causation coding systems currently used across Europe is that they do not separate the 'errors' (or human failures) from the 'factors' which lead to these failures. The grid of factors compiled in TRACE deliverable D5.2 aims to include only factors (not confusing with their consequences) and these factors can then be linked to the human failures investigated in D5.1 (cf. § 3), and be used to create 'scenarios' as part of D5.3 (cf. § 5).

4.1 Methodological Approach

To overcome the confusion of factors and errors that were found in the literature review, it was decided that a holistic approach would be adopted, enabling the analyst to look at the factors in an encompassing and complete manner. The approach enables many of the potential factors to be identified. However it is then necessary to apply a systematic approach in dealing with the factors that were generated in order to create categories or lists. The systematic approach allows the categorisation process to be consistent and thorough which can be particularly difficult when processing large numbers of factors.

Using a holistic approach, the methodology of this task adopted a fundamental ergonomic model based on a model described by Eason (1981). The model is outlined in Figure 7 below:

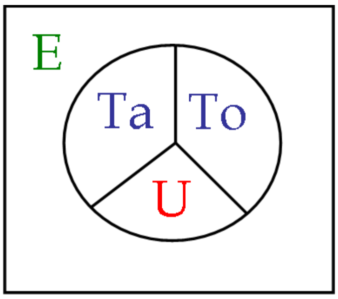


Figure 7 - Fundamental Ergonomic Model (Eason 1981)

This model is described in more detail in table 1 below:

Table 1 - Further Description of the Fundamental Ergonomic Model Outlined in Figure 2

User (U)	The individual involved and all of their personal demographic
Task (Ta)	The activity the user is attempting to undertake
Tool (To)	The equipment or devices the user is interacting with in the task
Environment (E)	The surroundings in which the user is carrying out their task

This model was adopted to assist in a logical and practical method for generating a grid of factors which contribute to functional failures occurring and the related driving situations.

When considering the driving situation, specifically in terms of accident analysis, the 'user', 'task' 'tool' and 'environment' can be interpreted in the following way:

Table 2 - Adaptation of Fundamental Ergonomic Model for Use in Accident Analysis

U = Road user	A human in charge of a vehicle (e.g. driver, motorcyclist, cyclist) or pedestrian involved in the accident
Ta = Task	Driving, riding, walking, running...
To = Vehicle	A **vehicle** involved in the accident (e.g. car, truck, bus, van, motorcycle, bicycle…). Consideration should also be given about whether a pedestrian has an equivalent 'tool'?
E = Environment	Encompasses all aspects related to the **road user's** surroundings (i.e. external to the vehicle and road user)

In addition to the holistic approach, in order to further identify the factors, a top-down and bottom-up[5] approach was also taken using the sources of potential factors identified in the literature. To expand, a classification system was created based on those factors identified in the literature and using the categories defined, the many factors identified were sorted into these categories. Conversely, similar factors were grouped together and from these, an effective way of categorising was devised. The results of both of these methods were summarised and a comprehensive grid of factors which lead to human functional failure and categorisations was defined.

The schematic in Figure 8 is divided into two parts, 'Pre-Accident Driving Situations' and 'Factors' which lead to functional failures. The pre-accident driving situation is related to the 'task' in Eason's model and the 'factors' are related to the 'user', 'tool (vehicle)' and 'environment' from the same model. In addition to the task, the 'driving situation' is further defined by the location of the accident and any opponent manoeuvres from other vehicles in the accident (described as 'conflict' from here on).

The concept outlined in the schematic also considers both 'Current' and also 'Future' issues. 'Current' issues describe the factors that are relevant in current accident analysis and are often considered in current accident data collection systems. The 'future' aims to describe potential 'future factors' which may not be considered in current data collection systems, but could contribute to functional failures in accidents as technologies and driving task demands change over the next 5-10 years (and may even be influencing current accidents) and may also affect the types of driving situations drivers are involved

[5] Top-down - firstly formulating an overview of the system and then each subsystem is then refined in greater detail, until the entire system is reduced to base elements.

Bottom-up – firstly the base elements of the system are formulated in detail and then the elements are linked together until the complete system is formed.

in. From the compiled categories and the generated list of factors, it became possible to identify and look ahead to ask questions like: 'What factors are not considered in present classifications that could potentially be influential over the next 5-10 years, and would they still apply or fit with the current categorisation?' The overall approach is outlined in full using the example schematic shown in the following figure:

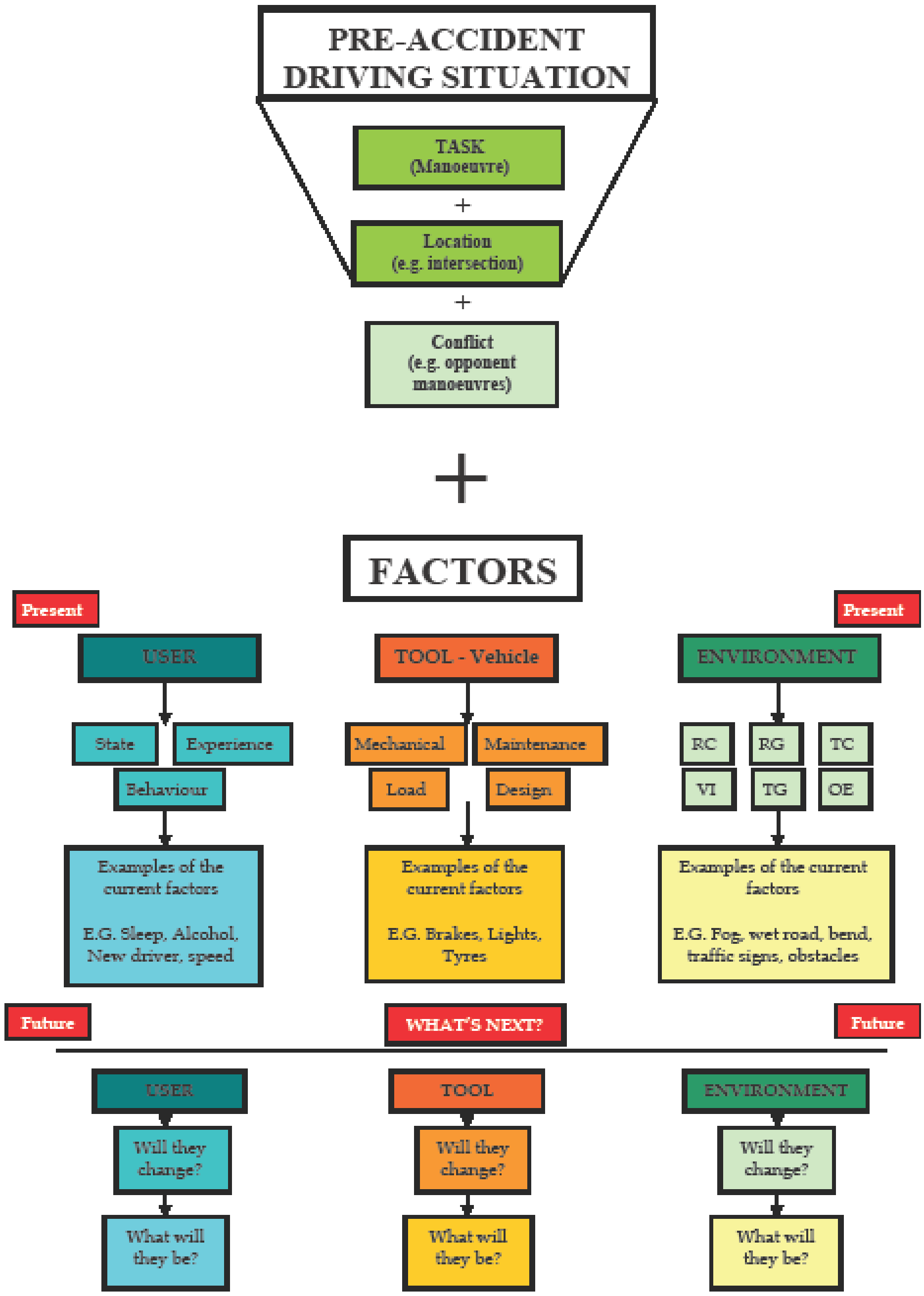


Figure 8 - Overall Approach for Determining Driving Situations and Factors

To help focus on this holistic approach, each top level factor category was considered independently (User, Vehicle and Environment). Task was also considered in a similar way, but in order to define pre-accident driving situations. The following sections identify in detail how the holistic approach generated sub-categories and what factors were identified within each of these sub-categories.

As TRACE is focussing mainly on motor vehicles, in particular cars, the compilation of both the grid of factors and the pre-accident situations has also focussed mainly on motor vehicle drivers, in particular cars. Where possible, the involvement of pedestrians has been taken into consideration, but this is an issue that requires further in-depth investigation which is beyond the current scope of TRACE.

4.2 Factors Leading to Human Functional Failure

Human failures occur at the end of a dysfunctional process. They are explained by factors characterizing the state of the system, i.e. the defects of its components (human and other) and of their interactions. These factors form the explicative elements of the road users' incapacity to adapt to the situation in hand or to adopt a suited behavior. They are essential to be clearly characterized in order to find operational means to prevent the occurrence of human failures.

In terms of road accident causation, a factor has been defined as 'any circumstance connected with a traffic accident without which the accident could not have occurred'. However, this factor alone 'is not sufficient itself to cause an accident' (Baker and Ross, 1961).

Depending on the specific accident scenario, the same factors can appear at different stages of the accident and may have different roles, being contributing, triggering, or aggravating factors to the process[6]. In the mentioned above D5.1 report, a division of the different phases within an accident scenario has been outlined and is reproduced in Figure 9. A specific factor could appear within any of these four phases and influence the likelihood of a functional failure, which occurs between the rupture phase and emergency phase.

For example, a specific factor may already be present at the start of the 'Driving phase' (e.g. alcohol intoxication) and this would become a 'Contributor' when the 'Triggering' factor is introduced (e.g. encountering a difficult bend). The fact that the driver is 'speeding' when the bend is negotiated both 'Aggravates' the likelihood of the functional failure occurring (e.g. poor control of the vehicle) and also the severity of the outcome (i.e. more severe injuries).

However, in other accident scenarios where these similar factors appear, their role in the accident process may be different (e.g. the vehicle's speed may be the 'Trigger' or 'Contributor' of the functional failure).

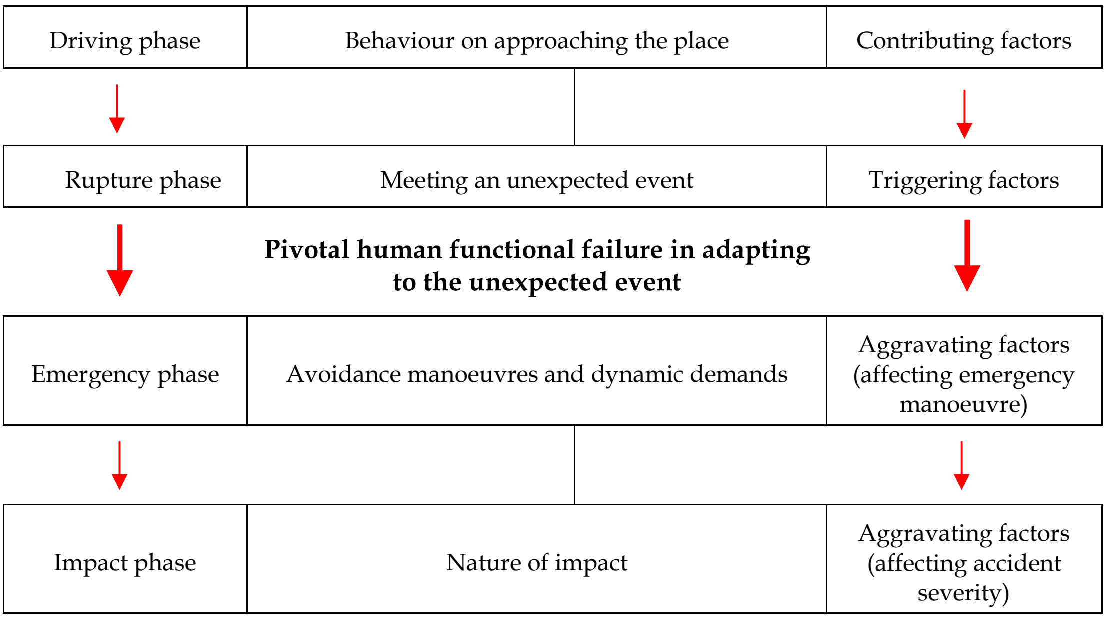


Figure 9 - Main Phases within an Accident Sequence

[6] A definition is provided in the glossary at the end of the report.

As part of classifying factors which lead to human functional failure, three integrated levels of categorisation were developed, corresponding to the types of real world accident data commonly available to analysts. This would ensure the classifications were versatile and flexible enough to be of use in accident data analysis at different levels of detail depending of the data used. It is of course not worth to mention that the more detailed the data the more accurate the analysis will be.

When using these factors as part of an analysis of real-world accidents, for each causal factor identified, it should be determined, if possible, whether each was a 'contributing' factor to the onset of the accident, a 'triggering' factor (i.e. led to the rupture phase), or an 'aggravating' factor (increased the likelihood of an impact occurring at the emergency phase), as outlined in Figure 9.

To enable the comprehensive grid of factors to be used at all levels of analysis, three levels of classifications were developed for both user, vehicle and environment-related factors. These levels were defined as 'descriptive' (see Table 3 below), 'generic' and 'in-depth' (see Table 11, Table 12 and Table 13 in Annex).

Table 3 – General Classification of Factors

<table>
<tr><td rowspan="7">User (U)</td><td rowspan="3">A. User State</td><td>1. Physical/ Physiological</td></tr>
<tr><td>2. Psycho-Physiological Condition</td></tr>
<tr><td>3. Internal Conditioning of Performed Task</td></tr>
<tr><td rowspan="2">B. Experience</td><td>1. Little/None</td></tr>
<tr><td>2. Over- Experienced</td></tr>
<tr><td rowspan="2">C. Behaviour</td><td>1. Conflicting (Distraction)</td></tr>
<tr><td>2. Risk Taking</td></tr>
<tr><td rowspan="6">Vehicle (To)</td><td colspan="2">A. Road Condition</td></tr>
<tr><td colspan="2">B. Road Geometry</td></tr>
<tr><td colspan="2">C. Traffic Condition</td></tr>
<tr><td colspan="2">D. Visibility Impaired</td></tr>
<tr><td colspan="2">E. Traffic Guidance</td></tr>
<tr><td colspan="2">F. Other Environmental Factors</td></tr>
<tr><td rowspan="4">Environment (E)</td><td colspan="2">A. Electro-Mechanical</td></tr>
<tr><td colspan="2">B. Maintenance</td></tr>
<tr><td colspan="2">C. Design</td></tr>
<tr><td colspan="2">D. Load</td></tr>
</table>

4.2.1 User (Human)

This category of factors is described as any factors related to the individual and personal demographic. This includes any physical (e.g. level of vigilance) and psychological (e.g. level of attention) states that may be of relevance, any psychomotor disorders that the user may have incurred through alcohol or misuse of drugs, or any emotional/motivational states unfitted with safe and efficient driving. The user is defined as any human in charge of a vehicle within the accident (e.g. driver, motorcyclist, cyclist) or any pedestrian injured in the accident, and is described as a 'road user'.

From reviewing the literature and current data collection systems, three main subcategories of user factors were decided on, as follows:

1. User State
2. Experience

3. Behaviour

Table 11 in Annex outlines the classification of road user-related factors which could potentially lead to functional failures. The three main categories of user factors defined (plus a number of sub-categories) are outlined at different level of precision. These levels of classification must be used depending on the level of quality of the data at disposal.

4.2.2 Environment

The environment encompasses all aspects related to the users' surroundings (i.e. external to the vehicle and road user). Six categories of environment-related factors have been defined and are outlined below:

1. Road Condition
2. Road Geometry
3. Traffic Condition
4. Visibility Impaired
5. Traffic Guidance
6. Other Environmental Factors

Table 12 in Annex outlines in detail the classification of factors related to the environment.

4.2.3 Vehicle (Tool)

This category involves the equipment or devices the user is interacting with in the task. The subcategories developed to deal with the vast array of tools were:

1. Mechanical – Vehicle failures which directly affects vehicle control;
2. Maintenance - Anticipated vehicle fault, indirectly affects control of vehicle;
3. Design - Design of vehicle affects safe/efficient operation;
4. Load - Did a vehicle load affect ability to control vehicle?

Further thought is needed to ensure that the 'tool' can be related to any type of 'vehicle' used on the road, including car, van, truck, bus, motorcycle, bicycle. Also, if this tool is also to be relevant for pedestrians, consideration must be given to what the 'pedestrian's' equivalent 'tool' (vehicle) is? For example in OTS, 'shoe' is coded as the pedestrian's vehicle. However, as TRACE is focussing specifically on motor vehicles, in particular cars, this should be a consideration for further work.

Table 13 in Annex outlines the classification of factors related to the tool, which is defined as any *vehicle* involved in an accident (e.g. cars, trucks, buses, vans, motorcycles, bicycles etc…).

It is envisaged that the grid of factors will be a valuable tool in TRACE, helping analysts determine the factors involved in accidents at a greater depth than other research studies have undertaken in the past. It will also help to form a basis of the types of typical failure generating scenarios that have been investigated as part of Task 5.3. The concept of the grid could also act as a valuable analysis tool beyond TRACE, not just for issues that are relevant in current accident analysis, but also issues that could potentially affect future accidents.

4.3 Critical driving situations in which Human Functional Failures occur

'Factors' were defined as being elements that 'influence' the road user's ability to undertake the task rather than just the 'causes' of the accident. In the same vein, 'situations' were defined from an ergonomic point of view as being a task to perform at a given time within certain conditions, requirements and constraints (i.e. task demands).

These driving situations in which those factors intervene also have to be examined in order to better know the types of driving tasks in which difficulties are found by road users. In fact, HFF happen in a certain context which represents not only the task that road users had to perform (e.g. cross a junction), but also some constraints (potential 'conflicts') involved in this task performing (e.g. manage another car approaching). The different resulting 'malfunction tasks' (i.e. the tasks within which a malfunction occurred) are described through a classification grid of so-called 'pre-accident situations'.

These pre-accident situations are essential to identify when analyzing road users' difficulties. They are defined below by: 1) the driving situation including the type of driving task being performed and the task location and 2) any potential 'conflicts' that the driver had to manage in order to perform the driving activity. In the diagram shown in Figure 9, the pre-accident driving situation can be defined as the 'driving phase' and describes what the road user was undertaking and the circumstances surrounding this prior to the rupture phase occurring.

4.3.1 The driving situations

A number of subcategories were initially developed to understand further the complexity of the driving task and these were related to the importance of the aspect of the driving task being undertaken.

Table 4 – General Classification of driving tasks

A. Stabilised Situation	Going ahead
B. Intersection Situation	On approach, Stopped, Going ahead, Turning
C. Manoeuvre Situation	Overtaking, Changing lane, Slowing, Starting, Turning (not at intersection), Reversing, U-turn, In wrong direction
D. Other Situation	Parked, Stopped in traffic queue, Pedestrian crossing, Railway crossing

A. Stabilised Situations

The situations defined in this category are those which do not occur at intersections and where no manoeuvres are being undertaken

B. Intersection Situations

They stand for situations which occur at or on approach to an intersection. An intersection is defined as a connection of two or more public roadways (i.e. a main road and at least one side road). These roadways do not include slip roads or private roads, driveways or paths. Intersection includes those controlled by 'give way' signs and markings, 'stop' signs and markings and those controlled by traffic light.

C. Manoeuvre Situations

These are situations where the road user is undertaking a specific manoeuvre which does not necessarily occur at an intersection (i.e. those already specified in the previous section).

D. Other

These are other types of situations which do not involve a specific manoeuvre and did not occur at an intersection (as defined in 'B').

Table 5 – Classification of driving situations (Manoeuvre and Location)

Level 1	Level 2
A. Stabilised Situation	
Going ahead	Going ahead on a straight road
	Going ahead on a left bend
	Going ahead on a right bend
B. Intersection	
On approach	Approaching a 'give way' intersection
	Approaching a 'stop' intersection
	Approaching a 'traffic signal' intersection
	Approaching intersection where road user has right of way
Stopped	Stopped at a 'give way' intersection
	Stopped at a 'stop' intersection
	Stopped at a 'traffic signal' intersection
	Stopped in road/ turning lane waiting to turn
Going ahead	Going straight on at a 'give-way' intersection
	Going straight on at a 'stop' intersection
	Going straight on at a 'traffic signal' intersection
	Crossing intersection where road user has right of way
	Travelling on roundabout (not turning on/off)
	Travelling on slip-road (not turning on/off)
Turning	Turning across traffic at a 'give-way' intersection
	Turning across traffic at a 'stop' intersection
	Turning across traffic at a 'traffic signal' intersection
	Turning across traffic from main road into side road
	Turning away from traffic at a 'give-way' intersection
	Turning away from traffic at a 'stop' intersection
	Turning away from traffic at a 'traffic signal' intersection
	Turning away from traffic from main road into side road
C. Manoeuvre	
Overtaking	Overtaking stationary vehicle on left
	Overtaking stationary vehicle on right
	Overtaking moving vehicle on left
	Overtaking moving vehicle on right
Changing lane	Moved into lane on left (NOT overtaking)
	Moved into lane on right (NOT overtaking)
Slowing	Stopping (not at junction)
	Parking (roadside)
Starting	Starting (not at junction)
	Leaving parking space (roadside)
Turning (not at intersection)	Turning across traffic from main road into private drive
	Turning away from traffic from main road into private drive
	Turning across traffic out of private drive
	Turning away from traffic out of private drive
Reversing	Reversing
U-turn	U-turn
In wrong direction	Driving in wrong direction (e.g. down a one-way road)
D. Other	
Parked	Parked
Stopped in traffic queue	Stopped in traffic queue
Pedestrian crossing	Approaching pedestrian crossing
	Stopped at pedestrian crossing
Railway crossing	Approaching railway crossing
	Stopped at railway crossing

4.3.2 The potential conflicts to manage

The grid of pre-accident situations was made complete with the inclusion of the potential 'conflicts' to manage in the driving situation. These potential conflicts are part of the pre-accident situation as they make part of the constraints that the drivers have to integrate in the performing of their task in the given location.

Conflicts can be described as potential opponent manoeuvres that the road user could be faced with during the pre-accident driving situation. In most 'situations', each road user will not experience more than one conflict at the rupture phase.

However, on some occasions, it is possible that more than one conflict could occur. However, it is the first conflict that led to the rupture phase which makes up the pre-accident driving situation that is described here. It is possible that this first conflict may involve a vehicle that is not involved in the eventual collision, so is not recorded in the accident (e.g. a vehicle swerves to avoid a stationary vehicle ahead but then eventually has a head-on impact with a vehicle travelling in the opposite direction).

The following describes the types of conflicts which have been identified (outlined in Table 6). Again, two levels have been developed:

Level 1 – Providing a basic level of information;

Level 2 – Providing a more detailed level of information.

Table 6 - Potential Conflicts That the Road User Could be Faced With During the Pre-Accident Driving Situation

Level 1	Level 2
None	None
Oncoming vehicle(s)	Oncoming vehicle(s) in correct lane
	Oncoming vehicle(s) in wrong lane
Vehicle ahead (moving in same direction or stationary)	Moving vehicle(s) ahead
	Stationary vehicle(s) ahead (congestion or accident)
	Stationary vehicle(s) ahead (parked)
	Car door open on stationary vehicle
Following vehicle(s)	Following vehicle(s)
Vehicle from side	Vehicle(s) from side road/path
	Vehicle in lateral lane travelling in same direction
Obstacle(s) ahead (non-vehicle)	Moving obstacle(s) ahead
	Stationary obstacle(s) ahead
Pedestrian in road ahead	Pedestrian crossing over
	Pedestrian walking along road
	Pedestrian playing/ running on road

The types of driving tasks, their location and the potential conflicts have been combined together to create a grid of pre-accident driving situations, which is displayed in Table 7. The user of the method therefore selects a row and column position to define the pre-accident situation.

Table 7 - Grid of Pre-Accident Driving Situations

PRE-ACCIDENT DRIVING SITUATIONS		Conflict														
	Level 1	None	Oncoming vehicle(s)		Vehicle ahead (moving in same direction or stationary)				Following vehicle(s)	Vehicle from side		Obstacle(s) ahead (non-vehicle)		Pedestrian in road ahead		
Manoeuvre and Location: Level 1	Level 2	None	Oncoming vehicle(s) in correct lane	Oncoming vehicle(s) in wrong lane	Moving vehicle(s) ahead	Stationary vehicle(s) ahead (congestion or accident)	Stationary vehicle(s) ahead (parked)	Car door open on stationary vehicle	Following vehicle(s)	Vehicle(s) from side road/path	Vehicle in lateral lane travelling in same direction	Moving obstacle(s) ahead	Stationary obstacle(s) ahead	Pedestrian crossing over	Pedestrian walking along road	Pedestrian playing/ running on road
Stabilised situation																
Going ahead	Going ahead on a straight road															
	Going ahead on a left bend															
	Going ahead on a right bend															
Intersection																
On approach	Approaching a 'give way' intersection															
	Approaching a 'stop' intersection															
	Approaching a 'traffic signal' intersection															
	Approaching intersection where road user has right of way															
Stopped	Stopped at a 'give way' intersection															
	Stopped at a 'stop' intersection															
	Stopped at a 'traffic signal' intersection															
	Stopped in road/ turning lane waiting to turn															
Going ahead	Going straight on at a 'give-way' intersection															
	Going straight on at a 'stop' intersection															
	Going straight on at a 'traffic signal' intersection															
	Crossing intersection where road user has right of way															
	Travelling on roundabout (not turning on/off)															
	Travelling on slip-road (not turning on/off)															
Turning	Turning across traffic at a 'give-way' intersection															
	Turning across traffic at a 'stop' intersection															
	Turning across traffic at a 'traffic signal' intersection															
	Turning across traffic from main road into side road															
	Turning away from traffic at a 'give-way' intersection															
	Turning away from traffic at a 'stop' intersection															
	Turning away from traffic at a 'traffic signal' intersection															
	Turning away from traffic from main road into side road															
Manoeuvre																
Overtaking	Overtaking stationary vehicle on left															
	Overtaking stationary vehicle on right															
	Overtaking moving vehicle on left															
	Overtaking moving vehicle on right															
Changing lane	Moved into lane on left (NOT overtaking)															
	Moved into lane on right (NOT overtaking)															
Slowing	Stopping (not at junction)															
	Parking (roadside)															
Starting	Starting (not at junction)															
	Leaving parking space (roadside)															
Turning (not at intersection)	Turning across traffic from main road into private drive															
	Turning away from traffic from main road into private drive															
	Turning across traffic out of private drive															
	Turning away from traffic out of private drive															
Reversing	Reversing															
U-turn	U-turn															
In wrong direction	Driving in wrong direction (e.g. down a one-way road)															
Other																
Parked	Parked															
Stopped in traffic queue	Stopped in traffic queue															
Pedestrian crossing	Approaching pedestrian crossing															
	Stopped at pedestrian crossing															
Railway crossing	Approaching railway crossing															
	Stopped at railway crossing															

5 An aggregation into typical HFF generating scenarios (TRACE report D5.3)

The purpose of this third WP5 task conducted in the frame of TRACE was to build a methodological frame allowing the aggregation of accident data under the form of generic accidental processes. It is viewed as an integration of the parameters characterizing the accident generation dealing with human factors. These scenarios define common situations holistically in the difficulties encountered by different types of road users, in different types of situations with the contribution of different types of factors. The interest of such a preoccupation was confirmed by literature review showing an open field on methodological aggregation of accident data, notably if these data are wanted to be exploited in their richness and complexity. The method defined in this chapter is though to promote a new regard on the search for regularities in the accident production processes, going further than usual disaggregated analysis. This research can be viewed at two levels depending on the purpose of the study and the quality of the data used: 1) building the generic scenarios from in-depth studies involving human data collected by specialists, 2) recognising already defined scenarios from less in-depth studies, at least not involving data collected by human factor specialists.

5.1 The search for generic processes leading to human failure

The overall purpose aimed at in the present section is to put forward recurring accident patterns showing a repetitive process that leads human to fail in its adaptation attempts. The term 'typical scenario' is used to designate a prototype of the accident process. This prototype is characterized by chains of facts, actions, causal relations and consequences. Typical accident scenario is an abstract construction, illustrating the main features of a series of similar accidents, and not the specific, concrete process of any one of these (Fleury & Brenac, 2001).

The TRACE report D5.3 report (Van Elslande & Fouquet, 2007b) proposes such a classification which tries to avoid the drawbacks of the two classical methods that are, one the one hand, statistical analysis –with the tendency of disaggregating data and loosing the notion of process, and on the other hand case by case analysis –which are difficult to generalize because of the specificity of each case when studied in-depth. This method makes use of the concept of 'typical scenarios' but focalising on the generic patterns of human failure-generating processes. Accidents are the result of a process involving the various, more or less complex, malfunctions that occur in different driving situations, and which need not to be lost in the analysis. That is the purpose of the method proposed.

This method takes the form of an integration of the results gained from D5.1 for the HFF and D5.2 for the factors and situations of these failures, inside Typical Human Failure Generating Scenarios (THFGS). The principle behind these typical scenarios is that they aggregate 'similar' processes, allowing to putting together different cases which are produced along the same chain of events, involving the same type of human failure and showing the same patterns of factors. The development of these scenarios has based on the analysis of accident cases from an intensive in-depth data bank involving detailed interviews of drivers involved done by psychologists (EDA from INRETS).

The double operational purpose of these THFGS is:

- To show the most occurring pathologies of the driving system that pushed the drivers' capacities up to their limits;

- To open to the countermeasures efficiency, as far as these diagnosed generic pathologies are thought to be fought against by similar means.

One methodological advantage is that, once their construction have been elaborated on the based of appropriate in-depth data, they can be recognised by similarity from less documented data.

The current development of detailed databases collected on the scene of road accidents, notably at the European level (e.g. Safetynet project, the European Road Safety Observatory, etc.), puts back to the agenda accident classification works, and notably asks for an adjustment of the conceptions according to the progress of the knowledge on drivers functioning and the inscription of this functioning inside the overall accident process. The purpose of TRACE report D5.3 which is summarized here is to contribute to this objective as part of methodological advancements supported by TRACE project.

A dilemma which is met in the exploitation of a set of descriptions of accidents results from the triple necessity of: 1) reporting the complexity of the phenomenon, 2) showing the variety of the circumstances of its occurrence, and 3) arriving nevertheless at results of a certain degree of generality. The present methodological work was devoted to the purpose of finding a way to overcome these difficulties, through the definition of typical human failure-generating scenarios showing the regularities behind 'human error' production.

5.2 Interest of typical accident-generating scenarios

The complexity of the phenomena in set in the production of an accident explains the difficulty finding a level of aggregation of the data that allows a classification of the cases integrating the sequential and interaction aspects of mechanisms involved. This complexity linking the elements constituting an accident is generally by-passed by considering only one moment of the accident process and/or separating the role of each participating elements.

The purpose here is to go further in the understanding of accident generation. It is to define a level of description of the accident phenomenon intermediate between case study and the statistical analysis, and organized around the human component of the driving system. In fact the drivers are the micro-regulating element of the system and they are the target of any safety measure. The generic configurations of human functional failure-producing described should help classifying accident cases in a more comprehensive way on the basis of recognition of the accident history.

Indeed, in-depth case studies presents the advantage to precisely report every history of accident by integrating essential dimensions such as the dynamics, the sequentially and the multi-causality of mechanisms into play. But one of its inconveniences lies in the weak generalizing power of empirical data which stick too much to the 'real world', to the point to make of every accident a particular case only analyzable in an *ad hoc* way. In line with the complexity of the accident phenomenon, retaining a too important level precision for event description may compromise the comparison between different cases.

By contrast, the interest of statistical analysis of accident data lies in the possibility of quantifying the importance of the problems on dimensions defined *a priori*, such as certain descriptive properties of the driver (age, fatigue, alcohol level, etc.) or of the environment (characteristics of infrastructure, weather conditions, etc.). It so allows estimating the interest of the actions to be led for an improvement of the road safety. However, the major inconvenience of this type of exploitation deals with the difficulty of reporting the complexity of the mechanisms of an accident from variables which are disaggregated, generally descriptive and loosened of any temporality. An analysis in term of statistical proximity allows with difficulty a real understanding of the processes of production of the accidents. For these reasons, we tried to find an intermediate level of analysis between case studies and statistical analyses, so as to integrate human factors into generic accident production processes.

The huge variety of accident situations does not allow categorizing the accidents on the basis of exclusive criteria, as can been shown by contradictory results usually found in the literature, each result insisting on one aspect of the accident to the prejudice of the others. It is thus around these typical scenarios that we tried to build accidents profiles presenting a 'family look' from the point of view of the mechanism of 'human error' generation. The use of such typical scenario is thought to allow putting forward aggregation of accidents that are similar not only in their result but also in their progress.

A typical scenario of accident is defined as the typical progress with which we can connect a group of accidents which present resemblances from the point of view of the chain of the phenomena, whether they are analyzed from an historical, a functional or a causal point of view (Fleury and Brenac, 2001). With regard to this overall conception, the specificity of the present analysis will consist in emphasizing the human component by defining scenarios of generation of human failure production.

Moving the scope of analysis from the accident in general to driver functioning does not mean does not mean denying the pluricausal character of the accident. It is simply a question of decomposing this multicausality to enlighten it under a particular angle: that of the cognitive processing which was not able to prevent the situation conditions from degenerating. The option taken for the analysis of the difficulties met by the driver is justified by the central position of this operator from the point of view of the micro-regulation of the road system. As stated in TRACE report D5.1, the driver is indeed not only a component of this system; he is above all the regulating element. It is by him that is going all the input and the output of this system, and he is for that the element to whom we tend to attribute causalities, sometimes abusively.

5.3 Method

A first phase of analysis consists of exploiting for every case individually, the totality of the information contained in every accident case, in order to identify the basic malfunction process in cause in the accident and all the parameters associated with it. Dealing with human factors, we will refer to the definition of HFF, the situation in which they are produced and the factors that lead to it, as described in the previous chapters.

On this base of detailed analysis of in-depth data, we selected the generic parameters constituting the gist of the event and authorizing an aggregation of the accidents, pushing aside those who were too specific in every case to allow such an aggregation.

The federative parameters used for the constitution of typical scenarios are the following ones (Figure 10):

- The task that the human function in question was intended to perform in the pre-accident situation (i.e. the outcome the driver wanted to attain and the constraints he had to cope with). The list of these 'malfunction tasks' will be found in TRACE report D5.2 (Naing *et al*, 2007).

- The combination of elements that most often explain the fact that the appropriate function failed in attaining the wanted outcome (i.e. the factors of HFF). The list of these explicative elements will be found in the same report as above (Naing *et al*, 2007).

- The specific type of Human Functional Failure (HFF) which put the driver in a 'rupture situation', analysed through the classification model presented in TRACE report D5.1 (Van Elslande & Fouquet, 2007a).

- The action resulting from the HFF. This parameter points out the event (manoeuvre, action or none action) which the human functional failure led to (i.e. what did the driver do that he shouldn't, or didn't do that he should, as a consequence of this failure).

- The crash configuration. This last parameter features the type of collision resulting from the 'HFF resulting action'.

The building of these Typical Human Failure Generating Scenarios allows identifying recurrent mechanisms of malfunction production which tend to be more or less systematically reproduced, even if this systematic nature is not so obviously due to the complexity of the underlying phenomena.

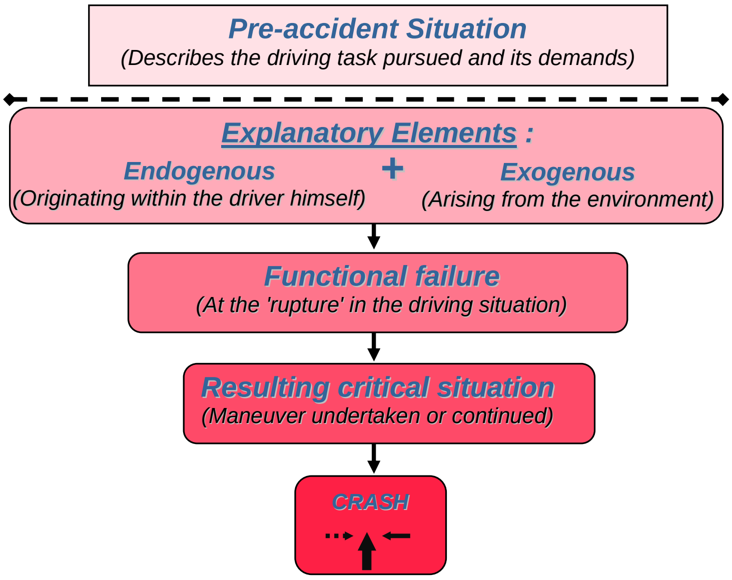


Figure 10: Structure of a typical failure-generating scenario

Such an aggregating work has to be done on a case by case analysis. Depending on the aim of the study, it can be based upon different levels of data. For relating the general descriptive aspects involved in the accident process, data recorded by police services can be of use to build typical accident scenarios. However, when dealing with human factors, such data is not rich enough and far too much biased toward the research for responsibility. When dealing with human factors we need consistent human data. As for other domains, data collected on human must be based upon dedicated protocols performed by specialists of the domain. And the best way to put forward reliable results on human factors in accidents involves resorting to psychologists collecting data on the scene and analysing it with the help of appropriate models.

In-depth data is then required to put forward typical human failure generating scenarios. Another possibility, if not having appropriate data at disposal, is to rely upon an already made classification, and then to work each case on the basis of similarity with one of the scenarios of the list. It is in fact far easier to recognize an accident process from the 'family air' of its story than to build the process from raw data.

In order to allow accidentologists using data that doesn't fulfil these ideal conditions for analysing human failures (i.e. in-depth, involving psychologists), we decided to define the most frequent scenarios found in the study of a large sample of in-depth accident cases, on which to base in order to recognize the overall process. The TRACE D5.3 report describes the 'top 30' scenarios (Table 8) extracted from the intensive in-depth accident survey performed by INRETS (France) set up not only on the reconstruction of physical parameters but also on detailed interviews performed by a psychologist to apprehend the precise difficulties met by the drivers. These 30 most frequent scenarios have been built from an aggregation of the 1109 drivers on a total database of 1637 drivers for whom a function failure could be determined. These TFGS account for 67.7% of 1637 accident situations. So they can be considered as representing the most recurrent configurations found. These configurations can be recognized from less in-depth data by looking through the overall cases and finding similarities with the classification.

In the report, the scenarios are described along a linear functional way: from problems of detection to 'overall' problems as it formalized in the human functional failure classification model presented in Trace report D5.1 (Van Elslande & Fouquet, 2007). A good understanding of these scenarios requires study of this report, and also at the TRACE report D5.2 (Naing, *et al*, 2007) dealing with the factors of these failures and the situations in which they occur.

Table 8 - List of most frequent Typical Human Failure Generating Scenarios

Categories of HFF	Human Functional Failure (HFF)	Typical Human Failure Generating Scenario
Perception	P1 failure - Non-detection in visibility constraints conditions	'P1C': Road user surprised by a pedestrian or a two-wheeler non-visible when approaching
		'P1D': Driver surprised by the manoeuvre of a non-visible approaching vehicle
	P2 failure - Information acquisition focused on a partial component of the situation	'P2A': Focalisation on a directional problem
		'P2B': Focalisation towards a source of information as a function of driver's layout representation
		'P2C': Focalisation towards a source of information regarding the importance of the traffic flow
		'P2D': Focalisation towards an identified source of danger
	P3 failure - Cursory or hurried information acquisition	'P3A': Cursory search for information while turning on the left (on the right for left driving countries)
		'P3B': Cursory search for information while crossing intersection
	P4 failure - Momentary interruption in information acquisition activity	'P4A': Non-detection of the rapprochement from the vehicle ahead
	P5 failure - Neglecting the need to search for information	'P5A': Late detection of the slowing down of the vehicle ahead
		'P5B': Late detection of a non-priority road user starting manoeuvre in intersection
Diagnosis (Treatment 1)	T1 failure - Erroneous evaluation of a passing road difficulty	'T1B': Under evaluation of the difficulty of an although known bend
		'T1C': Erroneous evaluation of a bend difficulty in a context of playful-driving
	T2 failure - Erroneous evaluation of the size of a gap	'T2B': Erroneous evaluation of a merging gap connected to the low attention paid to the manoeuvre
	T3 failure - Mistaken understanding of how a site functions	'T3A': Mistaken understanding leading to a stopping failure in intersection
	T4 failure - Mistaken understanding of another user's manoeuvre	'T4B': Mistaken understanding of the other's manoeuvre related to the polysemy of their signals
		'T4C': Mistaken understanding of other's manoeuvre related to cursory processing of the interaction
Prognosis (Treatment 2)	T5 failure - Expecting another user not to perform a manoeuvre	'T5A': Expecting a non priority vehicle not to undertake a manoeuvre in intersection
	T6 failure - Actively expecting another user to take regulating action	'T6B': Erroneous expectation of the stopping of a non priority vehicle approaching intersection
		'T6C': Erroneous expectation of the stopping of a non priority vehicle coming on the trajectory
	T7 failure - Expecting no perturbation ahead	'T7A': Expecting no vehicle ahead in a bend with no visibility
Decision	D1 failure - Violation directed by the characteristics of the situation	'D1A': Road user directed to go ahead in order to take the information
	D2 failure - Deliberate violation of a safety rule	'D2B': Overtaking on a zone with limited axial-visibility
	D3 failure - Violation-error	'D3B': Going ahead at intersection being drawn into manoeuvre
Execution of action	E1 failure - Poor control of an external disruption	'E1A': Sudden encounter of an external disruption
		'E1B': Sudden encounter of an external disruption, more or less expectable
	E2 failure - Guidance problem	'E2A': Guidance interruption consequently to attention orientation towards a secondary task
		'E2B': Guidance interruption consequently to attention impairment
General failure	G1 failure - Loss of psycho-physiological capacities	'G1A': Loss of psycho-physiological capacities consequently to a falling asleep or ill-health
	G2 failure - Alteration of sensorimotor and cognitive capacities	'G2A': Alteration of trajectory negotiation capacities
		'G2B': Alteration of guidance capacities
	G3 failure - Overstretching cognitive capacities	'G3A': Overstretching processing capacities in traffic interaction situation

5.4 Conclusion

The interest behind the simple definition of these typical scenarios is that they represent generic configurations which can be recognized even from less detailed accident data and even for non human factors specialists. In that purpose, they should contribute to the TRACE project by putting forward the regularities in accident processes from the angles of the different road users (Work Package 1), the different driving situations (WP2) and the different types of accident factors (WP3).

It has to be kept in mind that such a formalization is dependant on the level of aggregation wanted, and the more numerous accidents will be studied the more aggregation work will be needed. Typical Human Failure Generating Scenarios must not be seen as rigid object, but rather as moving 'models' depending on the data at disposal and the objectives pursued. Particularly, when dealing with a specific thematic studies (e.g. elderly drivers, Powered Two Wheelers), these typical scenarios can be reviewed and refined in a way as better showing the specificities of the difficulties encountered by these elderly drivers or PTW riders, by highlighting in more details the accident configurations in which they are more typically involved. This doesn't mean that scenarios do not have the same validity from one study to other. It means that their level of 'granularity' may be adapted to each particular study.

Of course, all accidents can't be aggregated into typical scenarios (unless becoming too general and loosing their operational utility). There are accidents which are more 'accidental' than others and for which the regularities behind their construction are not obvious. The effective purpose of this task was not the definition of a universal classification for every accident (this is more the objective of D5.1 and D5.2 classification grids). It is to help accident analysts at finding the most recurrent accident patterns showing a regular construction in the production of a human functional failure. These recurrent typical scenarios represent some more or less systematic 'pathologies' inside the driving system functioning. Once identified, they should be counteracted the same way by appropriate means.

The method proposed and the most typical scenarios presented should promote a more comprehensive analysis of the inscription of 'human factors' in the accident production process. This analysis steers away from the road user being always the main instigator of the accident, but more a link in a causation chain. And by better understanding the malfunction process behind this causation chain, the typical human functional failure generating scenarios will offer a better assessment of the safety devices capacity to break this malfunction chain. By so doing, it can be considered as a valuable methodological contribution to the main objectives of the TRACE project. A case study demonstrating the use of these methodologies is presented hereafter.

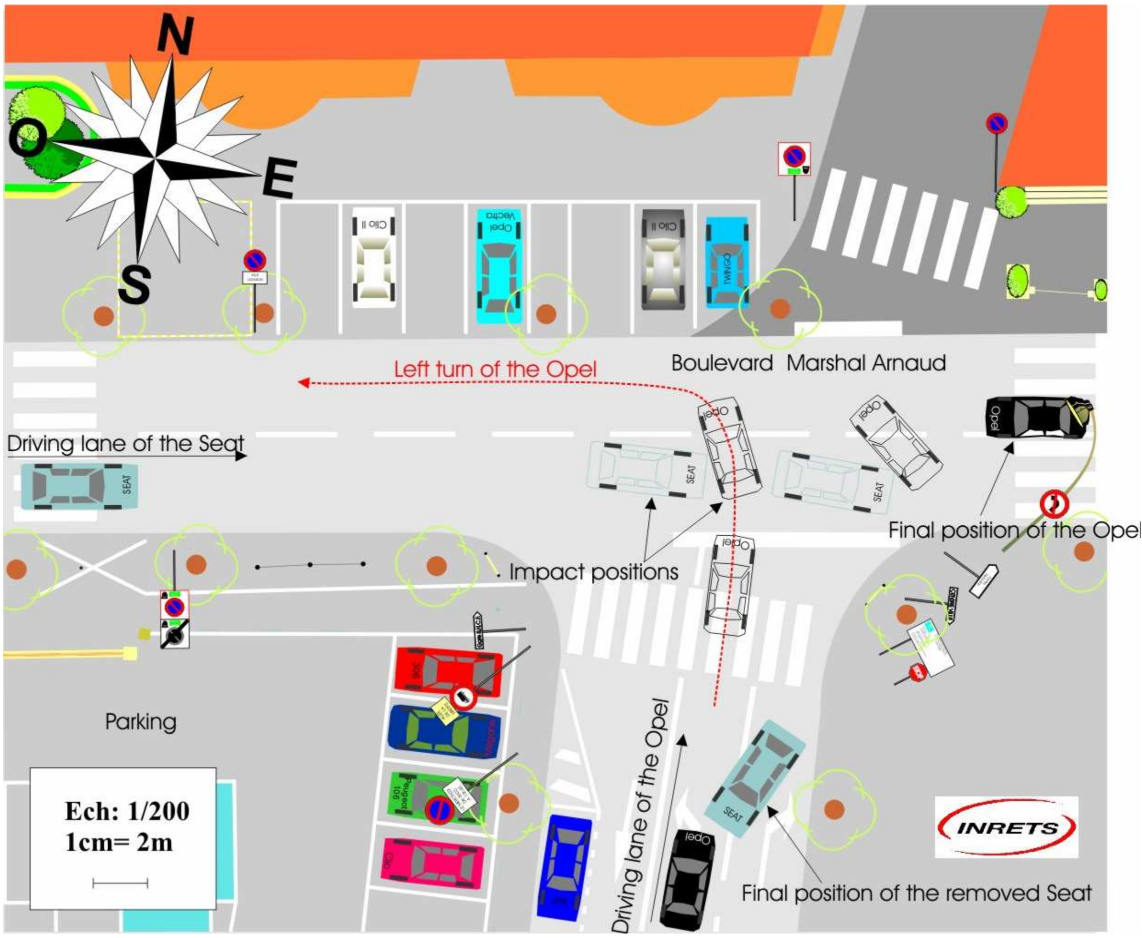
Case study

From an accident case collected in the frame of INRETS EDA in-depth study, the human functional failures, the explanatory elements and the driving situation can be figured and the typical scenarios to which the overall case belong is established, as well as the degree of participation of each driver.

Summary of the accident

On September 2006, around noon, the driver of an Opel drives in a secondary axis of the city centre. The weather is clear and the road dry. He stops by an intersection regulated by stop sign. He has to make a left-turn on a boulevard but having no sufficient visibility on the left, he moves his vehicle onto the stop line. He looks to the left, sees a Seat arriving from this direction on the boulevard Arnaud, then looks to the right, and finally crosses the intersection. While the Opel is completely engaged on the road, the driver suddenly notices that the Seat is close to him. He attempts an emergency manoeuvre but both vehicles collide in left front-side impact. Both drivers are slightly injured during this accident.

Map of the accident



Driver 1 (Opel) - Parameters to consider

- 24 year-old man
- Lives in the town
- Congenital deafness
- Has his driving license for 5 years

- Has to drive to a job interview and is just living the town to get there

Driving phase: the driver is heading his appointment place (≈145Km further) and has to drive through the town to get there. Reaching the intersection, he stops at the stop line. Although there are visibility constraints (trees, advertisement and road signs) on his left, he sees the car coming from the left with right of way.

Rupture phase: he thinks he has time to make a left turn and starts the manoeuvre.

Emergency phase: while he is turning left he realizes that the other car is coming fast. He tries to adapt, turning a little bit larger than he had planned.

Crash phase: the front of the car hurts his car on the left back side.

Driver 1 (Opel) - Accident analysis

- **Human Functional Failure** (cf. D5.1): T2 failure - Erroneous evaluation of the size of a gap
- **Explanatory elements** (cf. D5.2):
    - o Visibility: Road side objects
    - o Experienced: Over-experienced of the place
- **Pre-accident Driving situation** (cf. D5.2): Turning across traffic at a 'stop' intersection
- **Typical Failure Generating Scenario** (cf. D5.3): T2 B - Erroneous evaluation of a merging gap connected to the low attention paid to the manoeuvre
- **Degree of participation** (cf. D5.1): Primary active (the driver has generated the perturbation)

Table 9 - Synthesis for Road User 1

HFF (D5.1)	Explanatory elements (D5.2)		Driving situation (D5.2)	Scenario (D5.3)	Participation (D5.1)
T2	Visibility impaired by road side objects	Over-experience of the environment	Turning across traffic at a 'stop' intersection	T2 B	Primary contributing

Driver 2 (Seat) - Parameters to consider

- 30 year-old man
- Lives in the town
- Has his driving license for 10 years
- Drives a rent car and is used to this practice
- Comes back from work
- Started at 5am but declares that he is not tired

Driving phase: the driver comes back from work on his usual return journey. He had been working since 5am and has a physical activity but he declares he is not tired (practices boxing so professional activity fits with his expectations). He sees the non-priority car stopped at the intersection on the right.

Rupture phase: he knows he has the right of way and consider that the other driver will not start his manoeuvre.

Emergency phase: the non-priority car is turning left and he doesn’t have the time to stop as he was driving rather fast (60Km/h declared, 70-75Km/h reconstituted, 50Km/h limited).

Crash phase: the front of his car crashes into the back left side of the Opel.

Driver 2 (Seat): Accident analysis

- **Human Functional Failure** (cf. D.5.1): T6 - Actively expecting another user to take any appropriate regulating action
- **Explanatory elements** (cf. D5.2):
  - Behaviour: Risk taking: Speed exceeding the practices and the rules
  - User state: Rigid attachment to the right-of-way status
- **Pre-accident Driving situation** (cf. D5.2): Approaching intersection where road user has right-of-way
- **Typical Scenario** (cf. D5.3): T6 C - Erroneous expectation that the a non priority vehicle coming on the trajectory will stop)
- **Degree of participation** (cf. D5.1): Secondary active (the driver participates to the non-resolution of the problem by a wrong anticipation of the events evolution)

Table 10 - Synthesis for Road User 2

HFF (D5.1)	Explanatory elements (D5.2)		Driving situation (D5.2)	Scenario (D5.3)	Participation (D5.1)
T6	Speed	Rigid attachment to the right-of-way status	Approaching intersection where road user has right-of-way	T6 C	Secondary contributing

6 Further upstream Social and Cultural human factors (TRACE report D5.4)

The overall Work Package 5 of TRACE focuses on methodologies for the analysis of the human factors in accident causation. The aim of these methodologies is to go further in the understanding of the underlying causal chains involved so as to better define the appropriate means to help the drivers in their task. The above synthesized D5.1, D5.2 and D5.3 reports were specifically devoted to building operational models and grids for the definition of human failures, their factors and the conditions in which they occur. The D5.4 report related in the present section was intended to enlarge the question of human factors within a prospective work directed towards an integration of societal backgrounds in the accident causation process. These social aspects, whereas they are fairly never integrated in accident analysis, are important to consider as further upstream determinants.

Factors such as culture, social status or specific social group membership have an identifiable influence on individual behaviour. The integration of such socio-cultural background variables in the analysis of human failure production has the potential to increase the understanding of the accident causation process and to find additional means to fight against. These aspects should notably be taken into account when dealing with driving aids, so as to appropriately answer the needs and constraints coming from different drivers' social groups. The objective D5.4 is to contribute to the definition of analyzing techniques promoting a systemic view on 'human factors' by giving a complementary input for a wider vision on accident causation factors going further upstream in the search for intervening variables. It presents a scheme of analysis built upon the notion of 'social spheres'. This scheme is aimed at showing the relative influence of the different layers ('spheres') of socio-cultural variables that are located outside the individual sphere and which are supposed to potentially have a latent or manifest influence on the production of an accident. After a general presentation of the relevant socio-cultural variables to consider, the deliverable presents the possible application of the social spheres analysis scheme with the presentation of some accident case studies. This scheme is applied for practical developments in the operational Work Packages of TRACE (cf. D3.2 report Social and Cultural Factors, Engel, 2008).

6.1 Accident causation in a Social Sciences perspective: individuals in their social context

From a sociologic perspective, human beings are always social beings, existing and interacting in a given, specific social context. The scientific interest of this view relies in the understanding of human beings not only as individuals, but in their interaction with others and considering the cultural factors that predetermine their interactive behaviour. The objective is to understand what motivates human behaviour inside society and how social human beings orientate their behaviour from the others' behaviour.

The notion of *spheres* represents the dimensions that are usually related to sociological and psycho-sociological[7] analysis. These socio-cultural spheres aim to visualize the factors which are situated outside the individual, but which are having an impact on his individual representations, decisions and behaviour. Figure 11 illustrates the different spheres representing the different approaches of 'human factors' analysis from the closer to the event to the wider:

1- The analysis of *operational interactions* directly acting on the accident process

2- The analysis of *social representations* governing individual attitudes and behaviour

3- The analysis of *social and cultural determinants* of these attitudes and behaviour

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[7] Sociology and Social Psychology are two disciplines that interact very closely; the focus of Social Psychology is more on social representations and the influence of social factors on the individual.

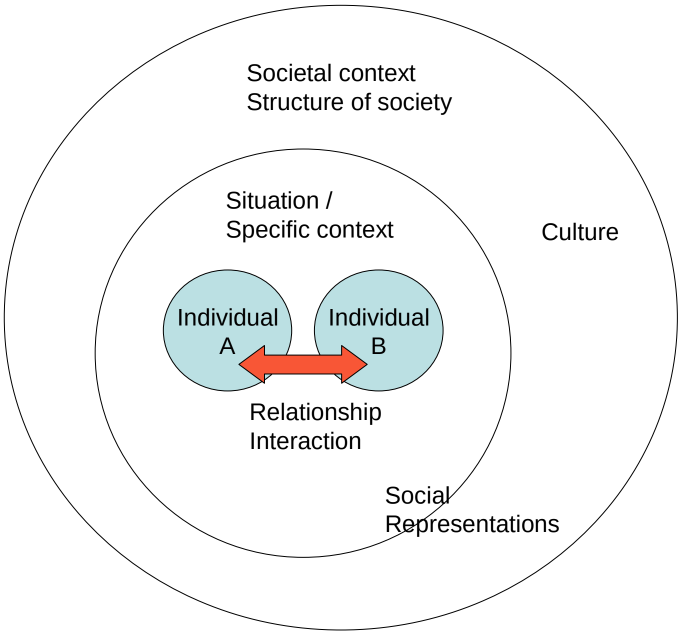

Figure 11: The individual in its social context

The objective of integrating wider socio-cultural factors is to understand human behaviour in its specific societal context. The notion of 'context' includes not only the situation in which the individuals interact, but also the broader frame, or social environment, that contributes to produce this specific situation.

Economic factors, for example, constitute a given cultural background that conditions a common understanding of 'how best to behave' under specific circumstances. Let us consider that western societies today are very much influenced by a cultural paradigm which values 'quickness and effectiveness', and encourages efficient 'time management'. The social valorisation of 'time saving' may lead to develop a certain driving style, symbolizing to other people that you are in a hurry; you do not have time to waste, so you are socially adapted. Besides the 'technical' aspect of being considered as 'more efficient', this behaviour has a highly symbolic content: your time is precious, which signifies to others that you are an important person. And your social status which integrates your eagerness in 'being efficient' is symbolically transposed by your driving style, showing that you are an important person who has no time to waste.

It is important to take into consideration that each individual is a product of the social influences he is integrating from his earliest stage of personal evolution, during the process of his socialization, specifically during childhood and as a young adult. The social environment which differs in several layers (or different spheres) is an integral part of the individual person, because it establishes a – variable – social context which functions as a 'navigation system', helping the individual to find his way in the social world, to make his choices and to orientate his behaviour. So it will condition drivers' behaviour and should be considered in accident causation analysis.

6.2 Integration of socio-cultural dimensions in the framework of 'human error' analysis

The question is the way to put forward an analysis framework where the sociological perspective could contribute to 'human error analysis' in a coherent way, bringing an added value for further accident causation understanding. As developed in TRACE deliverable D5.1, human 'error' or human 'failure' is a transient link in a malfunction chain. Reinach and Viale (2005), underline the relationship between '*downstream operator errors*' and '*upstream contributing factors*' such as supervision, procedures or organizational influences. Those upstream factors appeal to the sociologists understanding of individuals' characteristics, developed during the course of their lives, and which presents an incorporated socio-cultural capital that gives social identity and orientation on individual's actions.

Social beings are living in a social environment, and this environment is layered in several spheres of political, social or cultural dimensions, influencing themselves mutually. The 'social spheres' scheme invites to consider a broader definition of 'environment' as it is usually applied in accident causation analysis. The following paragraphs will develop the different layers of the 'social spheres analysis scheme', beginning with the individual sphere.

- The individual sphere

The individual sphere contains the social individual as a 'product' of sociological influences. For example, the individual person integrates a number of demographic variables; he is a man or a woman in a certain age with a specific educational background. He has specific experiences regarding driving, he has a specific social status that involves maybe a specific driving style and he could be a member of an informal social group with distinctive behaviour patterns that may have a distinctive part in the production of the accident.

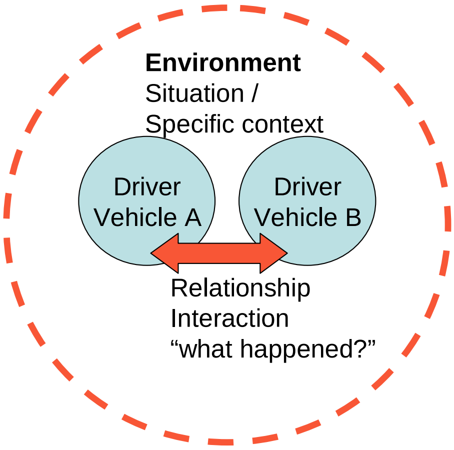

Figure 12: The driving environment

- The social environment

The idea of the multilayer system –referred as 'social spheres'- is an extension of the notion of 'environment' that is used in accident in-depth analysis. The notion of the -social- environment presents the key dimension for the sociological 'upstream factors' scheme.

Sociology perspective understands the 'social space' in the sense of a societal context that produces a specific environment, and the potential influences this environment may have on the individual. The road is actually a social space *par excellence* –possibly one of the most social places in today's life, a place where 24 hours a day individuals from the most diversified social backgrounds meet and have to interact (as drivers) together. There is also social setting inside the car with passengers interacting with the driver. By enlarging the 'field' of environment, can be explored factors which are acting prior to accident production. An individual driver is not 'neutral' when he causes or is involved in a road accident, he carries a lot of 'social luggage' with him; this 'social luggage' constitute in fact beforehand factors of behaviour, possibly acting in an accident causation situation. The driver is a product of a – unlimited – number of social factors and experiences that constitutes his individual person and consequently orientates his behaviour and interactions with the others.

The road is an environment where the interactions between social individuals are highly dynamic. So the notion of 'environment' should be reviewed in the sense of enlarging it from the road to social. The notion of social 'space' includes the specific connotations that each actor is involved differently according to the specific expectations he has towards the socially constructed environment, and assuming what expectations the other actors of the road have towards him.

The social space presents an extension to the 'human error' model as presented in the chapters above, as a complementary analysis frame: the social space is the dimension where socio-cultural dispositions manifest later in specific decisions and so into actions.

The definition of 'environment' for the social spheres scheme consequently should enclose:

- The understanding of the road as a place of social interaction according to formal, codified rules, informal rules and conventions
- The other drivers or passengers
- The other participants of the road (e.g. pedestrians, animals)
- The social space or social context: what are social expectations towards a specific environment

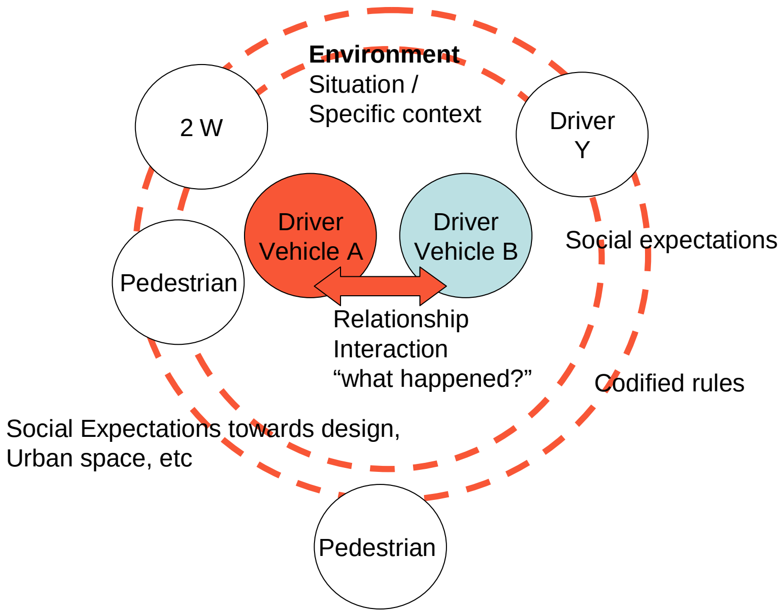

Figure 13: A broader understanding of environment

6.3 The multilayer spheres of sociological dimensions

The influences of the 'social environment' at the site of the accident now must be clarified regarding their direct impact on the accident production, or their more latent effects lying in socio-cultural or ethnological dimensions.

The 'social spheres' scheme objective is to propose a virtual map, which helps to locate and to connect the socio-cultural dimensions that are influencing the individual behaviour and so co-generate –going through the 'human error'- the accident as an outcome of a specific situation.

The wider levels of sociological dimensions integrate a number of dimensions that influence the individual level. In D5.4 TRACE deliverable, are presented the different dimensions which are relevant regarding their potential impact on the individual sphere, each dimension being is defined on behalf of its formal content and characteristics, as well as its potential impact on individual representations, decisions and resulting behaviour. In fact, different levels of upstream factors have to be distinguished according to their mutual impact. In the 'social spheres' scheme, three multidimensional social spheres will be distinguished interacting with each other. From the outer sphere to the individual sphere, there appear:

1. **The Normative sphere (prescription and social structure) integrates:**
   a. A formal structural level that integrates the dimensions of the law (the legal background), the normative system.
   b. An informal level that integrates customs and conventions;
   c. A level of culture, or the 'cultural bias'.

2. **The Reference Sphere (direct social interference) corresponds to:**
   a. A level that integrates dimensions of social conditions and / or social status that contribute to the social identity of the individual driver; the notion of habitus.
   b. A level that we want to qualify as 'membership' to a distinctive culture or subculture,
   c. Membership to an ethnic group, cultural backgrounds or age cohorts.
   d. Socio demographic factors (gender, profession, etc.)

3. **The Context sphere (social situation, social space) integrates the specific social** context of the accident causation situation, as well as further dimensions related to the implicated individuals
   a. Social expectations towards the presumed role of the 'others'
   b. Social expectations towards oneself ('expectations of expectations')
   c. Trip related information (urban structure, trip characteristics, etc)

4. **The individual sphere,** home of the 'human error' – here the upstream layers potentially impact on the individual decision making process and the behavioural outcome.

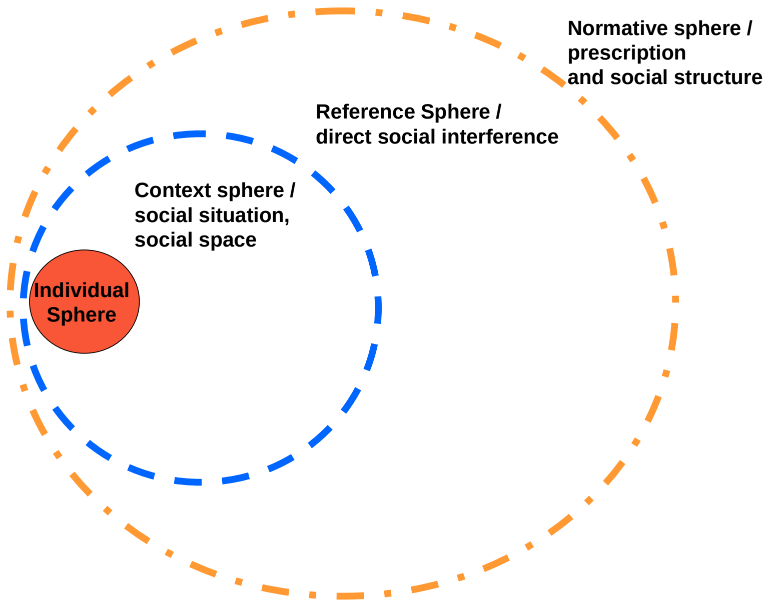

Figure 14: The different layers of the social spheres

6.4 The social spheres analysis scheme

Figure 15 shows the social spheres analysis scheme completed with the different socio-cultural variables according to each layer social and cultural variables. The method to understand such different spheres of variables is then proposed.

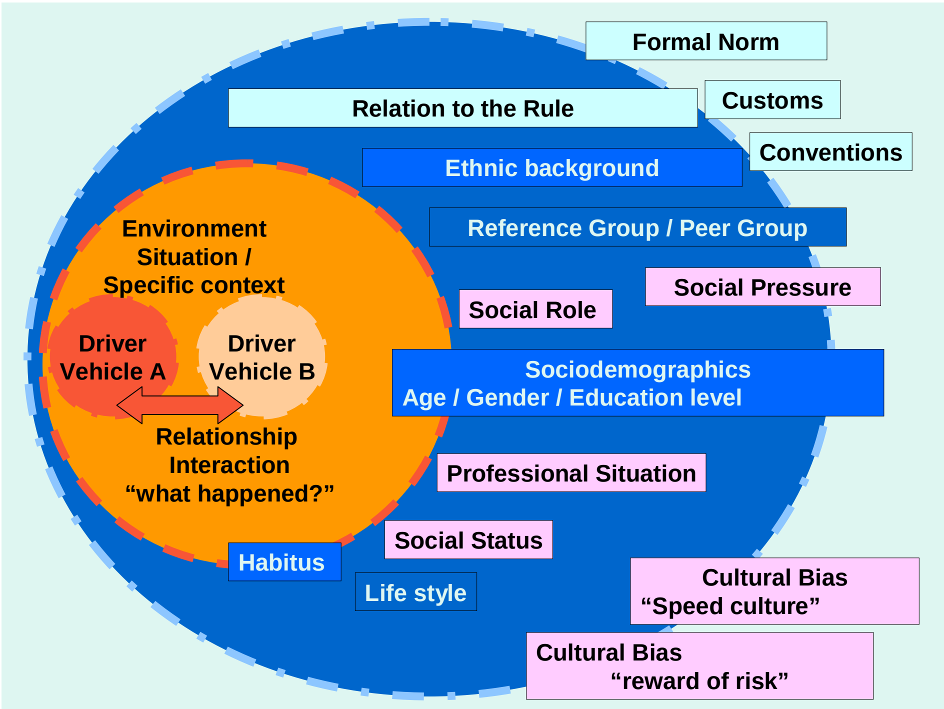

Figure 15: Dynamics of the social and cultural variables which constitute the 'social spheres'

In order to show the benefit of this analysis tool inside accident causation analysis, the D5.4 report gives example of practical application of the 'social spheres' scheme.

The practical application of the analysis scheme is twofold:

1. A tool for location of the human accident causation factor,
2. The construction of a social identity card for establishing social profiles on accidented drivers.

The benefit of the 'social spheres analysis scheme' is projected essentially in identifying predictors regarding socio-cultural impacts on human behaviour, notably upon which to base for defining prevention strategies.

Regarding the research aspect, the 'social spheres' present an investigation tool for usage in the framework of the in-depth accident interviews. In further generations of in-depth studies, the multi-dimensional variables from the 'spheres' can be formalized for statistical analysis.

6.4.1 The 'social spheres analysis scheme' as a tool for location of the human accident causation factor

The logic of the 'social spheres' is to give access to potential accident causation factors which are situated outside the individual sphere, where the 'human error' is analyzed, and so render visible upstream factors that can have an impact on the accident causation process.

For example an accident resulting from 'drink driving', following a combination of social influences (reference group, specific cultural context) the main cause for the accident is situated outside the individual sphere, even if the individual was subject to a certain failure (of decision, of behaviour) at a given moment of the accident process. The determining factors for the accident outcome were already prepared far ahead in the specific socio-cultural settings that led the individual to decide to consume alcohol.

An example could be the following: a male driver, 43 years, sales manager who drives - neglecting the speed limit - after a business lunch with alcohol consumption has an accident. What are the accident causation factors? From the perspective of the 'social spheres' scheme, the accident causation factors are situated in the reference sphere, the person responding to socially expected behaviour due to his social position and professional role, which implies a specific *habitus* regarding socio-professional situations including his driving style. To predict the potential outcome, the analysis should focus on the social frame and the social conventions before the person takes the wheel, the 'human error' he will commit being only the trigger of the malfunction social process.

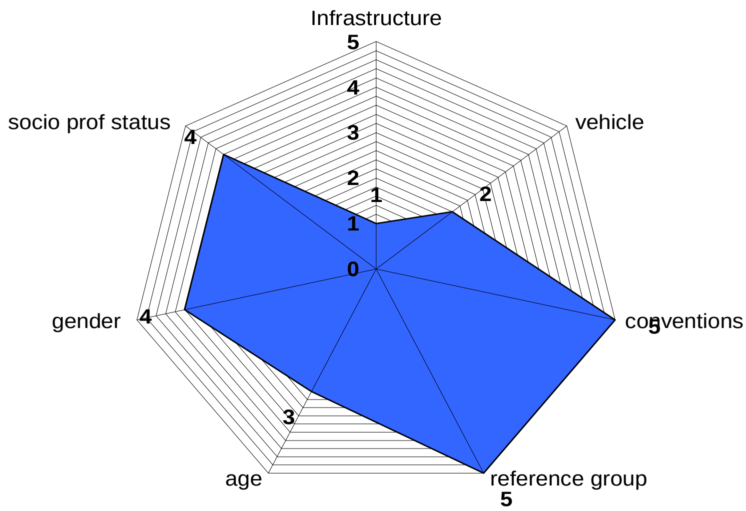

Figure 16: An example of location for ' drink driving ' according to the social spheres analysis framework

6.4.2 Proposal for a social identity card and its application

A further application of the 'social spheres' scheme is the social profiling of drivers which are involved in an accident. The principle is not to define risk groups in the sense of stereotyping or stigmatizing individuals regarding their specific personal background, but merely to collect relevant background information on what is the socio-cultural context of some accident scenarios. The utility behind collecting such information shall be looked into the capacity of adjusting safety measures (including the introduction of electronic safety functions) as a consequence.

Typically, the social identity card (Figure 17) would be part of the interview protocol conducted in the frame of in-depth accident studies, and so integrates the socio-cultural background information in the interview process. The objective of the social identity card is about systematically collecting driver information that contributes to establishing hypothesis on potential influences of social and cultural factors. Based on the information collected, the card can help to establish hypothesis regarding the social and cultural factors and contributes to explain the accident causation process and gives a better identification of specific countermeasures. In addition to the objective of a larger human factor analysis frame, the social spheres scheme presents a tool for comparative analysis in an international context.

	Age	Gender	Socio-professional status	Education
Accident scenario				
Membership				
Peer Group				
Trip related information				
Habitat				
Observations				

Figure 17: Social identity card

The following card is the translation of the 'drink driving' case presented above.

	Age	Gender	socio-prof.	education
	40-49	M	Manager (sales director)	Bac + 3
Speed, drink driving				
membership				
Peer Group	General Management	Speed culture		Recidivist
Trip related information	Professional trip, countryside; after business lunch			
Habitat			92 Paris, suburbs	
The person actually follows a training for driver's permit point recuperation				

Figure 18: An example of 'drink driving' for illustration of the social identity card

6.5 Conclusion

In this TRACE 5.4 report, a proposal for a larger perspective on human factors related accident causation analysis was introduced. The approach via a 'social spheres analysis scheme' is designed to visualize latent social and cultural factors, which are potentially affecting individual decisions and so behaviour.

The 'social spheres' is a tool that allows locating the socio-cultural influences outside of the individual sphere. This tool is supposed to enhance accidentologists' sensitivity to such potential influences for the benefit of the accident causation analysis procedure and of the definition of appropriate countermeasures. Such social variables must be notably taken into account when introducing more or less compulsory electronic devices, to guaranty a better acceptance by a better appropriateness to social patterns.

Especially in the context of an evolving European Community, the aspect of comparing the different societal and cultural backgrounds is an important challenge for further accident causation research, the understanding of socio-cultural differences being a key issue for future European road safety governance. However, the field of accident causation research has to evolve towards more interdisciplinary approaches and new -especially 'soft'- sciences approach must be integrated step by step.

The present methodological contribution to Work Package 5 of TRACE European project adds a complementary view on human factors inside the accident causation process by putting the individual in a larger framework of socio-cultural influences. The presented approaches allows the integration of a more complete view on additional accident mechanisms which are generated outside the individual, and can so help to improve accident data collection and its interpretation for future research. This method developed will be applied inside Work Package 3, which is dedicated to the operational analysis of Accident Factors. The confrontation of the methodological framework with accident data will allow defining in a more practical way the use of the 'social identity card' in the frame of in-depth accident analysis.

7 Conclusions

Accident causation is part of these domains that seems misleadingly simple, nearly obvious. It is thus often assumed that there is one cause or one responsible for an accident and that it would just take determining that cause or this responsible, suppressing the first and punishing the second, to prevent the accident occurring. Maybe such a view had reached a relative validity in the old times of the driving system when monolithic defects were easy to diagnose. However, it is less and less proving to be efficient as the system is continuously improving on the basis of research and developments addressing the different components involved. The problem is that, more and more, a cause becomes a cause only if it combines with several other hidden ones, and the so considered 'responsible' is more and more the heir of the influence of these combination of factors intervening in the driving interactions. Road safety of the 21st century has become a matter of complexity, apart from some residual extreme cases showing atypical accident patterns (e.g. involving big holes on the road, breakdown of the car brakes, aberrant drivers' behaviours). In order to go on improving safety of the driving activity, it has become essential to study this complexity. And the more we will gain in safety, the more thorough research works will be necessary to go on progressing.

The European TRACE project is turned toward developing a better understanding of accident causation, in order to reach the definition of more appropriate measures, involving notably electronic safety functions, possibly able at preventing it. Along this objective, Work Package 5 'Human Factors' of this project has been designed to contribute to the development of a deeper analysis of the difficulties encountered by the human component, the road user, in order to promote an improving of the driving system which is put at his disposal. The work done in TRACE WP5 has led to several operational grids of analysis, in line with theoretical models, which offer a means to progressing in the conceptions regarding the human role in accident generation, and in the methods allowing to better diagnosing the causes of human errors, violations, and capacity exceeding. The underlying conception behind these grids is oriented toward a 'safe system model' reminding that the purpose of any device dedicated to a human use should be conceived and built in a way of neither being problematic nor dangerous for its users. So should be the driving system.

In a first step, a grid has been elaborated for analysing the operational difficulties that human beings can find in driving, potentially resulting in accidents. This grid delineates so-called 'Human Functional Failures' (HFF) representing the weaknesses and limits in adaptive capacity of the human functions (perception, comprehension, anticipation, decision, action) to which drivers appeal in order to drive efficiently. And as far as an accident is not intentional for anyone (otherwise it is no more an accident) each HFF is considered as the result of a malfunction characterizing the driving system as a whole. It is a symptom which manifests a wrong interaction between a road user and his driving task environment. Human failure shall not be considered –whereas it is often the case- as the cause of the accident but rather as a weak link in a malfunction chain, this chain being necessary to find out if any efficient solution is thought to be defined. Thus, once a human functional failure is diagnosed, it still has to be defined which factors and which contexts have originated it.

The problem with many accident causation coding systems currently used across Europe is that they do not separate the 'errors' (or human functional failures) from the 'factors' which lead to these failures. The second step of the methodological work consisted in building a grid allowing the determination of all the elements (factors) -would they be referring to the road layout, the vehicle parameters, the driver or the traffic surrounding- that could originate or favour a Human Functional Failure, not confusing these factors with their consequences. A complementary grid also provides a classification of 'pre-accident driving situations' in which human failures occur. These pre-accident driving situations are built from a combination of: 1- the types of driving tasks (e.g. overtaking, crossing, turning), 2- their location (e.g. intersection, straight road, roundabout) and 3- the potential conflicts met in the situation (e.g. pedestrian crossing, oncoming vehicle, car door opening). The precise characterisation of these pre-accident situations in accident studies allows definition of the circumstances in which road users find difficulties.

A third step of this methodological work consisted in providing a method allowing the aggregation of similar accident processes on a multidimensional level (a scenario). The method consists in building typical scenarios of human failure production, integrating the elements studied in the previous steps. The Typical Human Functional Failure Scenarios represent the regularities which can be found in the process governing similar accidents. They are expressed under the shape of chains which connect a pre-accident situation, explicative elements involved, a consequent human functional failure and a resultant critical situation leading to a crash configuration. But a main difficulty in the determination of all these detailed variables is the necessity to base them upon in-depth accident data performed by specialists in the different domains. In order to allow accidentologists using data that doesn't fulfil these ideal conditions (i.e. in-depth, involving psychologists), we have defined the most frequent scenarios found in the study of a large sample of in-depth accident cases, on which to base in order to recognize the overall process on a 'family air' basis, which can be done from less in-depth data.

A last methodological work performed in TRACE WP5 is differentiating from the previous ones in its more prospective purpose. It was aimed at enlarging the classical view on driving behaviour determinants by incorporating the social and cultural dimensions as further upstream factors of human functional failures. Factors such as culture, social status or specific social group membership have an identifiable influence on individual behaviour. It presents a scheme of analysis built upon the notion of 'social spheres'. This scheme is aimed at showing the relative influence of the different layers ('spheres') of socio-cultural variables that are located outside the individual sphere and which are supposed to potentially have a latent or manifest influence on the production of an accident. The integration of such socio-cultural background variables in the analysis of human failure production has the potential to increase the understanding of accident causation process and to find additional means to fight against. These aspects should notably be taken into account when dealing with driving aids, so as to appropriately answer the needs and constraints coming from different drivers' social groups.

The different deliverables synthesized in the present report have been provided with the aim to progress in the search for understating accident causation and its underlying and upstream determinants. As such they contribute to the European TRACE project objectives of promoting a scientific knowledge on accidentalness so as to better defining the safety measures able reducing it. To this respect, the overall point of WP5 is to remind that the road user is the core of the driving system, and human performance the measure of its effectiveness. That is why possible human failures must be in-depth studied, their causes and producing contexts clarified in order to put forward the most efficient measures able at harmonizing human travelling behaviour inside the traffic system. Could the methods proposed as regard as 'Human Factors' act in such a way by allowing a more integrative approach inside accident research in Europe. This is being done in numerous studies conducted in TRACE operational work packages, addressed to the different roads users groups (elderly drivers, PTW, passenger cars, gender issue, etc.), to the main identified driving situations (intersection, specific manoeuvres, degraded situations, etc.) and to the most involved factors (vigilance, attention, experience, infrastructure, etc.). These different studies will make us progressing on the understanding about human factors in accident causation and the necessity to develop a safe system well addressed to human needs. And the 'human factors' methods put forward in TRACE WP5 should be constructive to base the building of a comprehensive European road safety observatory.

References

Baker, J.S., and Ross, H.L. (1961). Concepts and Classification of Traffic Accident Causes. *International Road Safety and Traffic Review*, *9*(31), 11- 18.

Eason, K. (1981). A Task-Tool Analysis of Manager-Computer Interaction. In B. Shackel (Ed.), *Man-Computer Interaction: Human Factors Aspects of Computers and People*. Alphenaan den Rijn: Sljhoff and Noordhoff.

Engel, R. (2007). *Social and cultural aspects of human factors*. TRACE report D5.4.

Engel, R. (2008). *Social and Cultural Factors*. TRACE report D3.2.

Fleury, D., Brenac, T. (2001). Accident prototypical scenarios, a tool for road safety research and diagnostic studies. *Accident Analysis and Prevention, 33*, 267–276.

Hoc, J.M. (1996). *Supervision et contrôle de processus : la cognition en situation dynamique*. Grenoble : PUG.

IEA (2000). Proceedings of the International Ergonomics Association XIVth Triennial Congress and Human Factors and Ergonomics Society 44th annual meeting. Paris: Lavoisier.

Hollnagel, E. (1991).The phenotype of erroneous action: implication for HCI design. In G. Alty et R.S. Weir (Eds.), *Human computer interaction and complex systems*. London: Academic press.

Leplat, J. (1999). Analyse cognitive de l'erreur. *Revue Européenne de Psychologie Appliquée*, *49*(1), 31-41.

Naing, C., Bayer, S., Van Elslande, P., Fouquet, K. (2007). *Which factors and situations for human functional failures? Developing grids for accident causation analysis*. TRACE report D5.2.

Parker, D., Reason, J., Manstead, A., Stradling, S. (1995). Driving errors, driving violations and accident involvement. *Ergonomics*, *38*(5), 1036-1048.

Reason, J. (1990). *Human error*. Cambridge University Press.

Reason, J. (1995). A model of organizational accident causation. *Ergonomics, 38*(8), 1708-1721.

Reason, J. (2000). Human error: models and management. *BMJ, 320*, 768-770.

Reinach, S., Viale, A. (2006). Application of a human error framework to conduct train accident / incident investigations. *Accident Analysis and Prevention 38*, 396- 406;

Van Elslande, P. (2003). Erreurs de conduite et besoins d'aide : une approche accidentologique en ergonomie. *Le Travail Humain*, *66* (3), 197-226.

Van Elslande, P., Fouquet, K. (2007a). *Analysing human functional failures in road accidents*. TRACE report D5.1.

Van Elslande, P., Fouquet, K. (2007b). *Typical human functional failure-generating scenarios: a way of aggregation*. TRACE report D5.3.

Glossary

Active failure pathway. In Reason's model, the way that facilitates the occurrence of errors and violations in the system process.

Aggravating factors. Elements that impede the capacity of the road user to avoid the crash during the emergency phase (e.g. insufficient verge width) or increase the likelihood of morbidity during the impact phase (e.g. rigid obstacle along the road).

Cognitive functions. Mental processes of perception, memory, judgment, and reasoning (in contrast With emotional and volitional processes) which enable the individual to understand and interact with his environment.

Contributing factors. Elements characterizing the driving phase, which will favour the future degradation of the situation (e.g. infrastructure inducing speed)

Crash phase. The crash phase comprises the crash and its consequences. It determines the severity of the accident in terms of material damage and bodily injury.

Decision stage. Once the driver gathered the right information items, has correctly interpreted the situation and anticipated its short termed evolution, he still has to 'select' amongst the driving strategies that are feasible in that situation the one that seems to him best suited to the event and its safety requirements. At this stage, the failures relate to decisions to undertake a specific manoeuvre and not to the broader decisional factors related to the circumstances in which the journey is being made (alcohol intake, journey for recreational purposes, and so on).

Detection / Acquisition stage. It deals with a specific moment of information processing when the subject is trying to collect all the relevant clues required for the task to perform. Detection failures can occur following different types of mechanisms which go far further than strictly sensorial mechanisms. They can refer to problems relating to information conspicuity, a deficient organisation of information acquisition, and a failure to search actively for information.

Diagnostic stage. At this stage of information processing the road user 1) evaluates the physical parameters (space, time, speed, acceleration, etc.) identified at the detection stage in order to assess the feasibility of undertaking his planned manoeuvre and 2) understands the information acquired concerning the type of situation with which he is confronted.

Driving phase. It is the situation in which the user is before a problem arises. It is the 'normal' situation, which is characterized for the driver by the performances of a specific task in a given context, with certain objectives, certain expectations and so on.

Emergency phase. IT is the period during which the driver tries to return to the normal situation by carrying out an emergency manoeuvre.

Error (for ergonomics). Undesirable result of interaction between an operator and a task, arising from an interaction between internal and external determinants

Error factor. It deals with the explanation of the human error and covers internal elements (vigilance, experience, distraction…) as well as external ones (traffic condition, layout parameter, vehicle defect…). It is essential to put them in evidence if we want to understand the origin and the process that conditions the error.

Handling stage. The stage involves the driver's manipulation of the controls of his vehicle to ensure it continues along his chosen trajectory. Failures classified in this category only include accidents in which a problem of vehicle control is the direct cause of the emergence of an accident situation. It implicitly means that they occur after the driver has successfully negotiated the other stages.

Heuristic. A rule of thumb, simplification, or educated guess that reduces or limits the search for solutions in domains that are difficult and poorly understood. Unlike algorithms, heuristics do not guarantee optimal, or even feasible, solutions and are often used with no theoretical guarantee.

Human error. Failure of the operator's attempt and/or capacity to adjust his activity, in terms of being able to successfully adapt to the difficulties encountered in task performance conditions

Human factor. Every parameter connected to human state and condition which has a role at one or another stage of the accident process.

Human Functional Failure (HFF). Define the failures of the human functions which usually allow the road user to adapt to the difficulties of the driving task. The HFF is described as the consequence of a gap between the requirements of a task and the capacities of an operator to face it, this gap resulting from the combined influence, and mostly inseparable, of the internal conditions characterizing this operator and external conditions to which he is confronted in the realization of his activity.

Latent failure pathway. In Reason's model, the way of not protecting operators against their potential errors.

Overall failure. It covers the notion of general failure which corresponds to a degradation of the whole functional chain, the outcome of which is a loss of control of the situation. These include those cases where the whole of the functions necessitate to drive seem to have been deficient in the mechanisms leading to an accident.

Prognostic stage. At this stage, the driver has two tasks: on the one hand ensuring he correctly anticipates the potential changes in the currently encountered situations and; on the other hand making a prevision on the possibilities of a not yet visible event potentially occurring in situation to come.

Rupture phase. The rupture is an unexpected (for the road user) event that interrupts the driving situation by upsetting its balance and thus endangering the system.

Triggering factors. Elements directly generating the rupture phase through the production of a human functional failure (e.g. Stop line erased)

Violation. A more or less deliberate deviation from the practices socially considered necessary for ensuring the safe functioning of a potentially dangerous system (must not be confused with 'infringement, referring to a strictly legal norm, and are more police matter than researchers' ones).

Annex

Table 11 – Grid of User Related Factors Which Could Lead to Human Functional Failures

Descriptive		Generic	In-depth Examples
A. User State	1. Physical/ Physiological	Medical condition	Heart condition/Epilepsy/Other brain condition/Respiratory condition/Blood condition/Other condition
		Pre-existing impairment	Hearing/Visual/Physical disability/Other impairment
	2. Psycho-physiological condition	Substances taken - alcohol	Above 'legal' limit/ Below 'legal' limit
		Substances taken - drugs	Illegal drugs/ Correctly used medication/ Misused medication
		Emotional	Upset/Angry/Anxious/Happy/Other emotion
		Fatigue	Physical/Mental
		In a hurry	In a hurry
	3. Internal conditioning of performed task	Right of way status	Rigid attachment to the right of way status
		Excessive confidence	Excessive confidence in signs given to others
		Identification of potential risk	Identification of potential risk about only part of the situation
B. Experience	1. Little/None	Driving	Learner/New driver/Infrequent driver/Other
		Route	New route/Road type/New road/Road feature/Driving on the left/Driving on the right/Other
		Vehicle	New vehicle/ Transmission type/ Left hand drive vehicle/ Right hand drive vehicle/ Other vehicle feature
		Environment	Night driving/City driving/Country driving/Driving in snow/Driving in fog/Driving in wet or flood/Driving in ice/Other
	2. Over-experienced	Driving	Change in driving rules/Other
		Route	Route in general/Road type/New road/Road feature/Other
		Vehicle	New vehicle/

			Transmission type/Other vehicle feature
		Environment	Night driving/City driving/Country driving/Driving in snow/Driving in fog/Driving in wet or flood/Driving in ice/other
C. Behaviour	1. Conflicting (Distraction)	Distraction outside vehicle*	Police/Animal in road/ Sunlight or sunset/ People in roadway/ Crash scene/Other perceived danger/Road construction/ Searching for directional information/ Unspecified outside distraction
		Distraction within vehicle*	Adjusting radio/ Adjusting cassette/ Adjusting CD/ Other occupant/ Moving object in vehicle/ sing or viewing device integral to vehicle/ Using other device brought into vehicle/ Adjusting climate controls/ Eating/Drinking/ Cell phone/ Smoking/ Looking inside vehicle/ Reaching for object/ Unspecified inside distraction
		Distraction within user*	Lost in thought/ Medical problem
	2. Risk taking	Speed	Illegal/Legal but inappropriate/Erratic/Other
		Vehicle positioning	In front/Lateral/Other
		Traffic control	Signs disobeyed/Signals disobeyed /Markings disobeyed/Other
		'Eccentric' motives	Testing a vehicle/Thrill-seeking/Competing/'Stunt'/Unspecified eccentric motives

** The distractions described at an 'in-depth' level are based on the sources of distraction described by Stutts et al. (2001)*

Table 12 - Grid of Environment Related Factors Which Could Lead to Functional Failures

Descriptive	Generic	In-depth examples
A. Road Condition	Contaminants: Wet/Flood/Snow	Wet/Flood/Snow
	Contaminants: Ice/Frost	Ice/Frost
	Contaminants: Oil/Diesel	Oil/Diesel
	Contaminants: Sand/Gravel/Mud	Sand/Gravel/Mud
	Surface defects	Potholes/Cracks/Bumps
	Surface type	Asphalt/Concrete/Untreated/Cobbles /Brick/Other
B. Road Geometry	Bend(s)	Left/Right/Wide/Tight/Multiple bends
	Slope(s)	Decline/Incline/Multiple slopes
	Road width	Wide/Narrow/Single lane/Multiple lanes/Change in width
	Adverse camber	Left/Right
	Traffic calming	Road hump/Speed table/Throttle/Chicane
	Temporary road layout	Roadworks/Other
	Misleading/complex road layout	Misleading/Complex
	Speed-inciting layout	Bend in road/Straight road/Gradient/Wide road/Continuity effect
C. Traffic Condition	Flow	Smooth/Erratic
	Speed	High/Low/Stationary
	Density	Low/High
	Other road user(s) : Absence of clues to manoeuvre	Absence of clues to manoeuvre
	Other road user(s) : Ambiguity of clues to manoeuvre	Ambiguity of clues to manoeuvre
	Other road user(s) : Atypical manoeuvres	Atypical manoeuvres
	Being drawn into manoeuvre	Passenger/Vehicle ahead/Vehicle behind/Pedestrian/Cyclist
D. Visibility Impaired	Road lighting	Type/Colour/Intensity/No lighting
	Vehicle lighting	Type/Colour/Beam type/No lighting
	Day/night	Daylight/Darkness/Dusk/Dawn
	Sun glare	Direct from sun/Reflection from wet road
	Weather	Rain/Fog or mist/Snow/Hail
	Smoke	Vehicle/Nearby fire/Other
	Terrain profile	Bend/Slope/Side slope(s)/Other
	Other vehicle(s)	High vehicle/Wide vehicle/Parked vehicle/Vehicle stopped in traffic/Other
	Roadside objects	Overhanging tree(s)/ Overhanging shrubbery/Sign(s)/Bridge structures/Barrier(s)/Wall(s)/Boundary

		fence(s)/Other
E. Traffic Guidance	Traffic signs/signals - Insufficient	Signs present but insufficient/Signals present but insufficient/Signs absent/Signals absent/Other
	Traffic signs/signals – Maintenance	Signs damaged/Signals damaged/Signs poorly maintained/Signals poorly maintained/Signs positioned incorrectly/Signals positioned incorrectly/Other
	Traffic signs/signals – Unexpected	Signs replaced/Signals replaced/Signs new/Signals new/Other
	Traffic signs/signals – Inappropriate	Signs inappropriate/Signals inappropriate/Signs confusing/Signals confusing /Other
	Road markings (visual/tactile) - Insufficient	Visual markings present but insufficient/Tactile markings present but insufficient/Visual markings absent/Tactile markings absent
	Road markings (visual/tactile) - Maintenance	Visual markings damaged/ Tactile markings damaged/ Visual markings poorly maintained/ Tactile markings poorly maintained/ Visual markings positioned incorrectly/ Tactile markings positioned incorrectly/Other
	Road markings (visual/tactile) – Unexpected	Visual markings replaced/ Tactile markings replaced/ Visual markings new/ Tactile markings new/Other
	Road markings (visual/tactile) - Inappropriate	Visual markings inappropriate/ Tactile markings inappropriate/ Visual markings confusing/ Tactile markings confusing /Other
F. Other Environmental Factors	Earlier collision	Vehicle(s)/Debris/Other
	Pedestrian in road	Adult/Child/Other
	Fire in road/roadside	Car in Road/Car in Roadside/Other in Road/Other in roadside
	Level crossing	Controlled/Uncontrolled
	Animal in road	Dog/Cat/Horse/Cow(s)/Pig(s)/Sheep/ Deer/Rabbit/Badger(s)/Fox(es)/Bird(s)/ Reptile(s)/Other animal(s)
	Other obstacle(s) in road	Vehicle part/Dead animal/Discarded vehicle load/Other
	Road works	Major/Minor/Other
	High wind	Gale force/Storm Force/Hurricane force/Other

Table 13 – Grid of Vehicle (tool) Related Factors Which Could Lead to Functional Failures

Descriptive	Generic	In-depth examples
A. Electro-mechanical	Steering	Partial failure/Total failure
	Brakes	Partial failure/Total failure
	Engine	Partial failure/Total failure
	Suspension	Partial failure/Total failure
	Electrical/electronics	Partial failure/Total failure
B. Maintenance	Windscreen/Glass	Front chipped/ Front cracked/ Front misted/Front dirty / Front scratched/Rear chipped/ Rear cracked/Rear misted/ Rear dirty/Rear scratched/ Side chipped/ Side cracked/ Side misted/Side dirty/ Side scratched/Other
	Tyre(s)	Incorrect type/Air pressure/ Tread/ Blow-out/Other
	Exterior lights	Headlight type/Headlight bulb needs replacing/Headlight cracked/Headlight broken cover/ Rear light type/ Rear light bulb needs replacing/ Rear light cracked/ Rear light broken cover/ Brake light type/ Brake light bulb needs replacing/ Brake light cracked/ Brake light broken cover/ Indicator type/ Indicator bulb needs replacing/ Indicator cracked/ Indicator broken cover/ Fog light type/ Fog light bulb needs replacing/ Fog light cracked/ Fog light broken cover/Other
	Interior lights	Fuel light/Oil light/Water light/Parking brake light/Other dashboard light/Other interior lighting
C. Design	Visibility	A-pillar(s)/B-pillar(s)/C-pillar(s)/Steering wheel blocking view/Rear view mirror/Wing mirror(s)/Seating/Other
	Auditory	Auditory warnings confusing
	Displays	Colour/Size/Confusing information/Other
	Controls	Colour/Size/Confusing information/Reach/Other
D. Load	Heavy	On vehicle/Within vehicle/Other
	Uneven	On vehicle/Within vehicle/Other
	Visibility obstructed	On vehicle/Within vehicle/Other