Deliverable 5.6

Manual for DREAM 3.0

Driving Reliability and Error Analysis Method

Please refer to this report as follows:

H. Wallén Warner, M. Ljung Aust, J. Sandin, E. Johansson, G. Björklund, Manual for DREAM 3.0, Driving Reliability and Error Analysis Method. Deliverable D5.6 of the EU FP6 project SafetyNet, TREN-04-FP6TR-SI2.395465/506723, 2008

Contract No: TREN-04-FP6TR-SI2.395465/506723
Acronym: SafetyNet
Title: Building the European Road Safety Observatory

Integrated Project, Thematic Priority 6.2 "Sustainable Surface Transport"

Project Co-ordinator:
Professor Pete Thomas
Vehicle Safety Research Centre
Ergonomics and Safety Research Institute
Loughborough University
Ashby Road
Loughborough
LE11 3TU

Organisation name of lead contractor for this deliverable:
Chalmers University of Technology, Chalmers

Report Author(s): **H. Wallén Warner, M. Ljung Aust, J. Sandin E. Johansson, G. Björklund**

Due Date of Deliverable: 30/10/2008

Submission Date: 01/09/2008

Project Start Date: 1st May 2004 **Duration:** 4.5 years

Project co-funded by the European Commission within the Sixth Framework Programme (2002 -2006)
Dissemination Level
PU Public

Transport
Project co-financed by the European Commission, Directorate-General Transport and Energy

MANUAL FOR

DREAM

VERSION 3.0

H. Wallén Warner, M. Ljung Aust, J. Sandin, E. Johansson & G. Björklund

Chalmers University of Technology,
Gothenburg, Sweden, 2008

MANUAL FOR DREAM, VERSION 3.0

H. Wallén Warner, M. Ljung Aust, J. Sandin, E. Johansson & G. Björklund, 2008

Vehicle Safety Division
Department of Applied Mechanics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone +46(0)31-772 1000
URL www.chalmers.se

Chalmers University of Technology,
Gothenburg, Sweden, 2008

ACKNOWLEDGMENTS

This Manual has been developed at Chalmers University of Technology by Henriette Wallén Warner, Mikael Ljung Aust, Jesper Sandin, Emma Johansson and Gunilla Björklund. The development was carried out within two projects; Factors Influencing the Causation of Accidents and Incidents (FICA), for further details see http://mvs.chalmers.se/~mikaljung and the SafetyNet project, for further details see http://www.erso.eu/safetynet/content/safetynet.htm

CONTENTS

APPENDICES

1. INTRODUCTION

The purpose of the tool *Driving Reliability and Error Analysis Method* (DREAM; first developed by Ljung, 2002; see also Ljung, Fagerlind, Lövsund, and Sandin, 2007) is to make it possible to systematically classify and store accident causation information which has been gathered through in-depth investigations by providing a structured way of sorting the causes behind the accident into a set of formally defined categories of contributing factors. This means that DREAM (like many other tools for accident analysis) is an organiser of explanations - not a provider. In order for any of the contributing factors to be applicable to an accident under investigation it must be supported by relevant empirical information about the accident. If no information exists, then nothing can be classified either.

DREAM was originally developed with the goal of identifying traffic situations for which development of technical solutions had the potential to decrease the number of future accidents. As can be seen in Table 1, accident preventive systems can roughly be divided into four main types, where each type presents its own challenges for accident investigation and countermeasure development.

Table 1. Different types of technical solutions targeting different areas of accident avoidance.

		Aim	
		Collision avoidance	**Risk avoidance**
Mode	**Autonomous systems**	Technically possible but difficult in a legal perspective.	Technically possible, but efficiency is threatened by driver adaptation.
	Interactive systems	Technically complicated since the time needed for driver action puts extreme demands on sensor and algorithm performance in situation identification.	*Technically possible and often easier than collision avoidance, but very demanding from an HMI* point of view.*

**HMI: Human-Machine-Interface*

When DREAM was first developed, it was decided that the main focus should be on only one of the four prevention types. More specifically, the interest laid in identifying *interactive systems for risk avoidance* (Table 1: lower right quadrant). Consequently, the causation categories in DREAM, as well as the underlying accident model reflect this focus. Before using DREAM for accident analysis in your project, it is therefore important to check whether the project goals match this purpose. If the goals do not match, the tool should be modified, complemented or replaced. For example, if the focus of the project is both risk avoidance and collision avoidance, DREAM can be combined with other methods for accident analysis such as Sequentially Timed Events Plotting (STEP; Hendrick & Benner, 1987) to cover the needs for collision avoidance engineering.

2. THEORETICAL BACKGROUND

DREAM is an adaptation of the *Cognitive Reliability and Error Analysis Method* (CREAM; Hollnagel, 1998). While CREAM was developed to analyse accidents within process control domains such as nuclear power plants and train operation, DREAM is adapted to suit the road traffic domain.

2.1. The three main elements in DREAM

The accident model

DREAM includes three main elements: an accident model, a classification scheme and a method. The accident model uses the human-technology-organisation (HTO) triad as a reference - represented by the driver (human), the vehicle and traffic environment (technology) and the organisation (see Table 2).

The *Contextual Control Model* (COCOM; Hollnagel, 1998; Hollnagel and Woods, 2005) is used to organise some of the categories (observation, interpretation and planning) related to the driver in the driver-vehicle/traffic environment-organisation triad. COCOM recognises that cognition includes processing observations and producing reactions, as well as continuously revising goals and intentions which create a "loop" on the level of interpretation and planning. This is assumed to occur in parallel with whatever else is going on (at the same time as it in some way is also being determined by what is going on). In later work, COCOM has been extended into the *Extended Control Model* (ECOM; Hollnagel and Woods, 2005), recognizing that control includes working towards multiple parallel goals on different time scales, so in reality a number of parallel control processes are at play. Cognition in the context of human-machine system performance should therefore not be described as a sequence of steps and any classification scheme based on this model must represent a network rather than a hierarchy. This theoretical standpoint is reflected in how the contributing factors in the classification scheme are defined as well as related to each other (for a more detailed description see section 3.3. Links).

Furthermore, Figure 1 shows how accidents are seen as the result of an unsuccessful interplay between driver, vehicle and traffic environment, as well as the organisation(s) responsible for shaping the conditions under which driving takes place. Failures at the sharp end as well as at the blunt end are taken into consideration. Sharp end failures happen in close proximity to the accident (e.g. the driver fails to see a red traffic light which contributes to two cars colliding), while blunt end failures occur at other times and/or at other locations (e.g. a mechanic fails to maintain the brakes properly which later contributes to two cars colliding).

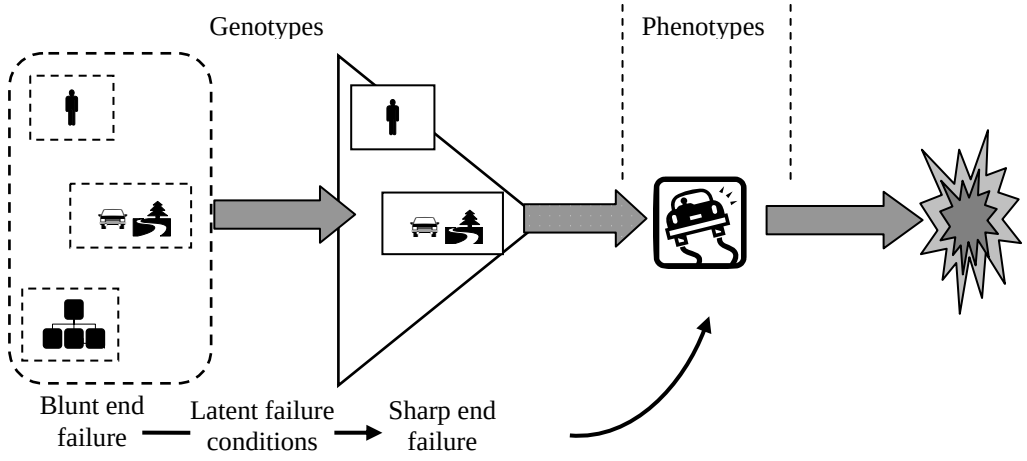


Figure 1. Blunt end and sharp end failures (after Ljung, 2002).

The classification scheme

The classification scheme of DREAM comprises a number of observable effects in the form of human actions and system events called phenotypes. It also contains a number of possible contributing factors which may have brought about these observable effects. The contributing factors are called genotypes and are organised according to the driver-vehicle/traffic environment-organisation triad mentioned above. The driver category consists of genotypes related to possible problems with cognitive functions such as observation, interpretation and planning (in accordance with COCOM). It also includes more general states of temporary and permanent person related factors that can contribute to an accident (e.g. inattention). The vehicle/traffic environment category consists of vehicle and traffic environment related genotypes, while the organisation category consists of genotypes related to organisation, maintenance and design. See Table 2 for a schematic presentation of different categories. Besides the phenotypes and genotypes mentioned above, the classification scheme in DREAM also includes links between phenotypes and genotypes, as well as between different genotypes. For further description of the classification scheme see section 3. The Classification Scheme.

Table 2. Overall grouping of the genotypes and phenotypes in DREAM.

GENOTYPES			**PHENOTYPES**
HUMAN	**TECHNOLOGY**	**ORGANISATION**	
Driver	**Vehicle and traffic environment**	**Organisation**	
Observation Interpretation Planning } in accordance with COCOM	Temporary HMI* problems Permanent HMI* problems Vehicle equipment failure	Organisation Maintenance Vehicle design Road design	Timing Speed Distance Direction
Temporary Personal Factors Permanent Personal Factors	**Traffic environment** Weather conditions Obstruction of view due to object State of road Communication		Force Object

**HMI: Human-Machine-Interface*

The method

The method in DREAM is fully bi-directional which means that the same principles can be used for analysing past accidents as for predicting future ones. With regards to this manual, the focus is however on retrospective analysis of accidents that have already occurred. The classification scheme is therefore organised to make this as easy as possible. Furthermore, the method contains several stop rules, e.g. well defined conditions that determine when the analysis should come to an end. These stop rules are necessary as the classification scheme represents a network (rather than a hierarchy) and the analysis or prediction could go on forever in the absence of these rules. For further description of the method see section 4. The Method.

2.2. Revision of DREAM

DREAM 2.1 (Ljung, Furberg and Hollnagel, n.d.) was first used in the Swedish project *Factors Influencing the Causation of Accidents and incidents* (FICA; for further details see http://mvs.chalmers.se/~mikaljun). When DREAM 2.1 was to be used in work package 5 of the European co-operation road safety project SafetyNet (for further details see http://www.erso.eu/safetynet/content/safetynet.htm), DREAM 2.1 was translated into English and adapted to suit the traffic environment in the participating countries. This adapted version was called *SafetyNet Accident Causation System* (SNACS 1.1; Ljung, 2006) and uses the same method, accident model and main structure of the classification system as DREAM 2.1 while some of the individual genotypes have been altered.

Both DREAM 2.1 (Ljung, Furberg and Hollnagel, n.d.) and SNACS 1.1 (Ljung, 2006) have been successfully used as a tool for accident analysis in Sweden as well as in other European countries and being applied extensively throughout the SafetyNet WP5 accident investigations. During this practical work some suggestions for improvements have been put forward. Both DREAM 2.1 and SNACS 1.1 were therefore revised by a reference group including Henriette Wallén Warner (researcher in psychology representing Chalmers University of Technology) leading the revision preceding DREAM 3.0, Gunilla Björklund (researcher in psychology representing Chalmers University of Technology in SafetyNet WP5's accident causation analyses), Johan Engström (researcher responsible for Safety Analysis at Volvo Technology and PhD-student at Chalmers University of Technology focusing on inattention-related factors in crash causation), Emma Johansson (Human Factor specialist at Volvo Technology and part of an accident investigation team using DREAM/SNACS), Mikael Ljung Aust (developer of DREAM/SNACS, researcher at Volvo Cars Safety Centre and PhD-student at Chalmers University of Technology focusing on accident analysis and driver behaviour), and Jesper Sandin (PhD-student at Chalmers University of Technology focusing on DREAM as a tool for accident analysis).

The revision resulted in DREAM 3.0 - which is written in English and adapted to meet the needs of practitioners all over Europe (DREAM 3.0 can of course also be used in other parts of the world but due to country specific differences further adjustments might then be needed). DREAM 3.0 uses the same accident model as the earlier versions while the classification scheme and the method has been somewhat adjusted.

With regards to the classification scheme in DREAM 3.0, the majority of genotypes are left in their original form, and where needed clarified by improved definitions. A few new genotypes have been added and a few old ones have disappeared, due to merging or exclusion. In connection with the revision a literature review was also conducted in order to investigate the empirical support for the links between the genotypes. For further details see Wallén Warner, Björklund, Johansson, Ljung Aust and Sandin (2008).

With regards to the method, the indirect linking in DREAM 2.1 (Ljung, Furberg & Hollnagel, n.d. pp 26-27) has been abandoned. The indirect linking made it possible to choose a link from another genotype in the same category when no suitable link was available for the genotype at hand - at the same time as it made linking between genotypes in the same category impossible. Instead of indirect linking it is recommended that the classification scheme should be continuously updated to fit new types of accident scenarios as well as new scientific findings. See section 3.4. Extending the classification scheme

3. THE CLASSIFICATION SCHEME

The classification scheme in DREAM 3.0 consists of phenotypes (the observable effects), genotypes (factors that can have contributed to the observable effects) and links between the phenotypes and the genotypes, as well as between different genotypes. For the complete classification scheme see Appendix A.

3.1. Phenotypes

Girard (1994) suggests that all accidents can be divided into four different phases: *the driving phase* (the "normal" driving situation where no unexpected demands are upon the driver; e.g. there is a balance between the demands and the ability of the system components to respond), *the discontinuity phase* (the "normal" driving situation is interrupted by an unexpected event; e.g. the demands suddenly exceed the ability of the system components to respond), *the emergency phase* (the time and space between discontinuity and impact; e.g. the time available for the system components to respond to the sudden increase in demands) and finally *the crash phase* (the crash and its consequences). When making a DREAM-analysis the first step is always to choose a phenotype - which is the first observable effect during the discontinuity phase (for further description see section 3.1.1. Phenotype choices).

The purpose of the phenotypes is to classify the observable effects into a relatively limited set of categories from which the actual analysis can start. In DREAM 3.0, there are six general phenotypes which are all linked to one or more specific phenotypes. The difference between general and specific phenotypes is the degree of information where the specific phenotypes describe more specific effects than the general ones. If the investigator has sufficient information about the accident, a specific phenotype should be chosen. The phenotypes and the specific phenotypes are presented in Table 3, a more detailed description can be found in Appendix A.

Table 3. Phenotypes and specific phenotypes of DREAM 3.0.

Phenotypes	**Specific phenotypes**
Timing	Too early action; Too late action; No action
Speed	Too high speed; Too low speed
Distance	Too short distance
Direction	Wrong direction
Force	Surplus force; Insufficient force
Object	Adjacent object

Some of the phenotypes (e.g. timing, distance and speed) are very closely related even though they are conceptually separated. If, for example, a car collides with an oncoming car when overtaking, should that be seen as an effect of timing (the overtaking was initiated too early or too late), distance (the stretch of free road was too short in order to complete the overtaking) or speed (the speed was too low in order to complete the overtaking)? The answer is that the investigator has to choose the phenotype that makes most sense given what is known about the accident.

With regards to the example above, although all three phenotypes are logically possible, one of them is probably more appropriate given the circumstances. Let us suppose that the overtaking is made in 160 km/h (speed limit 110 km/h) close to the crest on an uphill slope. *Speed: too low speed* is then a less appropriate choice of phenotype as the speed was more than sufficient (given the speed limit). *Distance: Too short distance* seems more appropriate as the stretch of free road was too short to safely overtake. However, it is common driver knowledge (taught in driver training) that one should not overtake unless there is a sufficient stretch of road with a free view and in this case the crest of the hill clearly blocked the view. Given this, the most appropriate phenotype would be *timing: too early action*.

Sometimes the choice of phenotype could be quite tricky. In DREAM 3.0, all phenotypes do, however, link to the same genotypes and therefore a less appropriate choice of phenotype will not affect the rest of the analysis.

3.1.1. Phenotype choices

Below, a number of common accident scenarios are described and for each of them phenotypes are suggested. This is done in order to make it as easy as possible to identify at what point in an accident scenario a phenotype should be chosen, as well as, which phenotype is most appropriate.

Intersection accidents

Includes accidents in intersections.

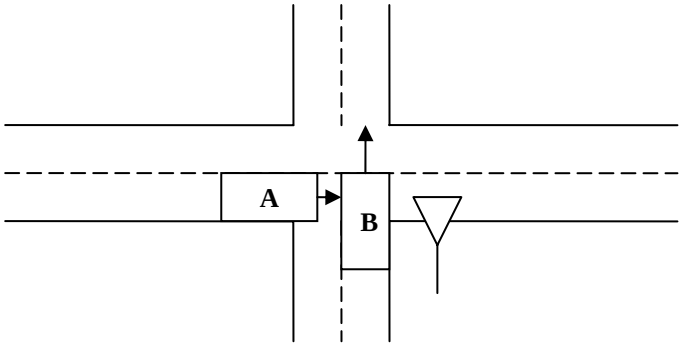


Figure 2. Intersection.

Driver with right of way (A)

When: The phenotype is chosen when the driver enters the intersection even though the road is not free

Phenotype: Timing: too early action, too late action, or no action
Speed: too high speed

Driver without right of way (B)

When: The phenotype is chosen when the driver passes the red traffic lights, the stop/give way sign or enters the intersection ignoring the right hand rule

Phenotype: Timing: too early action, too late action or no action

Illegally turning etc.

When: The phenotype is chosen when the driver initiates the illegal turn

Phenotype: Direction: wrong direction

Leaving lane accidents
Includes accidents where the driver leaves his own lane (accidents where the driver is changing into a lane going in the same direction are described in the next section).

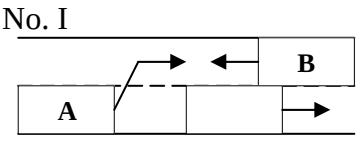


Figure 3. Overtaking.

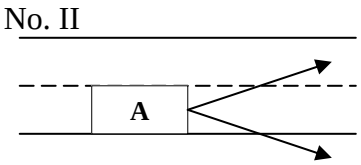


Figure 4. Straight road.

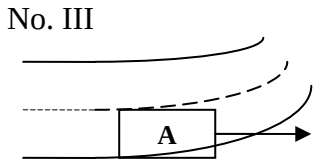


Figure 5. Curve.

Overtaking driver (No. I: A)
When: The phenotype is chosen when the driver leaves his own lane
Phenotype: Timing: too early action

Meeting driver (No. I: B)
When: The phenotype is chosen when there is no longer any time/space left for the driver to act in order to avoid the accident
Phenotype: Timing: too late action, no action
Speed: too high speed

Leaving lane on straight road (No. II: A)
When: The phenotype is chosen when the driver leaves his own lane
Phenotype: Direction: wrong direction
Force: surplus force

Leaving lane in curve (No. III: A)
When: The phenotype is chosen when the driver leaves his own lane
Phenotype: Direction: wrong direction
Speed: too high speed

Changing lane accidents
Includes accidents where the driver changes into another lane going in the same direction.

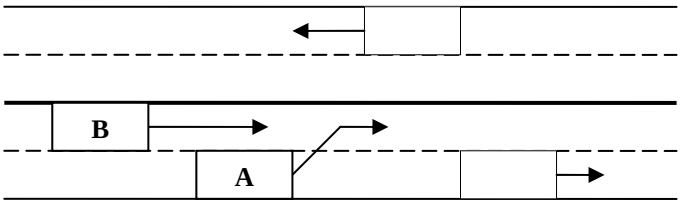


Figure 6. Changing lane.

Driver who is changing lane (A)
When: The phenotype is chosen when the driver leaves his own lane
Phenotype: Timing: too early

Driver who is catching up the car changing into his lane (B)
When: The phenotype is chosen when there is no longer any time/space left for the driver to act in order to avoid the accident
Phenotype: Timing: too late action, no action
Speed: too high speed

Catching up accidents
Includes accident where one driver catches up with another.

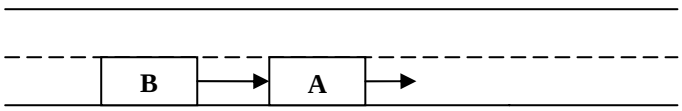


Figure 7. Catching up.

Driver who is caught up (A)
When: The phenotype is chosen when there is no longer any time/space left for the driver to act in order to avoid the accident
Phenotype: Timing: no action
Force: surplus force
Speed: too low speed

Driver who is catching up (B)
When: The phenotype is chosen when there is no longer any time/space left for the driver to act in order to avoid the accident
Phenotype: Timing: late action, no action
Speed: too high speed
Distance: too short distance

3.2. Genotypes
Genotypes are factors which may have contributed to the phenotypes (the observable effects). The genotypes can generally not be observed and therefore they have to be deduced from e.g. interviews with the drivers or other information available from the investigation. In DREAM 3.0, there are 51 genotypes, some of which are linked to one or more specific genotypes. As with the phenotypes, the difference between general and specific genotypes is the degree of detail in the information available where the specific genotypes describe more specific factors than the general ones. If the investigator has sufficient information about the accident a specific genotype should be chosen.

The genotypes are organised according to the driver-vehicle/traffic environment-organisation triad. The driver category consists of genotypes related to specific cognitive functions such as observation, interpretation and planning, as well as more general functions such as temporary and permanent person related factors. The vehicle/traffic environment category consists of genotypes related to the vehicle and the traffic environment, while the organisation category consists of genotypes related to organisation, maintenance and design. The genotypes are presented in Table 4 and a more detailed description can be found in Appendix A.

Table 4. Genotypes of DREAM 3.0.

HUMAN	TECHNOLOGY	ORGANISATION
Driver	**Vehicle and traffic environment**	**Organisation**
Observation	**Vehicle**	**Organisation**
Missed observation	**Temporary HMI* problems**	Time pressure
Late observation	Temporary illumination problems	Irregular working hours
False observation	Temporary noise problems	Heavy physical activity before drive
	Temporary sight obstructions	Inad. training
Interpretation	Temporary access limitations	
Misjudgement of time gaps	Incorrect ITS-information	**Maintenance**
Misjudgement of situation		Inad. vehicle maintenance
	Permanent HMI* problems	Inad. road maintenance
Planning	Permanent illumination problems	
Priority error	Permanent sound problems	**Vehicle design**
	Permanent sight obstruction	Inad. design of driver environment
Temporary Personal Factors		Inad. design of communication devices
Fear	**Vehicle equipment failure**	Inad. construction of vehicle parts
Inattention	Equipment failure	and/or structures
Fatigue		Unpredictable system characteristics
Under the influence of substances	**Traffic environment**	
Excitement seeking	**Weather conditions**	**Road design**
Sudden functional impairment	Reduced visibility	Inad. information design
Psychological stress	Strong side winds	Inad. road design
Permanent Personal Factors	**Obstruction of view due to object**	
Permanent functional impairment	Temporary obstruction of view	
Expectance of certain behaviours	Permanent obstruction of view	
Expectance of stable road environment		
Habitually stretching rules and recommendations	**State of road**	
	Insufficient guidance	
Overestimation of skills	Reduced friction	
Insufficient skills/knowledge	Road surface degradation	
	Object on road	
	Inadequate road geometry	
	Communication	
	Inad. transmission from other road users	
	Inad. transmission from road environment	

Inad. = inadequate
**HMI: Human-Machine-Interface*

3.3. Links

Besides the phenotypes and genotypes mentioned above, the classification scheme in DREAM also includes links between the phenotypes and the genotypes, as well as, between different genotypes. These links represent the existing knowledge about how different factors can interact with each other (for a review see Wallén Warner et al. 2008) and results in analysis-chains where a genotype can be both the consequent of a previous genotype, and the antecedent of another genotype, e.g. the cause of the genotype. If, for example, genotype A results in genotype B and genotype B results in genotype C, then A can be said to be the indirect cause of C and B can be said to be both a result of A and a cause of C. The genotypes in DREAM can therefore function both as links forwards and links backwards in a chain of reasoning, which makes it possible to deduce indirect causes (as A in relation to C in the example above).

If there was only a set of direct causes the analyses would have an enormous width but no depth. When the genotypes can act as links, whole chains of interlinked causes and

consequences can instead be deduced. Starting with a phenotype (this being the end point of the chain of causes that you want to deduce) the analysis then moves backwards from the event until there is no more available information about the accident or no more meaningful factors to analyse.

The links between the phenotypes and the genotypes, as well as between different genotypes, are described in Appendix A. The linking should be read from left to right, e.g. genotypes in the left hand columns are causes of the genotypes/phenotypes in the right hand column(s). This is clearly indicated in the tables through the heading ANTECEDENTS over the columns to the left and CONSEQUENTS over the columns to the right. Please note that all links are possible connections, not logically binding or inevitable connections. This means that you cannot use a link just because it can be found in the classification scheme. *The use of a link must always be supported by the data available!*

3.4. Extending the classification scheme

Obviously, the classification scheme in Appendix A does not cover all possible genotypes or all possible links between the existing genotypes. Even though there may have been traffic accidents due to grand pianos dropping out of the blue this is not included as a genotype. Instead, a selection has been made in order to avoid an endless list of genotypes making the tool impossible to use. This does however also mean that the classification scheme should be continuously updated to fit new types of accident scenarios as well as new scientific findings.

This is unproblematic, as long as certain rules are followed. When adding or removing genotypes, as well as changing the links between them, the links must be checked for consistency such that each general consequent must be found as a general antecedent in at least one place (e.g. in one or more of the tables in Appendix A). Also, any additional general genotypes must be clearly defined and for specific genotypes, examples must be added. While simple in theory it is recommended that primarily persons with good knowledge of the accident model, the classification scheme as well as the method used in DREAM make such alterations.

4. THE METHOD

In theory the method in DREAM 3.0 is fully bi-directional which means that the same principles can be used for analysing past accidents as for predicting future ones. With regards to this manual, the focus is however on retrospective analysis of accidents that have already occurred. The classification scheme is therefore organised to make this as easy as possible.

4.1. Stop rules

The DREAM 3.0 classification scheme is non-hierarchical, which means that no genotypes have precedence over others, and there are no highest or lowest levels where an analysis must end. Therefore, to avoid random or subjectively determined stops for the analysis, it is necessary to have stop rules.

Overall, general genotypes have the status of non-terminal events. If a general genotype is the most likely cause of a general consequent, that cause is chosen and the analysis must continue until one of the three stop rules below is fulfilled.

The stop rules in DREAM 3.0 are:

1. *Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.*
2. *If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.*
3. *If none of the available specific or general genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.*

5. THE ANALYSIS STEP BY STEP

Below, a DREAM-analysis will be described step by step. In order to carry out the analysis you need this manual including Appendix A with the linking table for phenotypes (observable effects) and genotypes (causes). You also need a copy of Appendix B with the linking template.

As investigators with different basic professional training (e.g. engineering or human factors) tend to focus on different aspects of the system interaction (Svenson, Lekberg and Johansson, 1999) it is recommended that the data collection as well as the analyses is carried out by a multidisciplinary accident investigation team.

5.1. Data collection

The minimum criteria for making a DREAM-analysis is that you have information about all drivers for which analyses are to be made as well as information about the accident scene. The information about the drivers is preferably collected through interviews with the drivers, passengers and other witnesses conducted as soon as possible after the accident. The information about the accident scene should also be collected as soon as possible – preferably before the involved vehicles have been moved, before the weather has changed, etc. It is also recommended that photos are used for documentation of the accident scene.

The interviews and the documentation of the accident scene should together contain the information needed in order to confirm or dismiss the presence of every single genotype. The overview of genotypes in Appendix A, page 6 can be used as a checklist!

It is also important that your project decides how to deal with missing, ambiguous and/or conflicting data before starting the data collection. In cases where the data collection and/or the analyses are carried out by a team of investigators, you also need to decide how to deal with different conclusions made within this team.

5.2. Accident Description

After the data collection is completed the first step in the analysis is to describe the accident in as much detail as possible based on data collected at the scene of the accident. This accident description should include all information needed to confirm the presence of different genotypes. It should also include information needed to dismiss genotypes that could have been expected to have contributed to the accident (e.g. if the driver was *not* tired even though he was driving at night this should be included in the accident description).

When writing the accident description it is important to be as neutral as possible and avoid jumping to conclusions. When writing and reading the accident description, remember that in order to do a DREAM-analysis it is completely irrelevant as to who can be blamed (e.g. who the police or insurance company will hold responsible) for the accident since the aim of the analysis is to provide means for future identification of countermeasures. Never start the DREAM-analysis before you have been through the whole material to avoid searching for facts to support your current theory rather than looking at the whole picture as neutrally as possible.

Below follows a description of an intersection accident seen from the perspective of Driver A. In all accidents, separate DREAM-analysis should be conducted for all vehicles involved but to keep the step by step section as short as possible only the analysis of Driver A will be described. The results of the analysis of Driver B are however presented under section 6. Example Accidents.

Accident description for an intersection accident

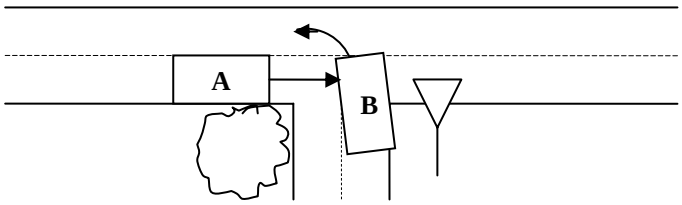


Figure 8. Intersection accident between two cars.

Driver A
A is on her way home and is driving on a priority road, approaching a T-junction (approximately 200 meters away from her house) in 45-50 km/h (speed limit 50 km/h). A is planning to continue straight ahead in the intersection and states that there is no other traffic around. When A discovers B, the vehicles are so close to each other that A does not have time to brake or to make an avoidance manoeuvre before A drives into B's left side. A states that she is well aware that the intersection is dangerous and that she has experienced several incidents there. A also states that she is very familiar with the road which makes it easy for her to forget to adapt the speed.
Driver: 38-year old woman (has had a driving licence for 20 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication, does, however, state that she is so familiar with the intersection that her level of attention was low
Vehicle: Peugeot in good condition
Traffic environment: T-intersection where vehicles on the connecting road should give way, the view is obstructed by a 1.6 meter high hedge in a garden, speed limit is 50 km/h

5.3. Context evaluation

After the accident description is written and read, the next step is to evaluate the context for the accident. This can, for example, be done by highlighting (see example above) all factors which can have contributed to the accident. Based on the highlighted information the actual DREAM-analysis is then performed.

5.4. Choice of Phenotype

After the evaluation of the context the actual DREAM-analysis starts. One analysis is done for each vehicle involved and the first step is to choose a phenotype. In section 3.1.1. Phenotype choices you find a description of at which point the phenotype should be chosen. In general the phenotype in intersection accidents should be chosen when the driver passes the red traffic light/stop sign/give way sign or enters the intersection before it is free (this is regardless of whether or not it is the driver's right of way). In the current example, Driver A did not pass any traffic light or stop/give way sign but she entered the intersection even though Driver B was approaching. Therefore the phenotype is chosen when Driver A enters the intersection.

Example from section 3.1.1. Phenotype choices

Driver with right of way (A)

When:	The phenotype is chosen when the driver enters the intersection even though the road is not free
Phenotype:	Timing: too early action, too late action, no action Speed: too high speed

The phenotypes suggested for this type of accident are *timing: too early action*, *timing: too late action*, *timing: no action* and *speed: too high speed*. Looking at table A in Appendix A the most appropriate phenotype is chosen. The table contains all the available phenotypes and the possible set of genotypes that can link to each phenotype. Figure 9 shows an extract from this table.

In the first column, under the heading of ANTECEDENTS, is a list of all the general genotypes linking to the phenotype, e.g. all genotypes that are possible causes as to why the phenotype happens. In the second column, under the heading of CONSEQUENTS, the general phenotypes are listed and described and in the third column, the specific phenotypes are listed and described. In the fourth and last column, examples for the specific genotypes are given.

As Driver A did not drive faster than what could be expected we start with looking at the different alternatives for the phenotype *timing*. As Driver A did not pass any traffic light/stop sign/give way sign, did not start from a stand still and did not brake before entering the intersection the most appropriate choice is the last alternative in Figure 9.

> The driver enters the intersection without doing anything (e.g. does not brake in order to avoid entering the intersection before it is free; this is regardless of whether or not it is the driver's right of way).

The phenotype *timing: no action* is therefore chosen and written in the phenotype box in Appendix B (see Figure 11).

You can only choose one phenotype for each vehicle involved. If you find it difficult choosing between two phenotypes it can be good to know that all phenotypes link to the same genotypes and therefore a less appropriate choice of phenotype will not affect the rest of the analysis. To make it possible to aggregate several DREAM-analyses it is however very important that all analyses start at the same point (in this case when the driver enters the intersection even though the road is not free).

PHENOTYPES (A)

ANTECEDENTS (CAUSES)	CONSEQUENTS (EFFECTS)		
GENERAL Genotypes	**Definition of GENERAL Phenotypes**	**Definitions of SPECIFIC Phenotypes**	**Examples for SPECIFIC Phenotypes**
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Timing (A1)** The timing for initiating an action.	**Too early action (A1.1)** The action is initiated too early, before the signal is given or the required conditions are established.	*Intersection accidents* Starting from a stand still the driver passes the traffic light too early - before it has turned green. Starting from a stand still the driver passes the stop/give way sign too early - before the intersection is free. Starting from a stand still the driver enters the intersection too early - before the intersection is free (this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.*
		Too late action (A1.2) The action is initiated too late.	*Intersection accidents* The driver starts to brake too late in order to stop for the red traffic light. The driver starts to brake too late in order to stop in front of the stop/give way sign. The driver starts to brake too late in order to avoid entering the intersection before it is free (this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.*
		No action (A1.3) No action is initiated.	*Intersection accidents* The driver passes the red traffic light without doing anything (e.g. does not brake in order to stop). The driver passes the stop/give way sign without doing anything (e.g. does not brake in order to stop). The driver enters the intersection without doing anything (e.g. does not brake in order to avoid entering the intersection before it is free; this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.*

Figure 9. Extract of intersection accident examples for the phenotype *timing* in the phenotypes table in Appendix A.

5.5. From Phenotype to Genotype

The next step in the analysis is to choose the first genotype(s) contributing to the phenotype. As mentioned above, all phenotypes link to the same set of genotypes which can be found in the first column in Figure 9. As Driver A, in the current example, misjudged the situation thinking the intersection was free and safe to enter, the second general genotype – *misjudgement of situation* – is chosen.

It is important to keep the accident description and context evaluation at hand so you can easily check the facts and circumstances for the accident you are analysing. Also, it is important that you know the meaning of all general genotypes listed in order to make a correct choice. If you need to check the meaning of one or more of the general genotypes you look at the code within the brackets. For *misjudgement of situation* the code is C2 which means that you can find a description of *misjudgement of situation* in table C row 2 in Appendix A. An extract from this table can be seen in Figure 10.

The first column contains of a list of all the general genotypes linking to each of the two genotypes *misjudgement of time gaps* and *misjudgement of situation*, respectively. In the second column, the specific genotypes are listed and described. In the third column, examples for the specific genotypes are given. In the fourth and last column, the two genotypes (*misjudgement of time gaps* and *misjudgement of situation)* that can be caused by the general genotypes in the first column, or by the specific genotypes in the second column, are listed and described.

When you have chosen one or more general genotypes, you write these in the genotype boxes closest to the phenotype box in Appendix B (see Figure 11).

INTERPRETATION C

Interpretation includes, for all but novice drivers, quick and automated (routine) procedures where typical situations and their associated actions are recognized and acted upon (script choice). Mistakes in interpretation occur at the sharp end – within the local event horizon.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Late observation (B2) **False observation (B3)** **Inattention (E2)** **Fatigue (E3)** **Under the influence of substances (E4)** **Psychological stress (E7)** **Permanent functional impairment (F1)** **Expectance of certain behaviours (F2)** **Habitually stretching rules and recommendations (F4)** **Overestimation of skills (F5)** **Insufficient skills/knowledge (F6)** **Incorrect ITS-information (G5)** **Reduced visibility (J1)** **Insufficient guidance (L1)** **Reduced friction (L2)** **Inadequate road geometry (L5)** **Inadequate transmission from road environment (M2)** **Unpredictable system characteristics (P4)**	**Misjudgement of time gap due to incorrect speed estimate (C1.1)** The driver misjudges the time gap due to a misjudgement of the approaching vehicle's speed.	*Intersection* The driver is waiting to cross a street and assumes that the approaching car is keeping the 50 km/h speed limit. The car is, however, approaching at 70 km/h and as a result the driver overestimates the time gap he has to the approaching car.	**Misjudgement of time gaps (C1)** The estimation of time gaps (e.g. time left to approaching vehicle, stop sign, traffic lights etc.) is incorrect.
Missed observation (B1) **Late observation (B2)** **False observation (B3)** **Priority error (D1)** **Inattention (E2)** **Fatigue (E3)** **Under the influence of substances (E4)** **Psychological stress (E7)** **Permanent functional impairment (F1)** **Expectance of certain behaviours (F2)** **Habitually stretching rules and recommendations (F4)** **Overestimation of skills (F5)** **Insufficient skills/knowledge (F6)** **Incorrect ITS-information (G5)** **Reduced visibility (J1)** **Insufficient guidance (L1)** **Reduced friction (L2)** **Road surface degradation (L3)** **Object on road (L4)** **Inadequate road geometry (L5)** **Inadequate transmission from road environment (M2)** **Unpredictable system characteristics (P4)**	**None defined**		**Row 2** **Misjudgement of situation (C2)** The situation is misjudged (e.g. the driver thinks that it is safe to enter the intersection as he/she has not noticed the traffic lights turning red or the vehicle approaching).

Figure 10. Extract of intersection accident examples for the genotypes in table C in Appendix A.

5.6. From Genotype to Genotype

The next step in the analysis is to choose the specific or general genotype(s) contributing to the genotype linked to the phenotype. You start with the first genotype chosen (*misjudgement of situation* in table C in the current example) which you find in the last column in one of the tables B - Q in Appendix A (in the current example you find the genotype in table C).

When looking for specific or general genotype(s) *you should always start to look for a specific genotype* which is found in column 2. In the current example, there is however no specific genotype corresponding to *misjudgement of situation* (for examples with specific genotypes see section *6.* Example Accidents) and therefore general genotypes have to be chosen in this example. Three contributing general genotypes can be found in the first column corresponding to *misjudgement of situation* in table C Figure 10. These general genotypes are *missed observation* (Driver A states that there was no other traffic around which implies that Driver A did not see Driver B approaching the intersection), *inattention* (Driver A states that her attention was low due to the familiarity of the road) and finally *expectance of certain behaviours* (Driver A drives on a priority road and therefore it is reasonable to assume that she expected any crossing traffic to give way in accordance with the give way sign).

Again, it is important to keep the accident description and context evaluation at hand so you can easily check the facts and circumstances for the accident you are analysing. Also, it is important that you know the meaning of all general genotypes listed in order to make a correct choice. In Appendix A, *missed observation* is described in table B row 1, *inattention* is described in table E row 2 and *expectance of certain behaviours* is described in table F row 2.

When you have chosen one or more specific or general genotypes, you write these down in the genotype boxes in Appendix B to the left of the general genotype they are contributing to (see Figure 11).

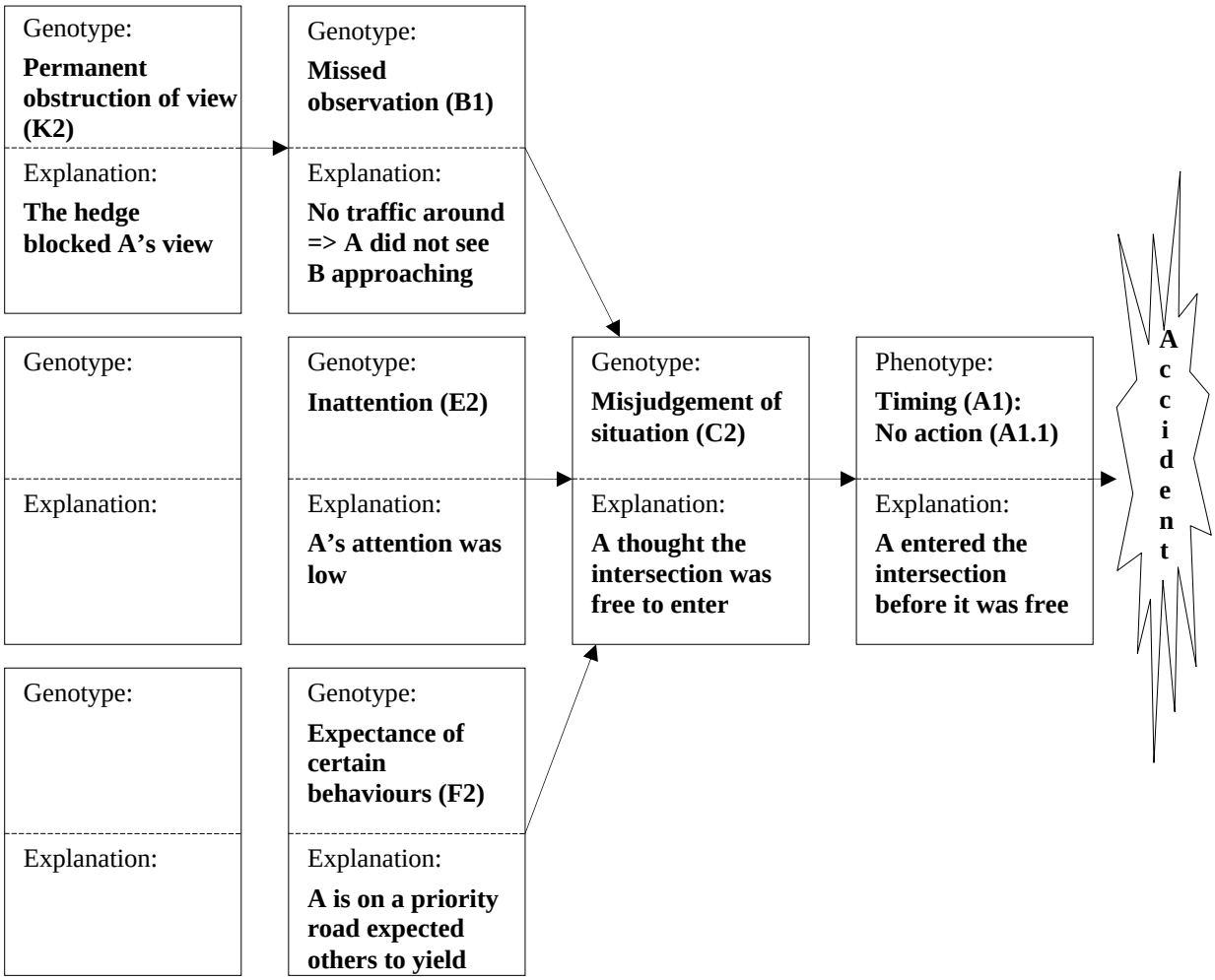
5.7. Ending the Analysis

The step described above is then repeated for each of the general genotypes chosen until the analysis is complete, e.g. one of the three stop rules is fulfilled.

In the current example, the reason for Driver A not seeing Driver B was that her view was blocked by the hedge and therefore the general genotype *permanent obstruction to view* is chosen as contributing to missed observation. With regards to *permanent obstruction to view* there are no specific or general genotype listed for this general genotype and therefore the analysis-chain stops in accordance with stop rule 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

The general genotype is written in the next genotype box in Appendix B (see Figure 11).

With regards to Driver A's low attention no specific or general genotype is relevant for the current example. The analysis-chain therefore stops in accordance with stop rule 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.



Comments: As A discovers B after she enters the intersection (after the phenotype was chosen) Missed observation (B1) and not Late observation (B2) is chosen.

Figure 11. DREAM-chart.

Finally, with regards to *expectance of certain behaviours* there are no specific or general genotype listed for this general genotype and therefore the analysis-chain stops in accordance with stop rule 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

When all analysis-chains have come to an end the analysis is completed (see Figure 11 in the current example). This does not necessarily mean that we have succeeded in systematically explaining completely why the accident happened. It just means that we have categorised everything we know about the accident as good as possible.

In cases where you find it difficult to choose between two or more genotypes it is very important that you make a comment and motivate your choice for future reference (see Figure 11).

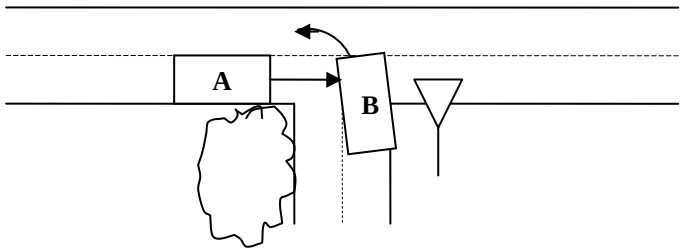
If this was a real accident analysis we would now repeat the whole procedure for Driver B. In this case, this will not be done but the results of the analysis of Driver B; together with a short

explanation as to why the specific phenotype and general genotypes were chosen can be found in the first accident scenario in section 6. Example accidents.

6. EXAMPLE ACCIDENTS

Some of the examples below are inspired by accidents described by Englund, Jarleryd, Lindkvist and Pettersson (1978).

Scenario 1 (intersection accident)



Driver A

A is on her way home and is driving on a priority road, approaching a T-junction (approximately 200 meters away from her house) in 45-50 km/h (speed limit 50 km/h). A is planning to continue straight ahead in the intersection and states that there is no other traffic around. When A discovers B the vehicles are so close to each other that A does not have time to brake or to make an avoidance manoeuvre before A drives into B's left side. A states that she is well aware that the intersection is dangerous and that she has experienced several incidents there. A also states that she is very familiar with the road which makes it easy for her to forget to adapt the speed.

Driver: 38-year old woman (has had a driving licence for 20 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication, does, however, state that she is so familiar with the intersection that her level of attention was low

Vehicle: Peugeot in good condition

Traffic environment: T-intersection where vehicles on the connecting road should give way, the view is obstructed by a 1.6 meter high hedge in a garden, speed limit is 50 km/h

Driver B

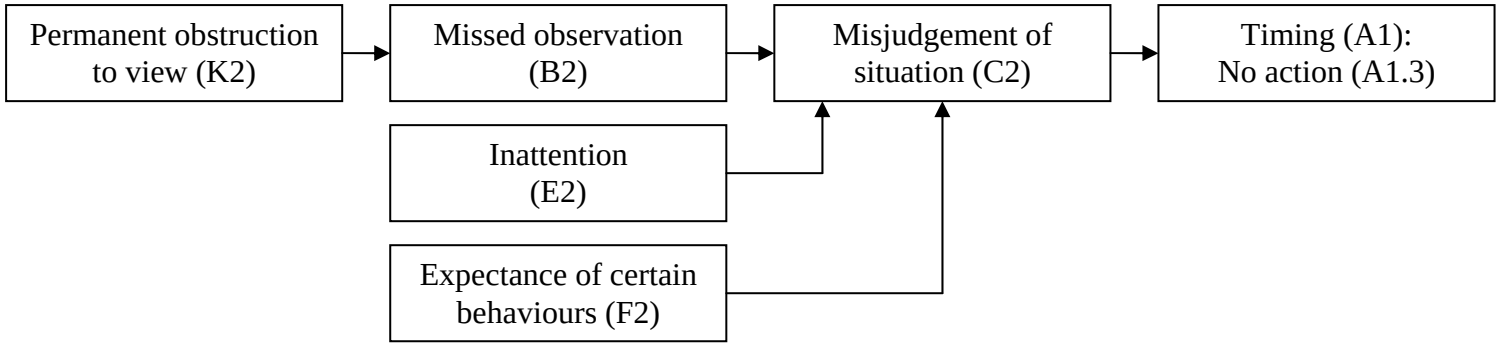
Just before the intersection B has stopped to look at a house and therefore she is approaching the intersection in a low speed (35-40 km/h). B notices the sign telling her to give way. There are no other road users around. B stops before the dotted white line painted on the tarmac in her lane. B looks to the right and to the left but does not see any vehicles approaching and therefore she drives into the intersection. Suddenly A appears from the left and drives into B's side. There are no brake marks in the intersection.

Driver: 36-year old woman (has had an African driving licence for 15 years and a Swedish driving licence for 10 years), was not in a hurry

Vehicle: Volvo in good condition which she has had for 6 months

Traffic environment: connecting road in T-junction, should give way which is signposted as well as marked with a dotted white line painted on the tarmac, the view is obstructed by a 1.6 meter tall hedge in a garden – to get a free view in the intersection it is necessary to stop after the dotted line.

Scenario 1 (intersection accident)
Driver A



The phenotype is chosen when A enters the intersection even though B is approaching. As A enters the intersection without doing anything (e.g. does not brake in order to avoid entering the intersection before it is free) the phenotype *timing: no action* is chosen.

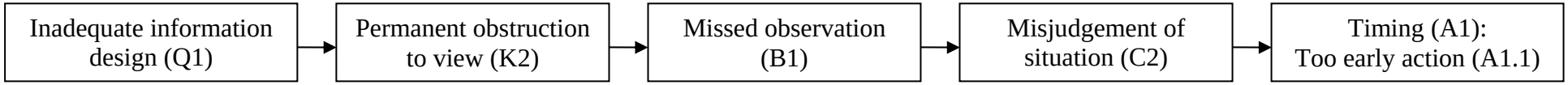
The cause behind A entering the intersection before it is free is that A misjudges the situation and thinks the intersection is free and safe to enter. Therefore the genotype *misjudgement of situation* is chosen.

There are three different factors contributing to A's misjudgement of the situation.
Firstly, A states that there is no other traffic around which implies that A does not see B approaching and therefore the genotype *missed observation* is chosen. The missed observation is caused by the hedge blocking A's view and therefore the genotype *permanent obstruction to view* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

The second factor contributing to A's misjudgement of the situation is that, according to A, her attention is low as she is very familiar with the road. Therefore the genotype *inattention* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

The third factor contributing to A's misjudgement of the situation is that A drives on a priority road and therefore it is reasonable to assume that A expects crossing traffic to give way in accordance with the give way sign. Therefore the genotype *expectance of certain behaviour*s is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

Scenario 1 (intersection accident)
Driver B



The phenotype is chosen when B passes the give way sign even though A is approaching the intersection. As B enters the intersection before A has safely passed, the phenotype *timing: too early action* is chosen.

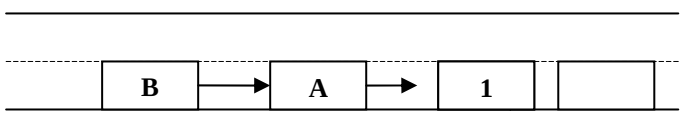
The cause behind B entering the intersection before it is free is that B misjudges the situation and thinks the intersection is free and safe to enter. Therefore the genotype *misjudgement of situation* is chosen.

B's misjudgement of the situation is caused by B not seeing A approaching. Therefore the genotype *missed observation* is chosen.

B not seeing A approaching is caused by the hedge blocking B's view. Therefore the genotype *permanent obstruction to view* is chosen.

B's view being blocked by the hedge is caused by the give way line painted on the tarmac being placed too far back in the intersection, making it impossible to see vehicles approaching from the left when stopping before the line. Therefore the genotype *inadequate information design* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

Scenario 2 (catching up accident)

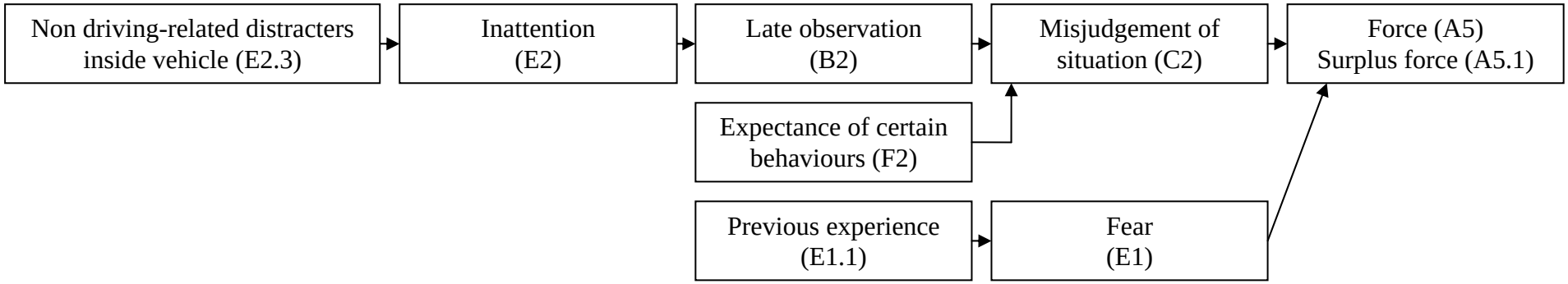


A still standing car queue has formed and vehicle 1 (which stands still) is last in this queue.

Driver A
A is driving in 50 km/h on a busy street. A is talking with her daughter who sits next to her in the front passenger seat. Suddenly the daughter says that the car in front of them has stopped. A brakes very hard and stops the car at least 10 meters behind the still standing car (position 1). A few second later, A is hit from behind by B.
Driver: 58-year old woman (has had a driving licence for 40 years), has previously been involved in an accident where she was hit from behind resulting in her getting a whip-lash injury, stats that she panicked when she, completely unprepared, found herself in the same kind of situation again, was not tired, was not under the influence of alcohol, drugs or medication
Vehicle: Toyota in good condition
Traffic environment: Busy city-street with a 50 km/h speed limit

Driver B
B is in a hurry to get to work and is driving 55-60 km/h on a busy street with a 50 km/h speed limit. Suddenly B sees A braking very hard. B brakes as hard as she can but still drives into A's rear end.
Driver: 25-year old woman (has had a driving licence for 5 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Opel in good condition
Traffic environment: Busy city-street with a 50 km/h speed limit

Scenario 2 (catching up accident)
Driver A



The phenotype is chosen when A suddenly brakes very hard. As A brakes unnecessarily hard (stopping 10 meters behind the queue) the phenotype *force: surplus force* is chosen.

There are two factors contributing to A braking so hard.
Firstly, A panics and therefore the genotype *fear* is chosen.

A's panic is caused by the fact that A, in the past, has been involved in a similar situation resulting in A getting a whiplash injury. Therefore the specific genotype *previous experience* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

The second factor contributing to A braking so hard is that A misjudges the situation thinking that braking really hard is the safest way of avoiding an accident. Therefore the genotype *misjudgement of situation* is chosen.

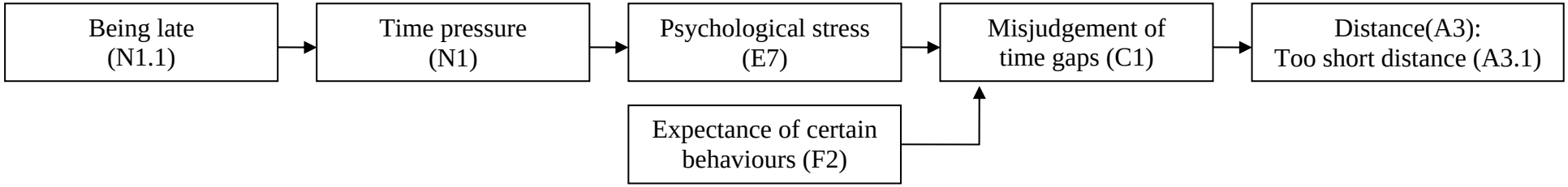
There are two factors contributing to A's misjudgement of the situation.
Firstly, A is not prepared for the situation as she does not expect cars in her lane to slow down and therefore the genotype *expectance of certain behaviours* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

The second factor contributing to A's misjudgement of the situation is that A does not see the car queue until her daughter informs her about it at which time it is too late for A to properly judge the situation and brake smoothly. Therefore the genotype *late observation* is chosen.

A's late observation is caused by her not focusing her attention on the road in front of her (if she had done she would have reacted to the car queue before her daughter informed her of it). Therefore the genotype inattention is chosen.

A's inattention is caused by her talking to her daughter. Therefore the specific genotype *non driving-related distracters inside vehicle* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

Scenario 2 (catching up accident)
Driver B



The phenotype is chosen when there is no longer any time/space left for B to act in order to avoid the accident. As B cannot avoid driving into A even though she brakes as hard as she can as soon as A starts braking, the phenotype *distance: too short distance* is chosen.

The cause behind B starting to brake too late is that B misjudges the time gap needed to the car in front (A) at the speed she is travelling. Therefore the genotype *misjudgement of time gaps* is chosen.

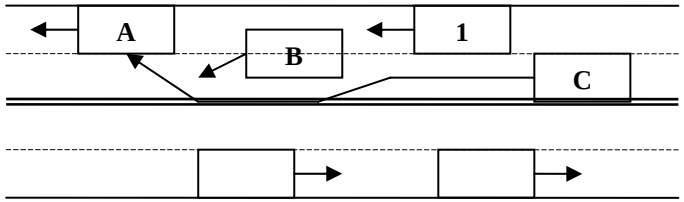
There are two factors contributing to B's misjudgement of the time gap.
Firstly, B does not expect A to suddenly brake so hard and therefore the genotype *expectance of certain behaviours* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

The second factor contributing to B's misjudgement of the time gap is that B is stressed. Therefore the genotype *psychological stress* is chosen.

B being stressed is caused by time pressure. Therefore the genotype *time pressure* is chosen.

B experiencing time pressure is caused by her being late for work. Therefore the specific genotype *being late* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

Scenario 3 (leaving lane accident)

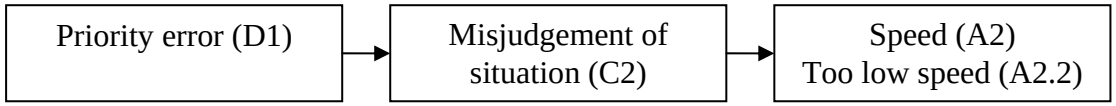


Driver A
A is driving on a motorway with a 110 km/h speed limit. It is late afternoon and A has just picked up his car at a garage where the chassis had been coated to resist rust. To avoid getting dust and dirt in the new coating A drives with a top speed of 50 km/h (which is also supported by other evidence at the scene). A drives as far to the right as he can, without crossing the white line painted on the tarmac. Suddenly – completely unexpected – A's left side is hit by C. A loses control over the car and drives down a slope to the right of the road. A stops against a bank of soil. Straight after the accident A does not understand what really happened.
Driver: 38-year old man (has had a driving licence for 20 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Volvo in good condition
Traffic environment: Motorway with a 110 km/h speed limit, late afternoon with dark but clear weather

Driver B
B is driving 100-110 km/h when he approaches a vehicle which he judges to drive approximately 80 km/h. In the rear mirrors B sees the head lights from a vehicle behind him. B does, however, judge the vehicle to be so far behind that he can start to overtake the slow vehicle in front of him. B cannot recall that there was any vehicle right behind him (position 1). B indicates to change lane and starts the overtaking. Suddenly, B sees C cut in front of him and drive into the left side of A. B brakes and stops his car at the road side.
Driver: 29-year old man (has had a driving licence for 10 years), was not in a hurry or distracted but has, during the previous week, slept worse than normal because of night duty, was not under the influence of alcohol, drugs or medication
Vehicle: Opel in good condition
Traffic environment: Motorway with a 110 km/h speed limit, late afternoon with dark but clear weather

Driver C
C is driving 100-110 km/h when he discovers a car queue in front of him. C judges the queue to drive quite fast – but slower than him. C changes to the left lane in order to overtake the queue. Suddenly B pulls out in front of C in the left lane. C has not seen B indicate to change lane and judges the distance to B to be between three to four car lengths. C judges it being impossible to slow down enough not to drive into the rear end of B and therefore he overtakes B by using the left shoulder. When C has nearly passed B he gets a skid and loses control over the car. C cuts in front of B and drives into A's left side. C then manages to stop his car on the right shoulder.
Driver: 66-year old man (has had a driving licence for 48 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Ford in good condition which he has had as a company car – before that he had another car of the same brand
Traffic environment: Motorway with a 110 km/h speed limit, late afternoon with dark but clear weather

Scenario 3 (leaving lane accident)
Driver A

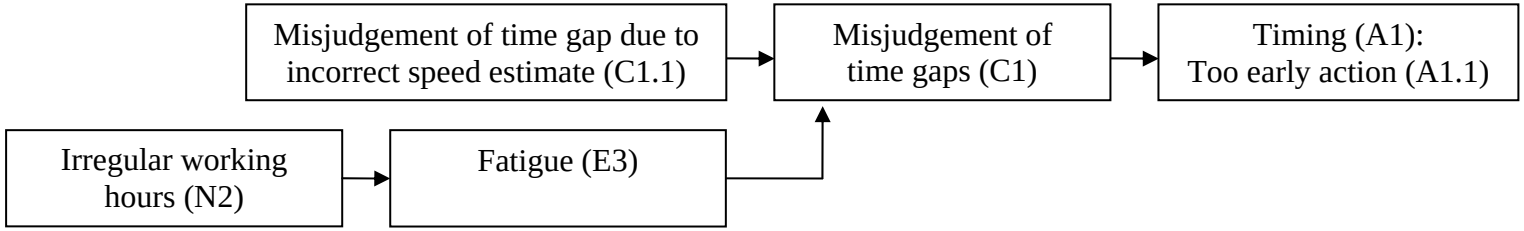


The phenotype is chosen when A decides to drive in 50 km/h on a motorway with a 110 km/h speed limit. As A drives slower than what can be expected by other drivers the phenotype *speed: too low speed* is chosen.

The cause behind A driving so slow is that A misjudges the situation thinking it is safe to drive 50 km/h on a motorway with a 110 km/h speed limit. Therefore the genotype *misjudgement of situation* is chosen.

A's misjudgement of the situation is caused by him choosing to drive slowly to protect his new coating on the chassis rather than keeping to the traffic rhythm – as he thinks both options are safe. Therefore the genotype *priority error* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

Scenario 3 (leaving lane accident)
Driver B



The phenotype is chosen when B leaves his own lane in order to overtake A. As B enters the lane next to him before C has safely passed the phenotype *timing: too early action* is chosen.

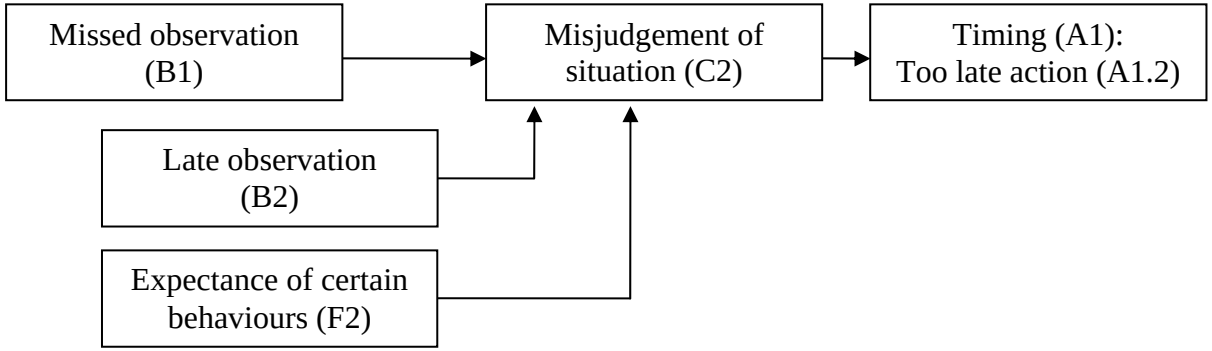
The cause behind B leaving his lane too early is that he misjudged the gap to C approaching from behind. Therefore the genotype *misjudgement of time gaps* is chosen.

There are two factors contributing to B's misjudgement of the time gap.
Firstly, B underestimates the time gap available until C will reach him (which is easily done when looking in the rear mirror) and therefore the specific genotype *misjudgement of time gap due to incorrect speed estimate* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

The second factor contributing to B's misjudgement of the time gap is that B is tired after having slept worse than normal. Therefore the genotype *fatigue* is chosen.

B having slept worse than normal is caused by him having night duty. Therefore the genotype *irregular working hours* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.

Scenario 3 (leaving lane accident)
Driver C



The phenotype is chosen when, there is no longer any time/space left for C to act in order to avoid the accident. As B reacts too late to avoid an accident, the phenotype *timing: too late action* is chosen.

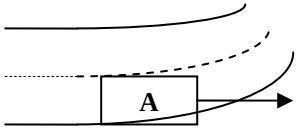
The cause behind reacting too late is that C thought it was safe to pass the car queue. Therefore the genotype *misjudgement of situation* is chosen.

There are three factors contributing to C's misjudgement of situation.
Firstly, C does not see B indicating to change lane and therefore the genotype *missed observation* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

The second factor contributing to C's misjudgement of the situation is that C suddenly sees B change lane - too late to avoid an accident. Therefore the genotype *late observation* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

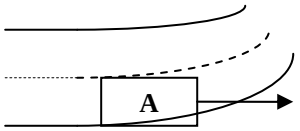
The third factor contributing to C's misjudgement of the situation is that it is reasonable to assume that C does not expect B to suddenly change lane right in front of him. Therefore the genotype *expectance of certain behaviours* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops

Scenario 4:1 (leaving lane accident)



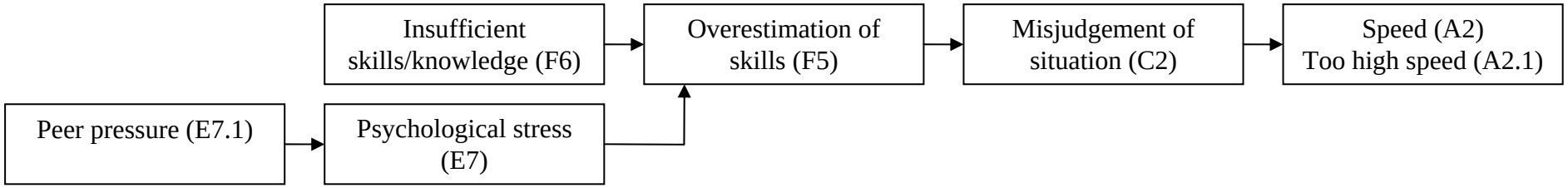
Driver A
A is driving 130 km/h on a road with a 70 km/h speed limit (that the speed was high is also supported by other evidence at the scene). A is on his way to a party but states that he is not in much of a hurry. There are four passengers (males in the same age of the driver) in the car. When A enters a sharp curve he gets a skid. A tries to control the skid but fails. A ends up, upside down in a ditch.
Driver: 19-year old man (has had a driving licence for 1 year), was not tired and states that he was not distracted by his passengers, was not under the influence of alcohol, drugs or medication
Vehicle: Older Volvo in good condition
Traffic environment: Rural road in normal condition with a 70 km/h speed limit

Scenario 4:I1 (leaving lane accident)



Driver A
A is driving 130 km/h on a road with a 70 km/h speed limit (that the speed was high is also supported by other evidence at the scene). When A enters a sharp curve, which is incorrectly cambered and the surface is covered in gravel, he gets a skid. A tries to control the skid but fails. A ends up, upside down in a ditch.
Driver: 19-year old man (has had a driving licence for 1 year), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Older Volvo in good condition
Traffic environment: incorrectly cambered curve on a 70km/h-road. The surface in the curve was covered with gravel.

Scenario 4:I (leaving lane accident)
Driver A



The phenotype is chosen when A leaves his own lane. As A drives too fast to take the curve under the prevailing conditions, the phenotype *speed: too high speed* is chosen.

The cause behind A driving too fast is that A misjudges the situation thinking it is safe to enter the curve in that speed. Therefore the genotype *misjudgement of situation* is chosen.

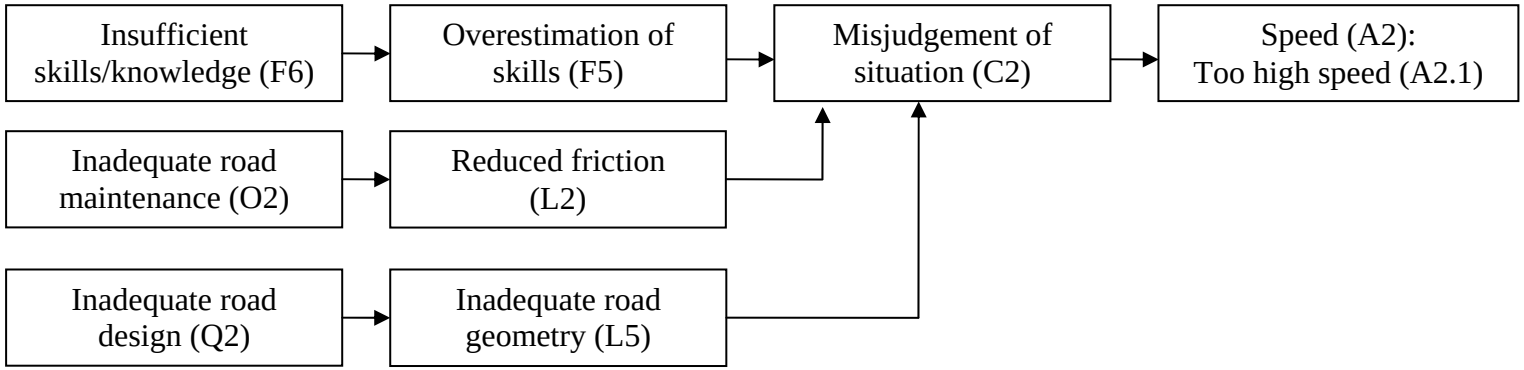
A's misjudgement of the situation is caused by A overestimating his own skills thinking he can handle the car in that speed. Therefore the genotype *overestimation of skills* is chosen.

There are two factors contributing to A's overestimation of his own skills.
Firstly, A has only had his driving licence for one year and has not enough skills and knowledge in order to handle the situation safely and therefore the genotype *insufficient skills/knowledge* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

The second factor contributing to A's overestimation of his own skills is that A is stressed. Therefore the genotype *psychological stress* is chosen.

C's stress is caused by him having several male passengers in his own age. Therefore the specific genotype *peer pressure* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

Scenario 4:II (leaving lane accident)
Driver A



The phenotype is chosen when A leaves his own lane. As A drives too fast to take the curve under the prevailing conditions the phenotype *speed: too high speed* is chosen.

The cause behind A driving too fast is that A misjudges the situation thinking it is safe to enter the curve in that speed. Therefore the genotype *misjudgement of situation* is chosen.

There are three factors contributing to A's misjudgement of the situation.
Firstly, A overestimating his own skills thinking he can handle the car in that speed and therefore the genotype *overestimation of skills* is chosen.

A's overestimation of his own skills is caused by A only having had his driving licence for one year and therefore not having enough skills and experience in order to handle the situation safely. Therefore the genotype *insufficient skills/knowledge* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

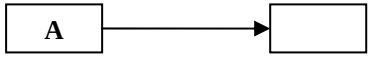
The second factor contributing to A's misjudgement of the situation is the gravel covering the tarmac resulting in poor friction. Therefore the genotype *reduced friction* is chosen.

The reduced friction is caused by the fact that no one has removed the gravel from the road. Therefore the genotype inadequate road maintenance is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

The third factor contributing to A's misjudgement of the situation is the curve being incorrectly cambered. Therefore the genotype *inadequate road geometry* is chosen.

The incorrect camber is caused by a poor road design. Therefore the genotype *inadequate road design* is chosen.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

Scenario 5 (unintended acceleration)



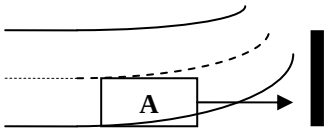
Driver A
A has just been shopping and gets into the car to drive home. A starts the car to turn out of a narrow parking space. To lower (the already low) speed A presses the brake. Instead of slowing down the car accelerates and therefore A presses the brake pedal to the floor. According to A something must be wrong with the brake because when she presses it to the floor the speed quickly increases and A drives into a parked car. After the accident A steps out of the car and could be interviewed. Nothing suggests that A was ill or has had some kind of seizure.
Driver: 67-year old woman (has had a driving licence for 45 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Newer Toyota which she has had for 6 months, the vehicle has automatic gear change and is in good condition. No failures were found on the brake- and fuel-systems.
Traffic environment: Fairly narrow parking space

Scenario 5 (unintentional acceleration)
Driver A

Object (A6): Adjacent object (A6.1)

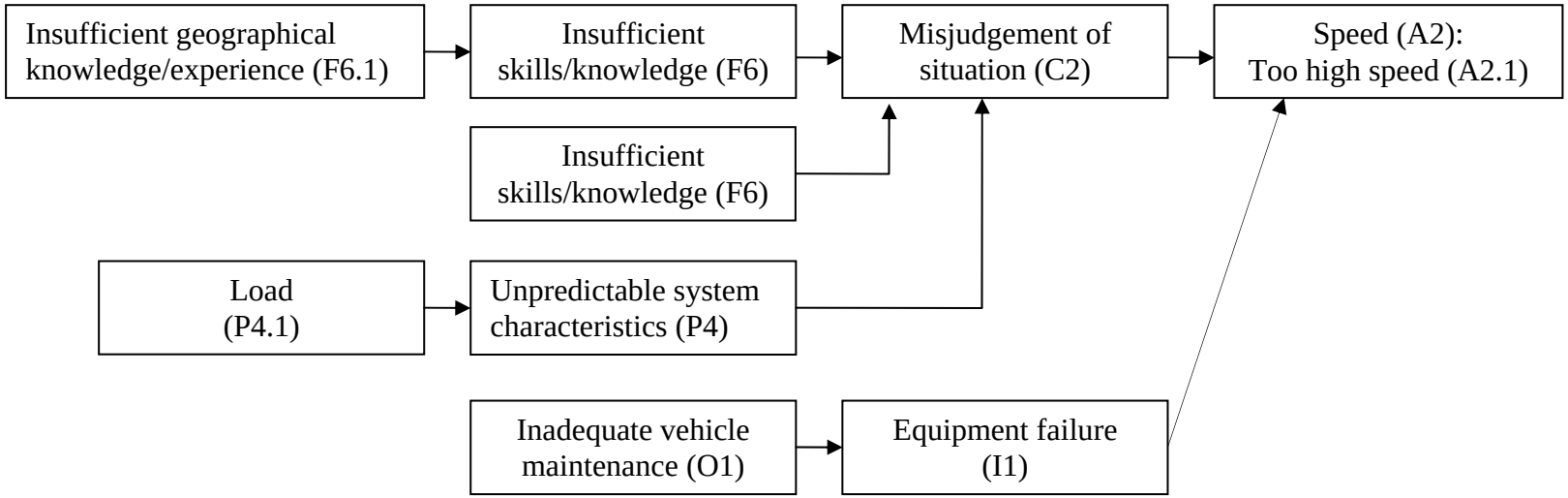
The phenotype is chosen when A presses the wrong pedal. As A presses the acceleration pedal, instead of the brake pedal, the phenotype *object: adjacent object* is chosen.
The analysis then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

Scenario 6 (leaving lane accident)
This example is based on an accident described by Leplat and Rasmussen (1987, p. 159).



Driver A
A is a lorry driver and is preparing a delivery. As A's usual lorry is at the garage he picks up a replacement lorry, which is unfamiliar to him. The borrowed lorry is somewhat smaller than the one A normally drives and its brake system has not been properly maintained (but A is unaware of this). The lorry is loaded with the cargo adapted to A's normal lorry which results in the borrowed lorry being somewhat overloaded. A leaves with his cargo but the route he normally takes is closed due to road repair. A takes a detour which turns out to have an unexpected long, steep and curvy slope downhill. A puts in a low gear and starts to brake. After a while A realises that the brakes are not working properly and the lorry catches speed. The speed is finally so high that the lorry continues straight ahead in a curve and hits a rock wall.
Driver 58-year old man (has been driving lorries for 38 years), was not tired or distracted, was not under the influence of alcohol, drugs or medication
Vehicle: Lorry with a badly maintained brake system
Traffic environment: Long, steep and curvy slope downhill.

Scenario 6 (leaving lane accident)
Driver A



The phenotype is chosen when A leaves his own lane. As A drives too fast to take the curve under the prevailing conditions the phenotype *speed: too high speed* is chosen.

There are two factors contributing to A entering the curve too fast.
Firstly, the brakes are not working properly and therefore the genotype *equipment failure* is chosen.

The equipment failure is caused by poor maintenance of the brakes. Therefore the genotype *inadequate vehicle maintenance* is chosen.
This accident-chain then stops in accordance with stop rule number 2:
If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops

The second factor contributing to A entering the curve too fast is that A misjudges the situation thinking he could safely drive the chosen route. Therefore the genotype *misjudgement of situation* is chosen.

There are three factors contributing to A's misjudgement of the situation.
Firstly, A does not have enough knowledge about the chosen route and therefore the genotype *insufficient skills/knowledge* is chosen.

A's insufficient knowledge about the route is caused by insufficient knowledge and experience of the chosen route. Therefore the specific genotype *insufficient geographical knowledge/experience* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

The second factor contributing to A's misjudgement of the situation is that A does not have enough knowledge about the lorry he borrowed resulting in him overloading it and also not being aware of the fact that the brakes had been poorly maintained. Therefore the genotype *insufficient skills/knowledge* is chosen once more.
This accident-chain then stops in accordance with stop rule number 3:
If none of the available general or specific genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.

The third factor contributing to A's misjudgement of the situation is that the brakes do not work as he expects. Therefore the genotype *unpredictable vehicle characteristics* is chosen.

The brakes not working as expected are caused by the lorry being overloaded. Therefore the specific genotype *heavy load* is chosen.
This accident-chain then stops in accordance with stop rule number 1:
Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.

7. REFERENCES

Englund, A., Jarleryd, B., Lindkvist, O., & Pettersson, H.-E. (1978). *TRKs haverikommission. Redovisning av försöksverksamhet* [Traffic Safety Committee of Insurance Companies: Research results]. TRK rapport nr 1. Stockholm, 1978.

Girard, Y. (1994, March). *In-depth accident investigation: A road safety tool.* Paper presented at the 1st Panhellenic Conference on Road Safety, Thessalonique, Greece.

Henrick, K., & Benner, L. (1987). *Investigating accidents with STEP*. New York: Marcel Dekker inc.

Hollnagel, E. (1998). *Cognitive Reliability and Error Analysis Method: CREAM.* Oxford, UK: Elsevier Science Ltd.

Hollnagel, E., & Woods, D. D. (2005). *Joint cognitive systems. Foundation of cognitive system engineering.* New York: CRC Press, Taylor and Francis Group.

Leplat, J., & Rasmussen, J. (1987). Analysis of human errors in industrial incidents and accidents for improvement of work safety. In J. Rasmussen, K. Duncan & J. Leplat, (Eds.), *New technology and human error* (pp. 157-168). New York: John Wiley and Sons Ltd.

Ljung, M. (2002). *DREAM: Driving Reliability and Error Analysis Method.* (Master's thesis). Retrieved December 10, 2007, from University of Linköping's web site: http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-2033

Ljung, M. (2006). *Manual for SNACS 1.1: SafetyNet Accident Causation System.* Gothenburg, Sweden: Chalmers University of Technology.

Ljung, M., Fagerlind, H., Lövsund, P. & Sandin, J. (2007). Accident investigations for active safety at chalmers: New demands require new methodologies. *Vehicle System Dynamics, 45,* 881–894.

Ljung, M., Furberg, B., & Hollnagel, E. (n.d.). *Handbok för DREAM 2.1*. [Manual for DREAM 2.1]

Svenson, O., Lekberg, A., & Johansson, A. E. L. (1999). On perspectives, expertise and differences in accident analyses: Arguments for a multidisciplinary integrated approach. *Ergonomics, 42,* 1561-1571.

Wallén Warner, H., Björklund, G., Johansson, E., Ljung Aust, M., & Sandin, J. (2008). *DREAM 3.0. Documentation of references supporting the links in the classification scheme.*

LINKING TABLE WITH GLOSSARY FOR PHENOTYPES (CRITICAL EVENTS) AND GENOTYPES (CAUSES)

PHENOTYPES (A)

General Phenotypes	Specific Phenotypes
Timing (A1)	Too early action (A1.1)
	Too late action (A1.2)
	No action (A1.3)
Speed (A2)	Too high speed (A2.1)
	Too low speed (A2.2)
Distance (A3)	Too short distance (A3.1)
Direction (A4)	Wrong direction (A4.1)
Force (A5)	Surplus force (A5.1)
	Insufficient force (A5.2)
Object (A6)	Adjacent object (A6.1)

See section *3.1.1. Phenotype choices* for further information about at which point in an accident scenario a phenotype should be chosen.

PHENOTYPES (A)

ANTECEDENTS (CAUSES)	CONSEQUENTS (EFFECTS)		
GENERAL Genotypes	**Definition of GENERAL Phenotypes**	**Definitions of SPECIFIC Phenotypes**	**Examples for SPECIFIC Phenotypes**
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Timing (A1)** The timing for initiating an action.	**Too early action (A1.1)** The action is initiated too early, before the signal is given or the required conditions are established.	*Intersection accidents* Starting from a stand still the driver passes the traffic light too early – before it has turned green. Starting from a stand still the driver passes the stop/give way sign too early - before the intersection is free. Starting from a stand still the driver enters the intersection too early - before the intersection is free (this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.* *Leaving lane accidents* The driver leaves his own lane in order to overtake the vehicle in front of him too early – before he has free visibility of a stretch of road long enough for him to complete the manoeuvre. *Changing lane accidents* The driver leaves his own lane in order to change lane too early - before the lane he is changing into is free.
		Too late action (A1.2) The action is initiated too late.	*Intersection accidents* The driver starts to brake too late in order to stop for the red traffic light. The driver starts to brake too late in order to stop in front of the stop/give way sign. The driver starts to brake too late in order to avoid entering the intersection before it is free (this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.*

Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**		***continuation*** **Too late action (A1.2)**	*Leaving lane accidents* The driver starts to brake and/or make an avoidance manoeuvre too late to avoid an accident when a car (e.g. making an overtaking manoeuvre) is coming towards the driver in his own lane. *Changing lane accidents* The driver starts to brake and/or make an avoidance manoeuvre too late in order to avoid an accident with the car changing into his lane. *Catching up accidents* The driver starts to brake and/or make an avoidance manoeuvre too late in order to avoid an accident with the slow driving/still standing car in front of him.
		No action (A1.3) No action is initiated.	*Intersection accidents* The driver passes the red traffic light without doing anything (e.g. does not brake in order to stop). The driver passes the stop/give way sign without doing anything (e.g. does not brake in order to stop). The driver enters the intersection without doing anything (e.g. does not brake in order to avoid entering the intersection before it is free; this is regardless of whether or not it is the driver's right of way). *NB! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.* *Leaving lane accidents* The driver does nothing (e.g. does not brake and/or make an avoidance manoeuvre to avoid an accident) when a car (e.g. making an overtaking manoeuvre) is coming towards the driver in his lane. *Changing lane accidents* The driver does nothing to avoid an accident with the car changing into his lane (e.g. the driver might not have seen the car in order to act).

		continuation **No action (A1.3)**	*Catching up accidents* The driver (e.g. caught in a car queue) does not do anything to avoid being hit from behind (this is regardless of whether or not he has the time and/or space to act). The driver does nothing to avoid an accident with the slow driving/still standing car in front of him (e.g. the driver might not have seen the car in order to act). The driver brakes softly in order to stop in time (for the traffic light, stop/give way sign, traffic in intersection or car queue in front) but does not make any manoeuvres in order to avoid being hit from behind.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Speed (A2)** The travelling speed.	**Too high speed (A2.1)** Driving too fast.	*Intersection accidents* The driver approaches the intersection faster then what can be expected by other drivers. *Leaving lane accidents* The driver approaches the meeting car (e.g. making an overtaking manoeuvre) faster then what can be expected by the overtaking driver. The driver drives too fast to take the curve, and stay within his own lane, under the prevailing conditions. *Changing lane accidents* The driver approaches the car changing lane faster then what can be expected by the lane changing driver. *Catching up accidents* The driver catches up with a slower car due to excessive speed.
		Too low speed (A2.2) Driving too slowly.	*Catching up accidents* The driver is caught up because he drives slower than what can be expected by other drivers.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Distance (A3)** The space between objects.	**Too short distance (A3.1)** The distance between the vehicle and other objects is kept too short.	*Catching up accidents* The driver keeps a too short distance to the car in front of him.

Appendix A: Linking table

Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Direction (A4)** The direction of the vehicle.	**Wrong direction (A4.1)** The manoeuvre is made in the wrong direction.	*Intersection accidents: Illegally turning etc.* The driver initiates an illegal left/right turn. *Leaving lane accidents* The driver leaves his own lane on a straight road or in a curve. *One-way lane/street accidents* The driver enters a lane or a one-way street against the traffic flow.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Force (A5)** The force with which an action is conducted.	**Surplus force (A5.1)** Too much force is used.	*Leaving lane accidents* The driver steers too hard resulting in him leaving his own lane. *Catching up accidents* The driver brakes harder (e.g. emergency braking) than what can be expected by other drivers.
		Insufficient force (A5.2) Too little force is used.	*Insufficient brake accidents* The driver does not brake hard enough to stop in time (this can also be caused by insufficient brakes).
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Object (A6)** An item or a control.	**Adjacent object (A6.1)** An item/control in close proximity of the correct item is wrongly chosen.	*Unintentional acceleration accidents* The driver mistakes the accelerator pedal for the brake pedal.

GENOTYPES (B-Q)

HUMAN (B-F)

Driver

B: Observation
Missed observation (B1)
Late observation (B2)
False observation (B3)

C: Interpretation
Misjudgement of time gaps (C1)
Misjudgement of situation (C2)

D: Planning
Priority error (D1)

E: Temporary Personal Factors
Fear (E1)
Inattention (E2)
Fatigue (E3)
Under the influence of substances (E4)
Excitement seeking (E5)
Sudden functional impairment (E6)
Psychological stress (E7)

F: Permanent Personal Factors
Permanent functional impairment (F1)
Expectance of certain behaviours (F2)
Expectance of stable road environment (F3)
Habitually stretching rules and recommendations (F4)
Overestimation of skills (F5)
Insufficient skills/knowledge (F6)

TECHNOLOGY (G-M)

Vehicle (G-I)

G: Temporary HMI* problems
Temporary illumination problems (G1)
Temporary noise problems (G2)
Temporary sight obstructions (G3)
Temporary access limitations (G4)
Incorrect ITS-information (G5)

H: Permanent HMI* problems
Permanent illumination problems (H1)
Permanent sound problems (H2)
Permanent sight obstruction (H3)

I: Vehicle equipment failure
Equipment failure (I1)

Traffic environment (J-M)

J: Weather conditions
Reduced visibility (J1)
Strong side winds (J2)

K: Obstruction of view due to object
Temporary obstruction of view (K1)
Permanent obstruction of view (K2)

L: State of road
Insufficient guidance (L1)
Reduced friction (L2)
Road surface degradation (L3)
Object on road (L4)
Inadequate road geometry (L5)

M: Communication
Inadequate transmission from other road users (M1)
Inadequate transmission from road environment (M2)

ORGANISATION (N-Q)

Organisation

N: Organisation
Time pressure (N1)
Irregular working hours (N2)
Heavy physical activity before drive (N3)
Inadequate training (N4)

O: Maintenance
Inadequate vehicle maintenance (O1)
Inadequate road maintenance (O2)

P: Vehicle design
Inadequate design of driver environment (P1)
Inadequate design of communication devices (P2)
Inadequate construction of vehicle parts and/or structures (P3)
Unpredictable system characteristics (P4)

Q: Road design
Inadequate information design (Q1)
Inadequate road design (Q2)

**HMI: Human-Machine-Interface*

OBSERVATION (B)

Observation includes detection as well as recognition of information that should have been the start of an action.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Fear (E1)	**Tunnel vision (B1.1)** The driver's peripheral vision is limited.	When the driver experiences high speed, the peripheral vision diminishes from 180 degrees to as little as 20-30 degrees thus reducing awareness of, or possibility to detect, objects to the side of the road.	**Missed observation (B1)** Some information (signal, sign or event) is missed. The reason for this can either be that the information is hidden (e.g. behind something) or that it is not noticed by the driver (e.g. as the driver predicts that the driver coming from the left will give way he does not look that way).
Inattention (E2)			
Fatigue (E3)			
Under the influence of substances (E4)			
Sudden functional impairment (E6)			
Psychological stress (E7)			
Permanent functional impairment (F1)			
Expectance of stable road environment (F3)			
Insufficient skills/knowledge (F6)			
Temporary illumination problem (G1)			
Temporary sound problems (G2)			
Temporary sight obstruction (G3)			
Permanent illumination problem (H1)			
Permanent sound problems (H2)			
Permanent sight obstruction (H3)			
Equipment failure (I1)			
Reduced visibility (J1)			
Temporary obstruction to view (K1)			
Permanent obstruction to view (K2)			
Inadequate road geometry (L5)			
Inadequate transmission from other road users (M1)			
Inadequate transmission from road environment (M2)			

Fear (E1) **Inattention (E2)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Psychological stress (E7)** **Permanent functional impairment (F1)** **Expectance of stable road environment (F3)** **Insufficient skills/knowledge (F6)** **Temporary illumination problem (G1)** **Temporary sound problems (G2)** **Temporary sight obstruction (G3)** **Permanent illumination problem (H1)** **Permanent sound problems (H2)** **Permanent sight obstruction (H3)** **Equipment failure (I1)** **Reduced visibility (J1)** **Temporary obstruction to view (K1)** **Permanent obstruction to view (K2)** **Inadequate road geometry (L5)** **Inadequate transmission from other road users (M1)** **Inadequate transmission from road environment (M2)**	**Tunnel vision (B2.1)** The driver's peripheral vision is limited.	When the driver experiences high speed, the peripheral vision diminishes from 180 degrees to as little as 20-30 degrees thus reducing awareness of, or possibility to detect, objects to the side of the road.	**Late observation (B2)** The observation of some information (signal, sign or event) is correct but late, i.e. when the observation is made there is insufficient time to act in an optimal way (e.g. brake to avoid a collision).
Inattention (E2) **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Psychological stress (E7)** **Permanent functional impairment (F1)** **Temporary illumination problem (G1)** **Temporary sound problems (G2)** **Temporary sight obstruction (G3)** **Equipment failure (I1)** **Reduced visibility (J1)**	**None defined**		**False observation (B3)** Some information (object, signal, sign or event) is misunderstood / misinterpreted as something else (e.g. the driver mistakes a motorcycle for a moped or thinks it is green because of looking at the wrong traffic light).

Appendix A: Linking table

INTERPRETATION (C)

Interpretation includes, for all but novice drivers, quick and automated (routine) procedures where typical situations and their associated actions are recognized and acted upon (script choice). Mistakes in interpretation occur at the sharp end - within the local event horizon.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Late observation (B2) **False observation (B3)** **Inattention (E2)** **Fatigue (E3)** **Under the influence of substances (E4)** **Psychological stress (E7)** **Permanent functional impairment (F1)** **Expectance of certain behaviours (F2)** **Habitually stretching rules and recommendations (F4)** **Overestimation of skills (F5)** **Insufficient skills/knowledge (F6)** **Incorrect ITS-information (G5)** **Reduced visibility (J1)** **Insufficient guidance (L1)** **Reduced friction (L2)** **Inadequate road geometry (L5)** **Inadequate transmission from road environment (M2)** **Unpredictable system characteristics (P4)**	**Misjudgement of time gap due to incorrect speed estimate (C1.1)** The driver misjudges the time gap due to a misjudgement of the approaching vehicle's speed.	*Intersection* The driver is waiting to cross a street and assumes that the approaching car is keeping the 50 km/h speed limit. The car is, however, approaching at 70 km/h and as a result the driver overestimates the time gap he has to the approaching car. *Overtaking* The driver is overtaking another car when he suddenly realise that he has underestimated the meeting car's speed and therefore also overestimated the available gap for the overtaking. *Catches up from behind* The driver is changing lanes when he suddenly realise that he has underestimated the speed of the car catching up from behind (in the lane he is changing into), and therefore he has also underestimated the available time gap. *Approaches from behind* The driver underestimates the time gap to the car in front of him because he overestimates its speed.	**Misjudgement of time gaps (C1)** The estimation of time gaps (e.g. time left to approaching vehicle, stop sign, traffic lights etc.) is incorrect. In order to misjudge a time gap the object (e.g. approaching vehicle, stop sign, traffic lights etc.) must have been observed!

Appendix A: Linking table

Missed observation (B1)	**None defined**		**Misjudgement of situation (C2)** The situation is misjudged (e.g. the driver thinks that it is safe to enter the intersection as he/she has not noticed the traffic lights turning red or the vehicle approaching).
Late observation (B2)			
False observation (B3)			
Priority error (D1)			
Inattention (E2)			
Fatigue (E3)			
Under the influence of substances (E4)			
Psychological stress (E7)			
Permanent functional impairment (F1)			
Expectance of certain behaviours (F2)			
Habitually stretching rules and recommendations (F4)			
Overestimation of skills (F5)			
Insufficient skills/knowledge (F6)			
Incorrect ITS-information (G5)			
Reduced visibility (J1)			
Insufficient guidance (L1)			
Reduced friction (L2)			
Road surface degradation (L3)			
Object on road (L4)			
Inadequate road geometry (L5)			
Inadequate transmission from road environment (M2)			
Unpredictable system characteristics (P4)			

PLANNING (D)

Planning includes fairly conscious and time consuming processes covering upcoming situations and eventualities beyond the local event horizon. Planning is a less frequent event than interpretation.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Fear (E1)	**None defined**		**Priority error (D1)** The driver prioritizes something else above safe arrival at the destination (e.g. uses the bus lane to save time or drives very fast to impress friends).
Excitement seeking (E5)			
Psychological stress (E7)			
Habitually stretching rules and recommendations (F4)			

TEMPORARY PERSONAL FACTORS (E)

Temporary personal factors includes temporary, or short-term, factors influencing driver's perception, interpretation, planning etc.

ANTECEDENTS			CONSEQUENTS)
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Sudden functional impairment (E6)	**Previous experience (E1.1)** The driver has previously experienced a similar traffic situation in which it was a negative outcome.	The driver is anxious about a particular situation due to previous bad experience or accident.	**Fear (E1)** Being afraid of something or being scared by a sudden event (e.g. the lead vehicle making an emergency brake or an animal jumping onto the road in front of you).
Under the influence of substances (E4) **Inadequate design of driver environment (P1)**	**Driving-related distracters inside vehicle (E2.1)** The driver is distracted by a driving-related object or event inside the vehicle.	The driver focuses his attention on the instructions given by a navigation system.	**Inattention (E2)** Any condition, state or event that causes the driver to pay less attention than required for the driving task.
	Driving-related distracters outside vehicle (E2.2) The driver is distracted by a driving-related object or event outside the vehicle.	The driver focuses his attention on road signs or an animal standing dangerously close to the road.	
	Non driving-related distracters inside vehicle (E2.3) The driver is distracted by a non driving-related object or event inside the vehicle.	The driver speaks to a passenger or on the mobile phone.	
	Non driving-related distracters outside vehicle (E2.4) The driver is distracted by a non driving-related object or event outside the vehicle.	The driver looks at a friend walking past on the pavement.	
	Thoughts/Daydreaming (E2.5) The driver is distracted by his/her own thoughts – including thoughts about how to, for example, find the best route.	The driver daydreams, thinks about a personal problem or how to find the best route.	

Appendix A: Linking table

Under the influence of substances (E4) **Reduced visibility (J1)** **Time pressure (N1)** **Irregular working hours (N2)** **Heavy physical activity before drive (N3)** **Inadequate design of driver environment (P1)**	**Sleep disorders (E3.1)** The driver suffers from a sleep disorder.	The driver suffers from sleep apnoea syndrome, of which the symptoms are heavy snoring and sleep disturbance resulting in daytime sleepiness.	**Fatigue (E3)** Being sleepy, tired or exhausted (mentally or physically).
None defined	**Alcohol (E4.1)** The driver is under the influence of alcohol.	The driver's performance is impaired as a result of being influenced by alcohol.	**Under the influence of substances (E4)** Being affected by different sorts of substances.
	Drugs (E4.2) The driver is under the influence of non-prescribed drugs.	The driver's performance is impaired as a result of taking ecstasy.	
	Medication (E4.3) The driver is under the influence of prescribed drugs.	The driver's performance is impaired as a result of taking strong sedatives.	
None defined	**None defined**		**Excitement seeking (E5)** Looking for adrenaline-kicks (e.g. by driving in high speed)
None defined	**Epilepsy (E6.1)** The driver suffers an epileptic seizure.	The driver is unresponsive or unconscious due to an epileptic seizure.	**Sudden Functional Impairment (E6)** Sudden onset of functional impairment due to illness. Does not include different kinds of sleep disorders!
	Diabetes (E6.2) The driver suffers a critically low concentration of insulin in the blood.	The driver is sweating and shivering before becoming unconscious due to low concentration of insulin in the blood.	
	Stroke (E6.3) The driver suffers a stroke.	The driver is sweating and shivering before becoming unconscious due to a stroke.	
Fatigue (E3) **Reduced visibility (J1)** **Inadequate road maintenance (O2)**	**Peer pressure (E7.1)** The driver experiences stress due to peer pressure.	The driver is feeling stressed because the car is full of passengers he wants to impress.	**Psychological stress (E7)** Different mental factors putting a strain on the driver.
Time pressure (N1) **Irregular working hours (N2)** **Inadequate road design (Q2)**	**Stressful life events (E7.2)** The driver experiences stress due to stressful life events (e.g. receiving bad news, newly divorce, recent loss of a loved one).	The driver is experiencing stress as he has just filed for divorce.	

PERMANENT PERSONAL FACTORS (F)

Permanent personal factors includes permanent, or long-term, factors influencing driver's perception, interpretation, planning etc.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Reduced vision (F1.1)** The driver's ability is impaired due to reduced vision.	The driver finds it difficult to drive at night due to reduced vision.	**Permanent functional impairment (F1)** Permanent or long term, functional impairment due to, for example, ageing, chronic illness or injury.
	Reduced hearing (F1.2) The driver's ability is impaired due to reduced hearing.	The driver finds it difficult to hear another road user honking his horn due to reduced hearing.	
	Reduced motor skills (F1.3) The driver's ability is impaired due to reduced motor skills.	The driver finds it difficult to look around properly when reversing due to reduced mobility.	
	Reduced cognitive capacity (F1.4) The driver's ability is impaired due to reduced cognitive capacity.	The driver finds it difficult to make decisions in complex traffic environments due to reduced cognitive capacity.	
None defined	**None defined**		**Expectance of certain behaviours (F2)** Expecting other road users to behave in certain ways following praxis (e.g. brake gently, stop for stop signs and red-lights, give way when driving on a non-priority or minor road and comply with the speed limits). This expectancy is still present even if no other road users are in view (e.g. when approaching a blind corner drivers expect oncoming traffic to keep to their lane).
None defined	**None defined**		**Expectance of stable road environment (F3)** Expecting no changes to the road environment (e.g. no new road signs or roundabouts) on familiar roads.
None defined	**None defined**		**Habitually stretching rules and recommendations (F4)** Habitually stretching rules and recommendations (e.g. habitually speeding or not stopping at stop signs or red traffic lights) as previous performance has not resulted in any negative consequences

Under the influence of substances (E4) **Insufficient skills/knowledge (F6)**	**None defined**		**Overestimation of skills (F5)** Overestimating one's own driving skills (e.g. overestimating the speed in which one is able to keep control over the vehicle).
Inadequate training (N4)	**Insufficient geographical knowledge/experience (F6.1)** The driver has insufficient knowledge or experience about the local area.	The driver, who is a visitor from a country with left-hand traffic, ends up, by mistake, on the wrong side of the road in a country with right-hand traffic.	**Insufficient skills/knowledge (F6)** Lack of practical skills (e.g. having to look down in order to change gear) and/or theoretical knowledge (e.g. not knowing the give way rules or the meaning of a road sign).

TEMPORARY HMI PROBLEMS (G)

Temporary HMI problems include temporary, or short-term, problems with human-machine-interfaces related to the vehicle.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Equipment failure (I1)	**None defined**		**Temporary illumination problems (G1)** The light inside the vehicle is too strong (e.g. causing reflexes) or too weak (e.g. causing reduced colour vision).
Equipment failure (I1)	**None defined**		**Temporary noise problems (G2)** Noise levels surrounding the driver are too high (e.g. the driver cannot hear the sirens on the ambulance as music is played at high volume).
Equipment failure (I1)	**Dirty windows and/or dirty mirrors (G3.1)** Dirty windows or dirty mirrors obstruct the driver's view.	The driver cannot see the car ahead clearly because of dirt on the wind screen.	**Temporary sight obstruction (G3)** The view is temporarily obstructed.
	Luggage (G3.2) Luggage or other objects obstruct the driver's view.	The driver cannot see out of the rear window because of bags obstructing the view.	
	Passengers (G3.3) People or pets inside the vehicle obstruct the driver's view.	The driver cannot see out of the rear window because a tall passenger seated in the middle of the back seat obstructs the view.	
Equipment failure (I1)	**Temporary obstruction (G4.1)** Temporary obstruction makes it difficult for the driver to reach one or more items/controls in the driver environment.	The driver finds it difficult to reach the brake pedal because he did not adjust the seat before starting to drive.	**Temporary access limitations (G4)** Temporary problems for the driver to reach or find items/controls in the driver environment.
Equipment failure (I1) **Inadequate design of driver environment (P1)**	**None defined**		**Incorrect ITS-information (G5)** Information given by an ITS-device (e.g. navigation, speed-information) is ambiguous, incorrect or missing.

PERMANENT HMI PROBLEMS (H)

Permanent HMI problems include permanent, or long-term, problems with human-machine-interfaces related to the vehicle.

ANTECEDENTS			CONSEQUENTS)
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate design of driver environment (P1)	**Weak light (H1.1)** The light inside the vehicle is too weak.	The driver has difficulty seeing the speedometer as the illumination of the dashboard is too weak.	**Permanent illumination problems (H1)** The light, on e.g. the dashboard, is too strong (causing glare) or too weak.
Inadequate design of driver environment (P1)	**Low sound signal (H2.1)** The signals from different driver support systems inside the vehicle are too low.	The driver has difficulty hearing the warning signal of the speed warning device as the signal is too low.	**Permanent sound problems (H2)** The sound signals inside the vehicle are too high (causing startle) or too low.
Inadequate design of driver environment (P1)	**None defined**		**Permanent sight obstruction (H3)** The view is permanently obstructed by parts of the vehicle.

VEHICLE EQUIPMENT FAILURE (I)

Vehicle equipment failure includes failures of the vehicle or any equipment or system related to it.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate vehicle maintenance (O1)	**None defined**		**Equipment failure (I1)** Some piece of equipment (e.g. tyres, steering, brake system or lighting) does not perform as intended or does not work at all (because it has broken).
Inadequate design of communication devices (P2)			
Inadequate construction of vehicle parts and/or structures (P3)			

WEATHER CONDITIONS (J)

Weather conditions include reduced visibility and stability due to environmental factors.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Low sun (J1.1)** Low sun facing the driver makes it difficult to see.	The driver cannot see the brake lights on the car in front as the low sun is shining directly in his eyes.	**Reduced visibility (J1)** The visibility is reduced due to low sun, fog, darkness etc.
None defined	**Non defined**		**Strong side wind (J2)** The stability of the vehicle is affected by strong side wind

OBSTRUCTION OF VIEW DUE TO OBJECT (K)

Obstruction to view due to objects includes all temporary and permanent objects, in the traffic environment, obstructing the drivers' view.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Temporary obstruction of view (K1)** Objects (e.g. driven or parked vehicles, gatherings of people) in the traffic environment cause temporary obstruction of view.
Inadequate information design (Q1) **Inadequate road design (Q2)**	**None defined**		**Permanent obstruction of view (K2)** Objects (e.g. buildings, fences, signs, vegetation) in the traffic environment cause permanent obstruction of view.

STATE OF ROAD (L)

State of the road includes problems with the road itself and its surface as well as the friction between the surface and tyres.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate road maintenance (O2) **Inadequate road design (Q2)**	**None defined**		**Insufficient guidance (L1)** The road guidance (painted lane markings, cat's eyes, roadside reflectors etc.) is insufficient.
Equipment failure (I1) **Inadequate road maintenance (O2)** **Inadequate road design (Q2)**	**Low noise tarmac in rain (L2.1)** Low noise tarmac, that has become wet, makes the road surface very slippery.	The driver finds a road with low noise tarmac very slippery after a light drizzle.	**Reduced friction (L2)** The friction is reduced due to ice, snow, oil, gravel etc. on the road or due to bad tyres on the vehicle.
Inadequate road maintenance (O2) **Inadequate road design (Q2)**	**None defined**		**Road surface degradation (L3)** The road surface has degraded (e.g. have potholes or deep ruts). Does not include problems resulting in reduced friction!
Inadequate road maintenance (O2)	**Animals (L4.1)** Animals, dead or alive, are on the road.	The driver's progression is hindered by a dead badger lying in the middle of the road or wild dears crossing the road.	**Object on road (L4)** The road is partly, or completely, blocked by objects other than vehicles (e.g. stones, exploded tires, lost cargo, animals).
Inadequate road design (Q2)	**None defined**		**Inadequate road geometry (L5)** The road geometry (e.g. curves, camber, road shoulder) is inadequate.

COMMUNICATION (M)

Communication includes failures to transmit correct information from other road users or from the traffic environment to the driver.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate transmission from other road users (M1)** Other road users fail to transmit information (e.g. not using the indicator when turning) or the information transmitted is ambiguous or incorrect.
Inadequate information design (Q1)	**None defined**		**Inadequate transmission from road environment (M2)** The road environment fails to transmit information to the driver and/or the vehicle (e.g. traffic lights or transmitters to ITS systems are out of order, warning signs or signals are missing) or the information transmitted is ambiguous or incorrect.

ORGANISATION (N)

Organisation includes structures in social- or working life which might impede the private- or professional driver's driving performance.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Being late (N1.1)** Being late for a professional or private appointment makes the private driver experience time pressure.	The private driver experiences time pressure as he is late for work, nursery pick-up, a party or some other professional or private appointment.	**Time pressure (N1)** Private or professional obligations resulting in time pressure.
	Inadequate time schedule (N1.2) Working under tight time margins for pick-ups and deliveries makes the professional driver feel pressured to exceed the legal speed limit and/or the legal number of working hours.	The professional bus driver experiences time pressure as his time table is very tight.	
None defined	**Night shift (N2.1)** Working night shift forces the private driver to drive home during the circadian morning dip.	The private driver is driving home early in the morning after having worked at a hospital all night.	**Irregular working hours (N2)** Irregular working hours makes it difficult to follow the circadian rhythm.
	Scheduled night driving (N2.2) Night driving makes it hard for the professional driver to follow the circadian rhythm.	The professional truck driver drives all night in order to deliver his goods on time.	
None defined	**Heavy physical activity for private drivers (N3.1)** Heavy physical activity precedes the private driver's drive.	The private driver drives home after a heavy days work in the forest or after having participated in an important football match.	**Heavy physical activity before drive (N3)** Heavy physical activity or work before the private or professional driver's drive.
	Heavy physical work for professional drivers (N3.2) Heavy physical work precedes the professional driver's drive.	The professional driver drives after having performed heavy physical work in order to load his truck.	
None defined	**None defined**		**Inadequate training (N4)** Insufficient training to acquire the skills and knowledge needed for the task.

MAINTENANCE (O)

Maintenance includes maintenance of the vehicle as well as the traffic environment.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate vehicle maintenance (O1)** The vehicle, or parts of it (e.g. tyres, steering, brake system, lighting), has been inadequately or incorrectly maintained.
None defined	**None defined**		**Inadequate road maintenance (O2)** The road, or parts of it, has been inadequately or incorrectly maintained.

VEHICLE DESIGN (P)

Vehicle design includes problems with the design of one or more parts of the vehicle.

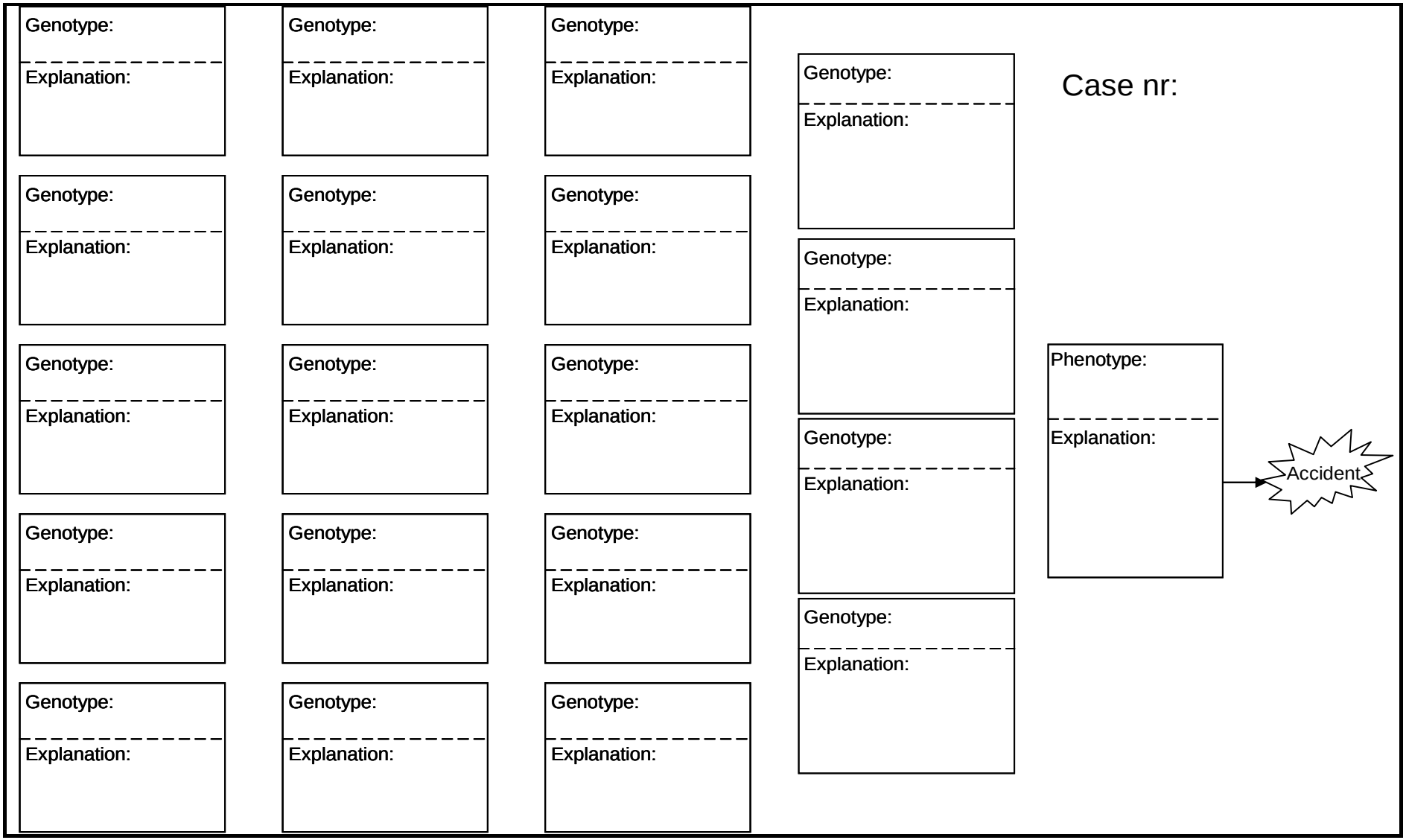
ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate design of driver environment (P1)** One or more parts of the driver environment are inadequately designed from an HMI (*Human-Machine-Interface*) or ergonomic point of view (e.g. ITS-system is very distracting, driver's seat is hard to adjust, pillar obstructs the view).
None defined	**None defined**		**Inadequate design of communication devices (P2)** One or more of the communication devices (e.g. indicators, brake lights, reverse lights) are inadequately designed.
None defined	**None defined**		**Inadequate construction of vehicle parts and/or structures (P3)** The vehicle has been insufficiently built or the construction has been insufficiently considered resulting in suboptimal performance (e.g. poor road friction, large steering radius, limited braking power, insufficient head light) or complete equipment failure (e.g. balks breaking, seats becoming loose, head lights failing).
None defined	**Load (P4.1)** Heavy load makes the vehicle behave unpredictably.	The driver experiences the car behaving unusually (e.g. under steering) when the boot is heavily loaded.	**Unpredictable system characteristics (P4)** The characteristics of the vehicle become unpredictable under certain circumstances (e.g. a vehicle that is normally under-steered might become over-steered when taking sharp curves in high speed).

ROAD DESIGN (Q)

Road design includes problems with the design of road information or the road itself.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate information design (Q1)** The design of the traffic guidance or control is inadequate (e.g. road signs are too many, ambiguous or inappropriately placed, traffic lights are inappropriately timed or inappropriately placed; lines on the tarmac supporting stop/give way signs or traffic lights are inappropriately placed).
None defined	**None defined**		**Inadequate road design (Q2)** The planning and/or the construction of the road are inadequate (e.g. inadequate road surface, curve, camber, road shoulder, vertical/ horizontal alignment or inadequately placed guard rails).

Appendix B: Linking Template



Comments: