Tool for the determination of influence parameters on the accident emergence during the pre-crash phase as an enhancement of the Accident Causation Analysis System ACAS

Pund, B.[1], Jänsch, M.[2], Otte, D.[2]
[1] *TÜV Technische Überwachung Hessen GmbH, Life Service*
[2] *Accident Research Unit, Hannover Medical School*

Introduction

The method of causation analysis applied under the German accident survey GIDAS, which is based on Accident Causation Analysis System (ACAS) focuses on an on-scene data collection of predominantly directly event-related causation factors which were crucial in the accident emergence as situational resulting events and influences. The paradigm underlying this method refers to the findings of the psychological traffic accident research that most causally relevant features of the system components human, infrastructure and vehicle technology are found directly in the situation shortly before the accident.
This justifies the survey method which is conducted directly at the accident (on-scene), shortly after the accident occurrence (in-time) with the detection of human-related causes (in-depth). Human aspects of the situation analysis that interact and influence the risk situations shortly before the collision are reported as errors, lapses, mistakes and failures in ACAS in specific categories and sub-categories. Thus methodically ACAS is designed primarily for the collection of accident features on the level of operational action, which certainly leads to valid findings and behavioral causes of accidents. The enhancement by means of Moderating Conditions concerns the pre-crash phase in different levels: strategical, tactical and operational.

Accident Moderating Conditions as influence factors

Overlasting influence factors which are temporally active before the accident and which themselves are not a direct cause of the accident, however, which play an indirect, rather moderating role in the accident occurrence, are only marginally detected by ACAS, which focuses on the situational factors within the conflict phase. Examples are the existence of perceptual debilitating symptoms due to distraction or the influence of human affective situations such as sensation of stress. Such influences have existed for some time before the accident and do not represent a necessary condition for the occurrence of the accident, but can in the immediate conflict situation play a crucial role, as they affect the availability of human functions such as attention attitude.
Even technical or infrastructural deficiencies or organizational errors are often present in time far before the accident, but in the immediate conflict phase result in an additional destabilization of the system with the result of an increase in the probability of the occurrence of the accident, where they come to effect only in the interaction with situational features.

This rather invariant influences are present before the accident as moderating conditions, while the causation factors described in ACAS appear more situational and with higher variability. This applies especially to human behavior, where antecedent conditions are not fully covered with the previous methodology.
Therefore, an extended approach to the accident causation analysis was developed that not only takes into account the "final state" with the situational characteristics, but also records enduring characteristics which were active in time far before the accident. Although isolated these characteristics are not considered causative, they have however influenced the accident occurrence in a reinforcing manner. Such moderating conditions at the level of human behavior are for example attitudinal and motivation-related personal characteristics such as adaptability, risk tolerance and aggression. Another class of in time preceding or strategic planning errors that are only effective at the time of the accident, refer to the human-machine interface (for example, incorrect attachment of a trailer which shows effect only in the conflict situation shortly before the accident).
This study deals with the presentation of such moderating conditions and displays the possibilities and limitations to make these factors accessible for an accident analysis as an addition to the data from ACAS.

Development of Accident Moderating Conditions (AMOC)

Two classes of models with different backgrounds and purposes have become useful in distinguishing between different driving tasks and respective driver information processing activities. One class is in the tradition of the attempt to model driver behavior as a hierarchical task (JOHANNSEN 1976, JANSSEN 1979), the other has been developed by RASMUSSEN (1983) in the context of supervisory control tasks. Several authors have attempted to combine these models (e.g. PARKES 1989, HALE et al 1990).

The general plans from the strategic level have to be transformed into controlled patterns of action. Behavior at this manoeuvring level is mainly rule-based, i.e. it follows learned “if-then” rules. The driver e.g. decides to overtake and retrieves the necessary information about the actions for that manoeuvre from long-term memory. Finally, on the control level of driving, strongly habitualized action patterns dominate the behavior. Actions on that level are quick, efficient and can be taken without great subjective effort. They are called skills and they don’t afford conscious attentional control by the driver. For an experienced driver, examples of skills are using the steering wheel, clutch, brake etc.

Level	Strategical	Tactical	Operational
Human related organizational conditions	e.g. bad driving education e.g. driving in darkness despite reduced contrast eyesight	e.g. poor management concerning drinking and driving e.g. false attachment of trailer to vehicle e.g. driving despite lack of sleep	e.g. dysfunctional DAS (ACAS)
Human functional conditions	e.g. high potential of aggression e.g. restricted driving ability by dementia e.g. general non-acceptance of traffic rules	e.g. aggressive driving due to irritation e.g. risky driving to impress others e.g. deliberate red light violation	e.g. distraction (ACAS)

Figure 1: Accident moderating conditions concerning the 3 levels of driving tasks (examples).

The enhancement of the accident causation analysis concerns the consideration of factors that are effective during the pre-crash phase. The data collected by ACAS provide more immediate / direct factors from the phase of the traffic conflict, whereas the enhanced approach considers those features which precede temporally and represent a more general factor in the accident development. These factors relate to the strategic or tactical level, whereas the level of direct operations are covered by the ACAS parameters during the conflict phase (see figure 1). The question is, which over lasting factors, mostly human, contribute to the emergence of an accident and make the accident occurrence more likely. Even though these unspecific conditions cannot be regarded as direct accident causes they can be effective as additional risk factors, which show their influence in an instable and ambiguous conflict situation. They can be described as hidden immanent hazards, situated mostly on the strategic level. These indirect antecedent features are effective as accident moderating conditions (AMOC) at the accident origin and primarily represent enduring characteristics in the human system component. These are mostly safety related attitudes and inappropriate personality factors such as impulsivity, general hostility towards others, bad self-control and positive attitude towards excessive speeding. Well known are empiric findings that indicate a high correlation between traffic accidents and biographical data of the person that is involved in an accident (e.g. the number of previous violations of traffic rules and the number of previous accidents). Moreover international findings emphasize the influence of certain personal disorders on hazardous behavior in traffic and on high risk of accident emergence, like the borderline disorder and the dissocial disorder (Rößger et al, 2001; Schade, 2005; Junger et al, 2001; Dahlen et al., 2005; Banse, 2013; Sarma et al, 2013).

As "sleepers in the background" such moderating conditions show their effects only in interaction with situational conditions and will only be effective in traffic conflict situations certain driving tasks need to be accomplished and/or instable vehicle dynamics. Those "sleepers" also affect the

availability or provision of necessary human functions, by suppressing e.g. orientation reactions or avoidance reactions.

Examples for causation factors	Methods of investigation
Inclination to aggression Arousal of anger / irritation Hostility towards other road users	➢ Observed aggressive action (by witnesses) ➢ Self reported aggressive behaviour (in interview) ➢ Aggressive interaction during interview ➢ Findings by retrospective questionnaire
Hypoglycemia (diabetes)	➢ Self reported prodroms and symptoms ➢ (Self) reported diagnosis ➢ Findings by retrospective questionnaire ➢ Interview of doctors ➢ Access to clinical reports

Figure 2: Examples for accident moderating conditions and possibilities of identification in the scope of accident investigation.

With the help of two examples from the human system component (figure 2) possible data sources and the possibilities of identifying hidden immanent hazards in the field of personality and traffic-relevant diseases are displayed (inclination to aggression and diabetes). Although accident moderating conditions are more difficult to identify than ACAS data, indicators for the presence of such indirect effective causation factors that can be identified in the scope of in-depth accident data collection.

If we take into account such clinical, psychological and organizational data of the “history of an accident” we come much closer to the idea of an in-depth analysis in real-world accident scenarios.

Literature

BANSE R. 2012, Aggressivität, Straftaten und Fahreignung: Empirische Zusammenhänge und Implikationen für die Fahreignungsbegutachtung. Zeitschrift für Verkehrssicherheit, 3, 119-123.

DAHLEN E.R., MARTIN R.C., RAGAN K., KUHLMANN, M.M. 2005, Driving anger, sensation seeking, impulsiveness and boreddom proneness in the prediction of unsafe driving. Accident Analysis and Prevention, 37 (2), 341-348.

JUNGER M., WEST R., TIMMAN R. 2001, The relation between crime and risky behavior in traffic. Journal of research in crime and delinquency, 38, 439-459.

HALE A.R., STOOP J. & HOMMELS J. 1990, Human error models as predictors of accident scenarios for designes in road transport systems. Ergonomics, 33, 1377-1388.

JOHANNSEN G. 1976, Preview of man-vehicle control session. In: SHERIDAN T.B. & JOHANNSEN G. (Ed.): Monitoring Behaviour and Supervisory Control. New York: Plenum Press.

PARKES A. 1989, Changes in driving behaviour due to two models of route guidance information presentation: a multi—level—approach. Drive Project V 1017 (BERTIE), Report No. 21.

RASMUSSEN J. 1986, Information processing and human-machine interaction. Amsterdam, Elsevir.

REASON J. 1990, Human Error. Cambridge University Press.

RÖSSGER L., SCHADE J., SCHLAG B.-J., GEHLERT T. 2011, Verkehrsregelakzeptanz und Enforcement. Forschungsbericht W06, Berlin: Gesamtverband der deutschen Versicherungswirtschaft e. V.

SARMA K.M., CAREY R.N., KEVICK A.A., BIMPEH Y. 2013, Psychological factors associated with indices of risky reckless and cautious driving in a national sample of drivers in the Republic of Ireland. Accident Analysis and Prevention, 50, 1226-1235.

SCHADE F. 2005, Lebt gefährlich, we rim Verkehrszentralregister steht? Das Verkehrszentralregister als Prädiktor habituellen Verkehrsrisikos. Zeitschrift für Verkehrssicherheit, 1, 7-13.