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A support tool for identifying evaluation issues of road safety measures

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Abstract

The introduction of new technologies in traffic produces a range of unknown deviations in the desired traffic process. These developments require additional ex-ante assessment procedures for measures which will be implemented in the traffic system. In this paper, the HAZOP methodology is applied to road traffic measures to provide scenarios based upon predicted deviations and problems with new, mainly in-vehicle technologies. To make HAZOP applicable for road safety purposes analysis of the expectations of road users is added to the traditional approach. In this paper, some results are shown for speed reduction measures. The dependency of the results on the membership of the HAZOP team and especially the question if a mixture of expertise is required are also discussed.

Keywords: Road safety; Ex ante evaluation; New technologies; Policy making

1. Introduction

The HAZOP technique has long been used in the chemical industry for assessing designs In recent years its area of application has increasingly been extended to other industries and technologies. In the Safety Science Group in Delft these applications have included road maintenance work, tunnel building and more recently driving [e.g. 1, 2]. This paper describes the approach taken in the last area and the results which have been achieved in assessing the potential safety effect and effectiveness of both conventional road features, such as speed humps, and new technologies, such as intelligent speed adaptation (ISA).

This study forms part of a larger doctoral research into the proactive assessment of intended and unintended effects on safety of proposed new technology (both in-car and roadside).

2. Need for proactive safety assessment in traffic

The use of ICT (Information and Communication Technology) based technology in vehicles has been increasing since the 1980s [e g., 3]. Whereas the first applications were mainly based on providing various sources of information to drivers (e.g. RDC-TMC for regional traffic information and navigation systems), nowadays systems are on the market that are able to influence driving tasks directly. An example is adaptive cruise control (ACC), a system designed to keep a minimum headway to a vehicle in front. Although car manufactures sell these systems as so-called ‘comfort extensions’ functional safety problems might occur when using these systems. Furthermore the systems might influence one’s driving behaviour and through this the safety of the traffic system as a whole. Jagtman et al. [4] discussed the current knowledge on safety effects of ACC-like systems. They showed a gap in the types of effects that were incorporated in safety studies of these systems. The ex-ante studies performed covered safety problems relating to the desired process that was defined for a system (e.g. keeping a safe headway), but often did not deal with safety problems resulting from deviations from the desired process, such as malfunctioning of the system or driver adaptation.

Recently, Carsten and Nilsson [5] have argued that a generic safety assessment for driver warning and vehicle control systems is lacking. They concluded that a standardised safety performance test will not be feasible and that a process-oriented approach is necessary. Part of this

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approach is the definition of possible test scenarios. In order to assess the safety of driving support systems these scenarios should at least contain the normal and desired process and plausible deviations from this process. The scope of possible deviations should be known before defining the scenarios containing deviations. The complexity resulting from the implementation of all kinds of new technology increases the need for a method to identify the test scenarios. This paper addresses that need.

Elliott and Owen [6] described similar problems during the design of new chemical plants. They tried to provide a systematic approach to think about not only the process and its predictable deviations but also to try to take into account unknown deviations [7]. The ideas of Elliot and Owen were modified by Lawley [8] into the HAZOP method known today. The need to adopt such methods in the field of road traffic increases with the introduction of (complex) technologies that may affect the possibilities of the road users to adapt their behaviour to the situation they find themselves in. In the next section the traditional HAZOP is explained, and in the subsequent sections the research questions and the way in which the HAZOP was adapted for traffic use.

3. The traditional hazop approach

The method developed by Lawley [8] is designed to search for every conceivable process deviation and look backwards at possible causes and forwards at possible consequences His reason for developing the method was the assumption that most problems are missed because of the system's complexity rather than because of a lack of knowledge on the part of the design team. The main objective is to define safety (hazards) and operability problems. A secondary objective is to evaluate the possible consequences, which is done in a semi-quantitative manner. The approach is based on stimulating creativity and imagination through a structured brainstorm, in order to think of all possible manners in which hazards and operability problems can occur [9]. This is done in a systematic way by a team of specialists with different training and experience in order to reduce the chances of missing any hazard and operability problems. In order to perform the method systematically a matrix with *process parameters* (e.g. temperature and flow) and *guide words* (e.g. no, high and reverse) is used. A combination of a process parameter and a guide word (e.g. no flow) forms a potential deviation. For each deviation (cell of the matrix) the HAZOP team discusses the following questions [7,9]:

1. Could the deviation occur?
2. If so, how could it arise?
3. What are the consequences of the deviation?
4. Are the consequences hazardous or do they prevent efficient operation?
5. If so, can we prevent the deviation (or protect against the consequences) by changing the design or method of operation?
6. If so, does the size of the hazard or problem (that is, the severity of the consequences multiplied by the probability of occurrence) justify the extra expense?

4. Research questions

Extending the use of the HAZOP approach to the field of road traffic requires attention to be paid to the particular characteristics of traffic systems compared to the process industry and the needs for which the technique will be applied The first issue is concerned with the adaptations that were necessary to apply the methodology to road traffic operations. These included decisions about the representation to be used, the experts to be involved and the parameters and guidewords to be chosen. The usability of the adapted procedure in predicting the full range of deviations in a traffic system was assessed in the research. The adaptations are discussed in Sections 5 and 6.

Secondly, we pay special attention to the dependency of the HAZOP results on the composition of the HAZOP team. The question is whether a traffic HAZOP can be performed by a team consisting only of policy makers or only of traffic participants, as opposed to a team with a mixture of expertise, including designers, as the traditional method requires. If the homogenous groups of policy makers or traffic participants are found to be able to use the method just as successfully, it means that it can be used by policy makers alone for ex-ante assessment. To assess this the results of different groups are compared to analyse to what extent the identification of problems and the interpretation of these depend on the expertise and experience of the HAZOP team. This second issue will be addressed by means of both a quantitative and a qualitative analysis. The quantitative analysis assess whether the different groups come up with the same number of deviations and the same distribution of the deviations across the different system levels at which deviations can occur (see also Section 6). For example, policy makers might be expected to have little expert knowledge on the technology of new road safety measures which include ICT technologies, whereas designers of these systems will know a lot. Does the latter group therefore identify far more deviations for these new technologies, than the two groups without this expertise (see Section 7.1)?

The qualitative analysis compares whether the groups discussed the same subjects. Is a homogeneous group of policy makers able to identify the same issues as a group with a mixture of expertise, including designers? The expectation is that the mixed team will come up with a larger variety of issues (Section 7.2).