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Summary:

CREAM Analysis of "Signals Passed at Danger" (SPAD) events

When a train passes a stop signal, it is potentially a dangerous event. In this report six such events are analyzed, primarily in order to assess a generic method for error analysis in man-machine systems, and its applicability to the rail domain. The project resulted in several recommendations for improvements and adaptations of the method, as well as suggestions for measures to prevent SPADs. For example, there is a need for more standardized positioning of signals, and for improved communication between traffic control centre and train driver.

Railway transport safety depends heavily on an effective interaction between signal systems, rolling stock, train drivers and train control centres. When a train passes a stop signal, it is a potentially dangerous event, and it is therefore of utmost importance to get information about the factors that influence the probability of such events. "Signal passed at danger" (SPAD) is the common term used to denote such events (in Norwegian: "PASS-hendelser"), and railroad authorities have reporting systems to monitor SPADs in order to take appropriate countermeasures.

In this project a few cases of SPADs that may be related to train drivers having failed to observe a stop signal, have been investigated. The general purpose of the project was to develop and try out the Cognitive Reliability and Error Analysis Method (CREAM, Hollnagel 1998), which is a system for classification and analysis of error causation in transportation. Although the primary goal was to test the applicability of this classification system, the study was also expected to provide knowledge about factors that may influence the risk of SPADs, and thus provide a background for countermeasures.

The case studies are based on incidents within the NSB (Norwegian State Rail). NSB has procedures to secure that all unwanted incidents during train driving or shunting are reported. Each incident is reported in a database named Synergi (standard form). As the Synergi reports from the SPAD incidents were insufficient, in terms of information, for conducting a CREAM analysis, it was decided to conduct qualitative interviews with train drivers that had been involved in SPAD incidents.

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The applicability of the CREAM method in the rail domain

In all of the incidents examined here, human error is stated as a direct cause in the Synergi reports. Incidents where technical factors were stated as the direct cause, were not included in this study. In almost all the incidents that were analysed, the CREAM method manages to capture more contributing factors than in the original analysis as documented in the Synergi report. Moreover, it manages to capture the interaction between different contributing factors.

Our analysis shows that technical and especially organisational factors are important contributing factors in most of the cases even though not always mentioned in the Synergi reports.

A general remark to the CREAM classification scheme is that it could be expanded with regard to organisational categories, especially concerning more informal parts of an organisation and the relations/interaction between people within the system of an organisation. The human and technical categories seem to be dominating.

Based on the findings in our case studies, suggestions to new organisational categories have been made in order to adapt the CREAM method to the rail domain.

Furthermore, the case studies reveal that there is extensive communication between the train driver and the train dispatcher/traffic controller. Thus, we suggest to include a category under "communication" that specifically relates to this kind of communication.

In addition, the analysis revealed that the definition of the "Communication" category should be expanded when applying the CREAM method in the rail domain. As in one case, the train driver "reads" the actions by the train dispatcher/traffic controller through the technological system and uses this as information. Even though not considered as an information channel in the CREAM classification scheme, this is an information channel which is actively used by the train drivers. It should be included in the CREAM classification scheme (in the "Communication" category") as it might reveal possible errors on the part of the train dispatcher/traffic controller.

A general point, which summarises many of the remarks and suggestions above, is that the interaction between train driver and train dispatcher, as a representative for the organisation, has to be more fully described in the CREAM classification scheme, if used in the rail domain.

Suggestions to the Norwegian railways

The advantages of case studies are that one is able to get into the depth of complex questions. The application of the CREAM methodology enabled new questions to be asked and thus, new contributing factors to be revealed. Based on the findings in the case studies, the following suggestions can be made to the Norwegian railways:

- *Standardization.* The most common contributing factor in the case studies was the deviant placement of a dwarf signal (that is, placed on the left-hand side of the track instead of the right-hand side, marked with an arrow on the pole of the signal). In most of the cases where this contributing factor was present, the train driver did not have knowledge of this deviant placement of the signal. This indicates that the system, as it is designed today, requires local skills on the part of the train driver. The need for local skills is especially a problem in situations that are new to the train driver. Even though it is impossible for a train driver to be trained for all different situations, it would nevertheless be easier if the system was more standardized.

  Some of the case studies revealed that the train drivers expectations and habits are related to the design of the system.Standardization is also an important factor for avoiding errors by train drives due wrong expectations and different habits.

- *Knowledge about the train drivers' working conditions and practices*. The findings suggest that more knowledge among the train dispatchers/traffic controllers about the train drivers' working conditions and their practices would increase their understanding for the train drivers information needs and how they interpret different kinds of information given by the train dispatcher/traffic controller. This would possibly increase the communication between them, and hence possibly increase the efficacy of the system on the one hand and increase the train drivers feeling of control on the other.

- *Separate follow-up routines - a challenge*. The responsibility for the follow-up of an unwanted incident is today divided between NSB, when the incident is said to be directly caused by the train driver, and Jernbaneverket (the Norwegian rail administration) when the incident is said to be directly caused by factors under their responsibility (the infrastructure such as the track, the signalling system and train dispatchers and traffic controllers). One suggestion is to coordinate, in the case where human error is said to be the direct cause of an event (either by the train driver or the train dispatcher/traffic controller), the investigation and reporting between NSB and Jernbaneverket.

- *The CREAM classification scheme as a basis for reporting a SPAD event.* As the Synergi reports turned out to be insufficient for a CREAM analysis, and our findings show that the CREAM analysis reveals more contributing factors than stated in the synergi reports, we suggest to use the CREAM classification scheme as a basis for the reporting of SPAD events. This will secure necessary information to be reported. Even though CREAM analysis is not used in the investigation of an incident, it would be useful to use the CREAM classification scheme in the reporting of an incident.