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Evaluation of Human-Machine-Interfaces for Rail Signalers	Deutsches Zentrum für Luft- und Raumfahrt Institut für Verkehrssystemtechnik

Please highlight workshop topic(s) your paper is relevant for

- ☐ Ergonomics and Usability of advisory and assistance systems
- ☐ Automation, Train control systems
- ☐ Fatigue, monotony, mental workload
- ☐ Risk, Human error and Human reliability
- ☐ Situation awareness
- ☐ Incident investigation
- ☐ Safety culture
- ☐ Human Factors Integration (e.g., in organizational processes)
- ☐ Rules and Standards
- ☒ others

Abstract

The design of the human-machine interface (HMI) in socio-technical systems is important for the overall performance and safety of the socio-technical system. Poorly designed HMI can result in performance decrements, an increase in mental workload, and higher human error rates. In safety critical systems, such as the railway system, the performance of operators and the avoidance of errors – and, thus, the design of HMI – are especially important to avoid fatal consequences. One crucial operator for the safety of the railway system is the rail signaler. Rail signalers therefore need an HMI that optimally supports their tasks.

Several generations of interlockings and HMI for interlockings are still in use in the German railway system. The newest HMI that is currently in use is the computer-based *HMI for electronic interlockings*. The HMI for electronic interlockings was developed in 1985 and implemented into active use in 2000. The layout and design of the HMI has hardly changed since then. In the past, HMI in the railway domain were designed with a focus on technical issues; usability and human factors were not considered in the design of most HMI. No studies have been published detailing if and how usability related criteria were integrated in the development of the HMI for electronic interlockings. Most importantly, the HMI for electronic interlockings has not been evaluated comprehensively with regard to human factors. There are no data regarding potential issues resulting from the design of the HMI apart from HMI-analyses in the aftermath of accidents. Therefore, a study was conducted aimed at evaluating the HMI for electronic interlockings regarding mental workload, subjective situation awareness, and usability. In addition, the HMI for electronic interlockings was compared to a new HMI developed in a user-centered design process. In a simulator study, rail signalers worked with both HMI during normal operations and a disruption. Findings showed that the HMI for electronic interlockings and the new HMI resulted in a similar mental workload and subjective situation awareness. However, the usability of the HMI for electronic interlockings was not acceptable. In contrast, the new HMI achieved significantly better and acceptable results for usability.

These findings illustrate that the integration of human factors in the evaluation and development of HMI in the railway domain is of central importance. If HMI are designed with a focus on the technical side, this can lead to HMI with numerous human factors issues, as is illustrated by the inacceptable results for usability of the HMI for electronic interlockings found in this study. An HMI with an inacceptable usability can increase the danger of human error and can reduce productivity, which is undesirable especially in a safety critical system. This study showed that the early integration of user needs in the design process of a new HMI through a user-centered design process can improve the outcomes for usability in an HMI for the railway domain. Thus, the human as a factor should always be front and center in the development and evaluation of HMI in the railway domain.