

Oral presentation:

Tasks, roles, and workplaces in highly automated rail

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SUMMARY

The increasing digitalization and automation of the railway system is leading to a gradual and clearly noticeable change in terms of tasks and roles of personnel in rail transport. At the German Aerospace Center (DLR), we examine these changes and their consequences in the interplay between people, technology and organization, and we derive recommendations for a user-centered design of future workplaces in the railway system. Current projects and results are presented here.

KEYWORDS

Remote Train Operation, Human Machine Interaction, Usability

Introduction

Even lower grades of automation like Grade of Automation 2 (GoA2; International Association of Public Transport, 2012) result in a decrease of active tasks and a shift towards a necessity to predominantly monitor the technical systems on the side of the operators. Effects on the train driver and consequences for workplace design have been described earlier (see Naumann & Thomas-Friedrich, 2024). Effects of the introduction of higher Grades of Automation like GoA3 and 4 on tasks and roles of operational staff and workplace design are currently the main focus of research at the DLR. In both, GoA3 and 4, the train drives automatically and there are no train drivers in the cabin anymore. Instead, the new role of remote train operators (RO) is introduced. RO can drive the train remotely (Remote Train Operation – RTO) in case of disruption or malfunction of the Automatic Train Operation (ATO), for example from a control room. In GoA4, there is no operational staff on board, while in GoA3, a train attendant is still on board and can support in case of disruption, while an interaction between the train attendant on board and a remote train operator could also be possible.

The Remote Train Operator

RO would work, for example, from a control centre together with rail traffic controllers. In most scenarios, the goal is for the RO to be the fallback in case of a disruption of the ATO. Thus, tasks of the RO will include remotely driving the train in case of a malfunction of the automation and providing operational staff on board with information or instructions for troubleshooting. However, if the ATO system is working well, with rare disruptions, and RO would otherwise only have to passively monitor the system, there is again the risk of monotony - with the associated negative effects on performance, skills and abilities, job satisfaction, and health (Ahlstrom, 2016; DIN, 2000). Therefore, it is essential to develop a human-centred concept for the job. One proposal in this respect is the design of the RO workplace as an on-call workplace where the operators carry out other meaningful activities related to rail operations in periods without a need for intervention, and receive an alarm in case a train requires their attention (cf. Thomas-Friedrich et al., 2024a). Other aspects are to describe RO tasks and interactions with ATO and other parties depending on probable use scenarios and technical preconditions (cf. Thomas-Friedrich et al., 2024b), and to define the requirements concerning education and training of RO (work in progress; DLR, 2023). A prototypical work environment for RO was developed at DLR in a user-centred design process with several iterations and user tests (Brandenburger & Naumann, 2018b,c). In several projects with partners from research and the rail industry, the RO work environment has been further developed and investigated, for example in the projects *5G Living Lab* (Brandenburger et al., 2023) and *ATO Cargo* (Schöne et al., 2023).

In the project *ARTE* (Automated Regional Trains in Lower Saxony), a simplified remote train operation via tablet computer has been investigated together with TU Berlin with a strong focus on human factors aspects. In three user tests (model railway environment, test track, public rail infrastructure) and four different working positions (driver's cab, passenger compartment, next to the track, control room), the tablet remote control was evaluated (Naumann et al., 2023, Adam & Naumann, 2025). Performance, usability, and acceptance were measured. It was shown that using a tablet computer for remotely controlling a train (RTO) is a practicable solution, also from a human factors perspective, especially when personnel is still on board the train. Indications for improvements of the user interface and technical preconditions were derived.

The train attendant and the Remote Train Operator in GoA3

The train attendant in GoA3 is the only staff on board the otherwise automated train. Although the RO could perhaps rectify some disruptions from a control centre, the train attendant might have to take on some additional tasks that can only be carried out on site. This so-called 'train attendant plus' (TA+) with additional training could also drive the train manually via tablet in case of a disruption, similar to a RO. In *ARTE*, both roles, the RO and the TA+, were developed in detail (Naumann et al. 2024, 2025). Operating personnel was directly involved in the research, participating in workshops, user tests, and online surveys. Tasks and activity sequences as well as information and communication/interaction requirements of both roles were derived. Also, options for a collaboration of RO and TA+ were developed.

Conclusions for GoA4

In GoA4, there is no longer any staff on the train during the fully automated journey. This means that there are neither drivers in the driver's cab nor train attendants on board. In the event of a disruption, the RO will intervene, but there is no operational staff on board to support the clearance of the disruption. If the RO cannot deal with the disruption via remote control, technical staff must be informed and travel to the location of the train. This could lead to considerable delays, if technical staff is not in the immediate vicinity of the disrupted train. Thus, for the application of GoA4 in mainline operation, quite a view challenges have

to be overcome. In our point of view, GoA4 seems firstly to be applicable for short distances, e.g. in shunting and deployment journeys from a parking facility to the first station.

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