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Risk management in complex railway systems considering the human factor

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Hazard rates are lowered by the effectiveness of barriers to calculate accident rates in event trees, which can be understood as reduced initial hazard rates.
The quantification of a barrier and its effectiveness to calculate the hazard rate reduction depends on the barrier's functional type, which could be safety related to technical functions of technical systems or operational procedures or a combination of operational procedures and technical functions:

- Technical functions can be quantified by using RAM-data, failure rates or like hoods, data of relevant databases etc. of the safety subsystem which puts the safety function into effect.
- Operational procedures are separated into operational functionalities (rules) and human actions - normally executed by railway staff. The safety related quantification considers several human factors like education and experience, aptitude and capability, stress situations, influences from the surrounding environment, the complexity of the task, the quality of rules, etc.
- The combination of operational procedures and technical functions demands a comparability of technical based rates and the safety related quantification of human actions.

For the quantification of operational barriers or combined operational-technical barriers in the DEUFRAKO-project ROSA the Deutsche Bahn (DB Systemtechnik) with support of the Technical University of Dresden developed a straightforward model to estimate human safety related actions. This pragmatic approach helps to estimate human error probability and is easy to use.
The human factors which have an impact on human actions and the probability of human failures e.g. of a train driver or a dispatcher can be understood as physical, social or cognitive properties to fulfill a required task within a defined environment:

- Simplicity of the task
- Education and training
- Environmental conditions
- Stress

The initial reduction rate of an operational barrier based on human actions is valued by 1. Each relevant human factor, which should be seen as an order of magnitude than an exact numerical value, will reduce this rate. Therefore the resulting reduction factor will range from 1 (no influence, it implies that staff is not able to perform any notable reduction on the hazard rate) to 10-3 (maximal human reduction), corresponding with other published results [Hinzen 1993, Bubb 2000, Vanderhagen 2008, Moriyama and Ohtani 2009]. The human factor "stress" worsens the reduction rate and can be taken into account.