

Automated Deadman's Device Operation?

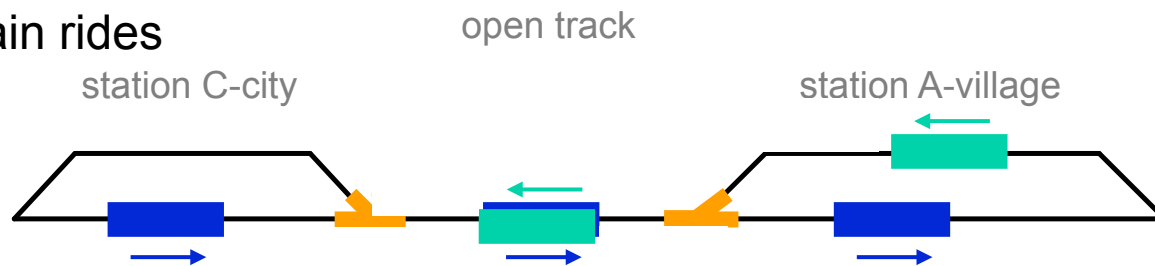
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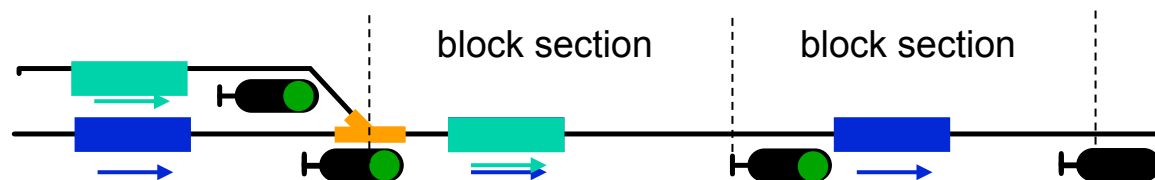
Introduction in railway systems

rail-borne traffic

➤ regulation of train rides



➤ driving in inter-block gap





Introduction in railway systems

train control system

- driving past red signal



- train speed supervision



- deadman's device



automatic train stop



Quelle Bilder: Wikipedia



Assistance and automation



- transformed workplaces in the railway domain
 - less physical work
 - more cognitive supervisory tasks
 - human operations are more and more replaced by automation
 - excluded from the active control process
- consequences
 - out of the loop phenomenon
 - monotony





The train driver's task during driving



in normal case

- controlling and monitoring the train and track according to technical and operational regulations
- observing speed limits:
 - train driver needs to integrate timetable information and signals on the line

in case of interferences and/or defects

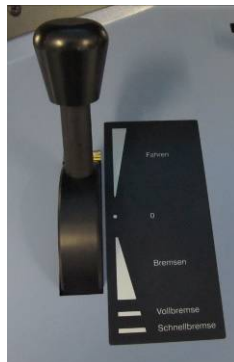
- resolving problems or limiting their impact in order to carry out the train ride as safe and as undisturbed as possible
- communication with train operator



Countermeasure for monotony

Deadman's device

- established to ensure the train driver's ability to act and to force him being permanently held in position while driving
- German system is called Sifa (Sicherheitsfahrschaltung)
- existing several types of the Sifa
- here the so called time-time-Sifa was realized



driving and brake lever

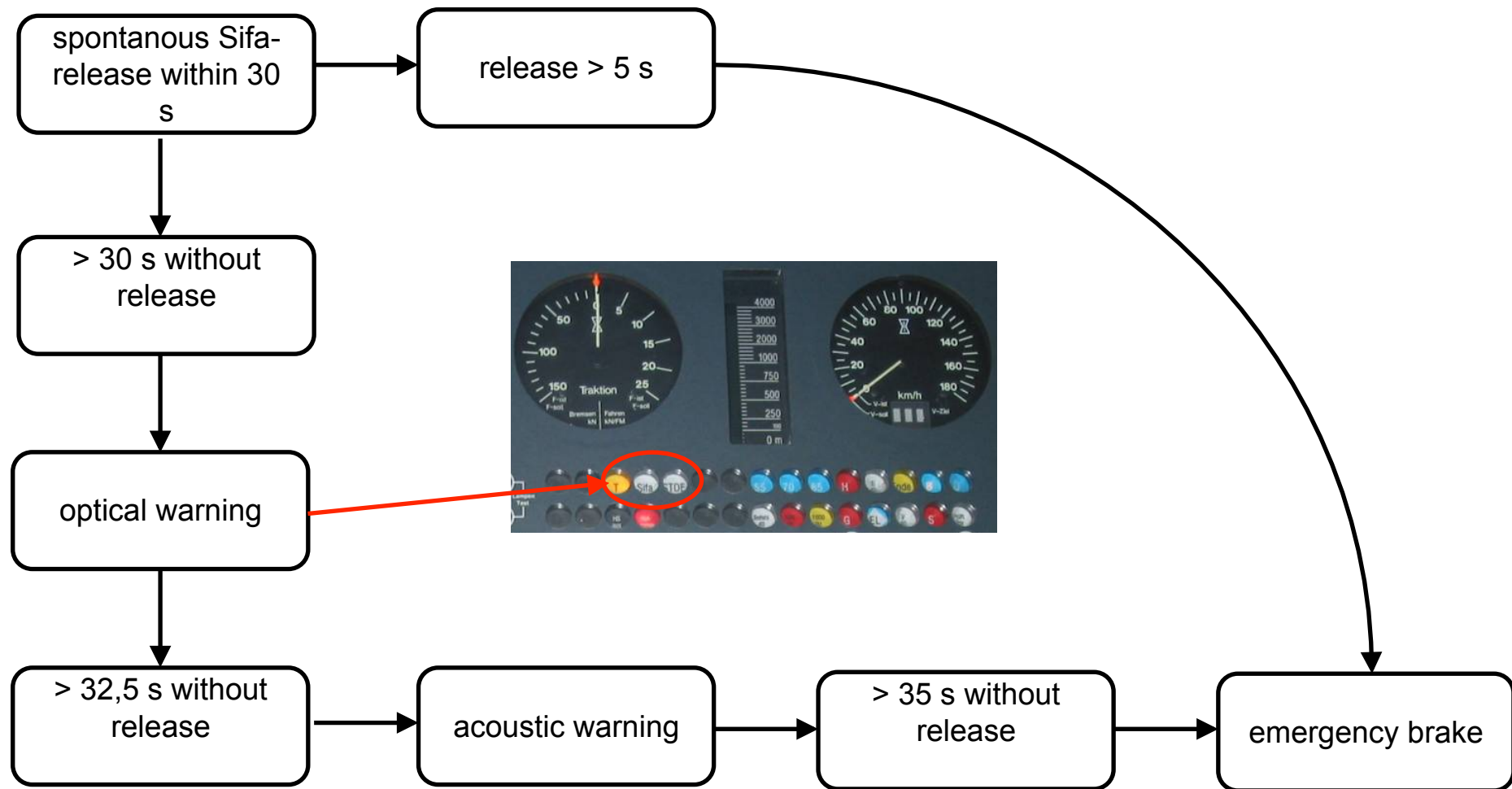


Sifa-pedal





Functionality of the Sifa





Motivation

- Peter (1980): even in fatigue the train driver presses the Sifa in his individual rhythm regularly and correctly
- observations of train drivers in their everyday working context and interviews with train drivers support Peter's hypothesis
- no redesign of the functionality of the deadman's device since its launch
- Research question:
 - Is the Sifa able to detect highly fatigued or even sleeping train drivers?
 - Do train drivers operate the Sifa automatically?





Simulator study

- simulator study in the laboratory *RailSET* (Railway Simulation Environment for Train drivers and operators)
- original German train class ET 423
- a driver's cabin isolated the participant from the laboratory (left)
- several monitors allow the observation of the subject in the cabin (right)

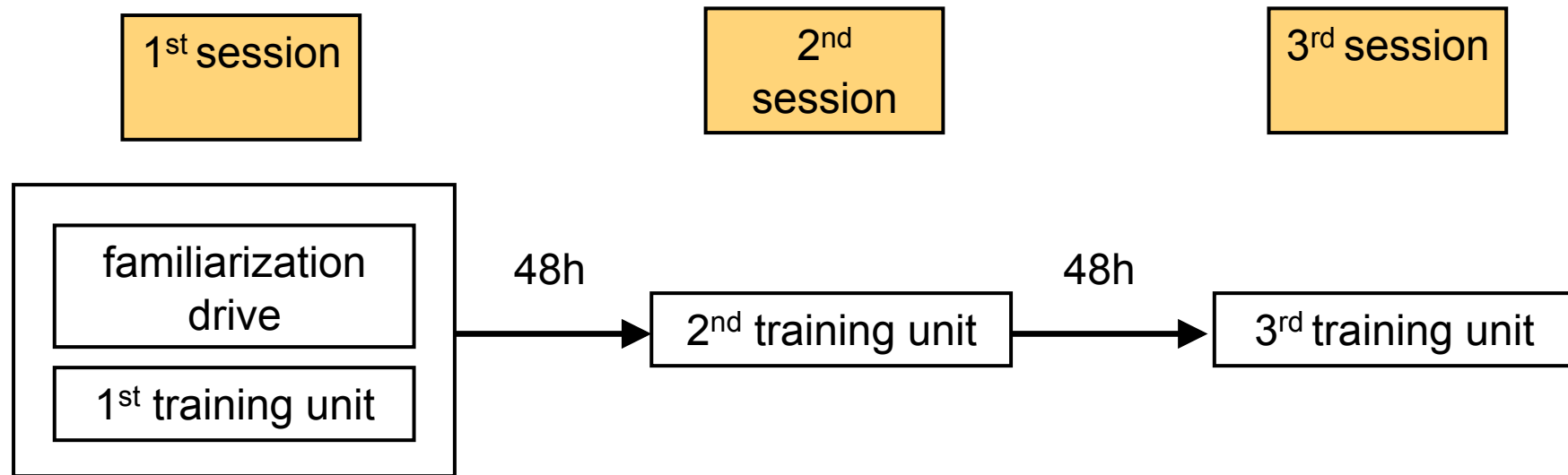


Driver's cabin in the RailSET



Investigator's workplace

Study procedure



➤ familiarization drive: 15 km (10 min)

➤ training unit: 40 km (30 min)



Selected Track

- realistic German routes digitalized and integrated into the simulation
- familiarization driver: straight track of 15 km
- training unit: simple track - occasional curves, hills and houses
 - both tracks quite monotonous

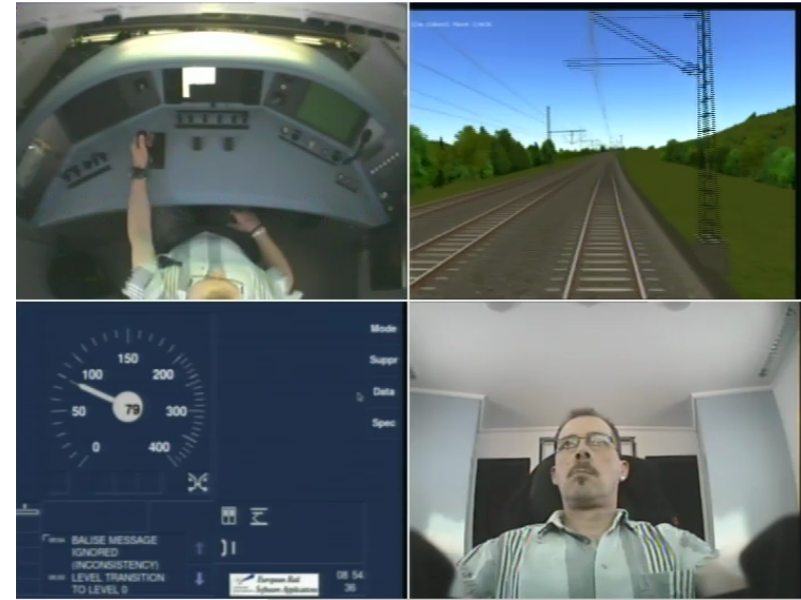




Experimental task

- holding a speed of 100 km/h
- watch the track and its signals
- operate the Deadman's device within the 30-seconds-interval

- clear signals during the train run → braking due to red signals was not demanded
- Besides the explanation of simple signal information (clear vs. red) no further rail specific knowledge was necessary for the experiment.





Recorded measures

Driving performance

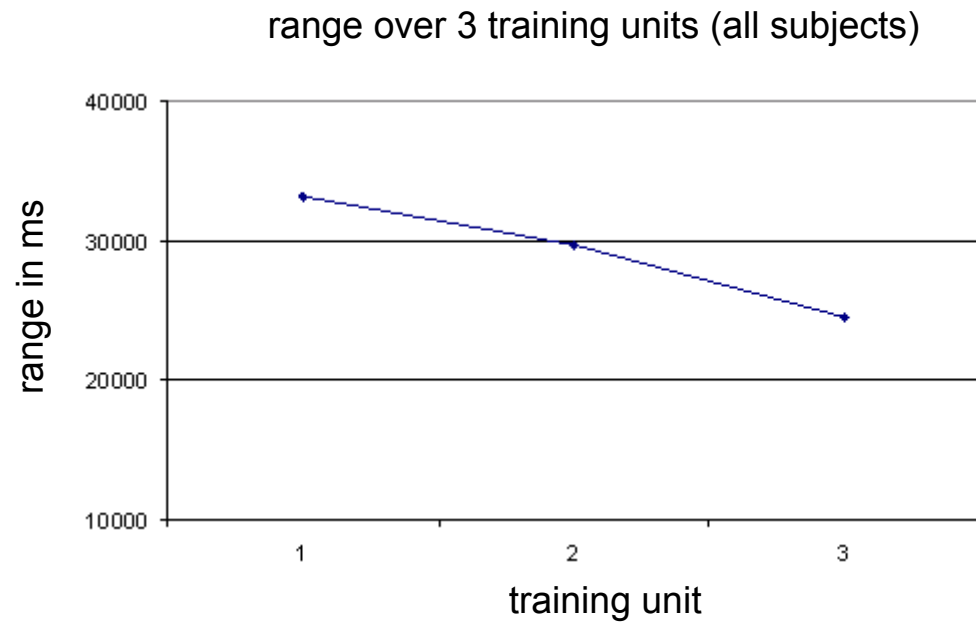
- Sifa-activation:
 - interval between successive Sifa releases
 - the intervals from the beginning of the pressing to the release of the pedal
 - visual and acoustic alarms
 - automatic train stop due to Sifa
- position
- speed
- acceleration





Results

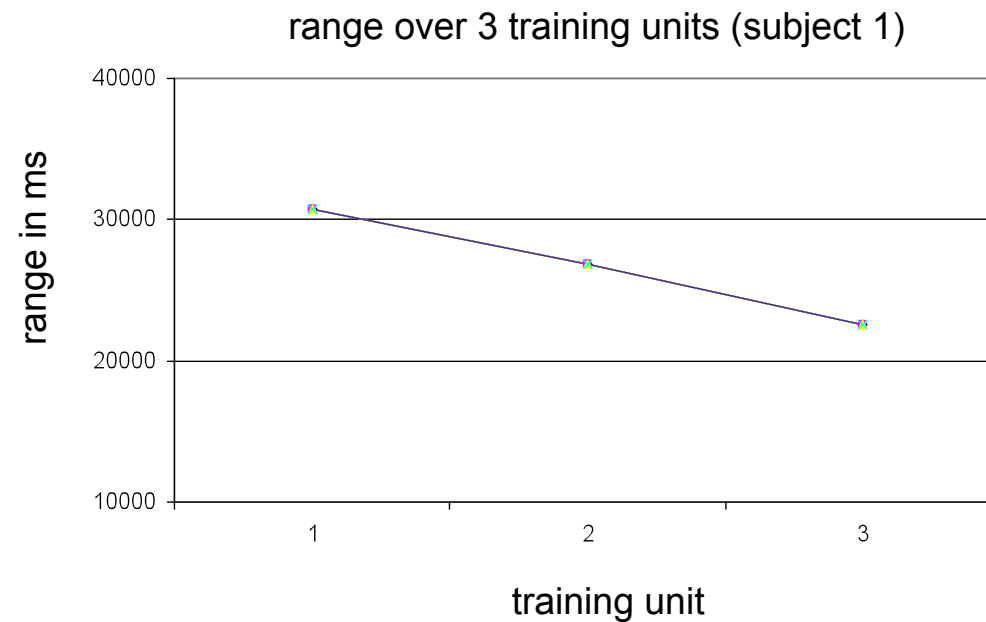
➤ decrease of the range over time





Results

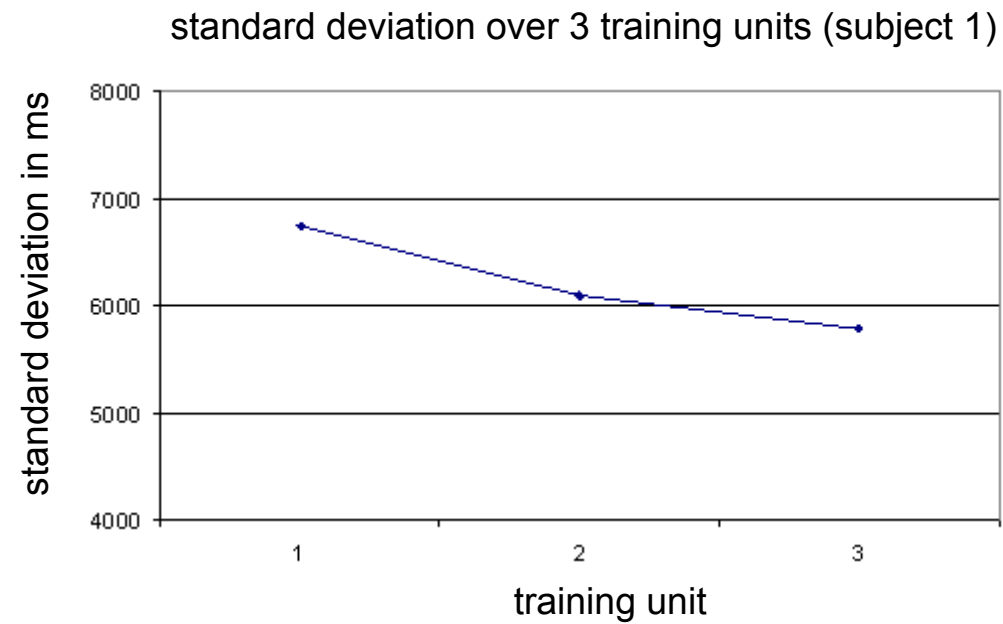
- focus on the individual rhythm → individual evaluations of the data
- representative for the whole sample
- all participants showed similar results





Results

➤ decrease of standard deviation over time





Results

- average interval between two releases of the Sifa: 24.37s
- the individual intervals lied between 18 s and 29 s



Summary of results

- participants showed a decline in range and standard deviation → indicator for an individual Sifa-rhythm
- participants learnt to operate the Sifa in an individual but constant rhythm within three sessions of 30 minutes each
- number of recorded alarms was extremely low.
 - in accordance with the results Peter et al. (1983) where emergency brakes due to a non-operation of the Sifa rarely occurred
- automatic operation of Sifa by professional train drivers seems possible and plausible
- results indicate that Sifa might need to be investigated more deeply to test its validity



Outlook

- study with professional train drivers:
 - Does such a individual rhythm really exist?
 - Do train drivers operate the Sifa in case of fatigue in the same correct way?
 - If yes, how should be a deadman's device designed that it controls the ability to act more reliable?





Thank you for your attention!

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