

# The Impact of Railway Automation on Train Driver Tasks and Skills

Niels Brandenburger, Dr. Anja Naumann  
German Aerospace Center (DLR)



Knowledge for Tomorrow



# Rail Human Factors



# Rail Human Factors

## Trends in the railway domain



- Digitalization
- Automation
- Centralization
- Shift from direct and active operations to supervisory activities

Human/  
Organisation/  
System Design

# Railway Automation

- General framework provided by Grades of Automation (GoA) <sup>[1]</sup>
  - + Railway specific
  - Proposed for closed metro systems
- At DLR, we study the role of the train driver at each grade up to GoA4 in mainline operation
  - Task analyses
  - Simulator studies
- Today's focus is on tasks and skills at GoA2

Grade of Automation	Type of train operation	Setting the train in motion	Stopping train	Door closure	Operation in event of Disruption
Grade of Automation 1	ATP with driver	Driver	Driver	Driver	Driver
Grade of Automation 2	ATP + ATO with driver	Automatic	Automatic	Driver	Driver
Grade of Automation 3	Driverless	Automatic	Automatic	Train attendant	Train attendant
Grade of Automation 4	Unattended train operation (UTO)	Automatic	Automatic	Automatic	Automatic

Source: [1] International Association of publicTransport, 2012



Source: DLR e.V.

# Train Driver Tasks in GoA2 [2]

- Characteristic changes in task environment
  - Quite infrequent manual speed control
  - Proportionally more visual monitoring tasks (displays and outside)
  - Infrequent but critical diagnosis and intervention

## Typical intermediate level of automation

Grade of Automation	Type of train operation	Setting the train in motion	Stopping train	Door closure	Operation in event of Disruption
Grade of Automation 1	ATP with driver	Driver	Driver	Driver	Driver
Grade of Automation 2	ATP + ATO with driver	Automatic	Automatic	Driver	Driver

Source: [1] International Association of publicTransport, 2012

Original Article

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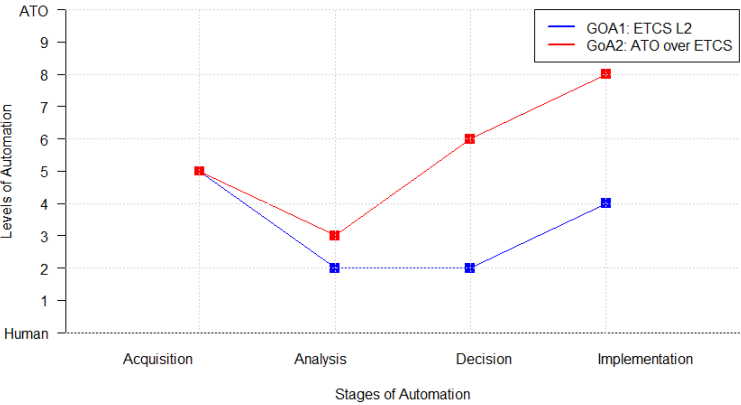
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**Tasks, skills, and competencies of future high-speed train drivers**

Niels Brandenburger<sup>1</sup>, Hans-Jürgen Hörmann<sup>2</sup>, Dirk Stelling<sup>2</sup> and Anja Naumann<sup>1</sup>



Source: DLR e.V.



# Train Driver Skills in GoA2 [2]

- Extracted job requirements for GoA2 train drivers (F-JAS[3]; n=21)
- Key changes in skills:
  - + Interactive/ social skills
  - + Perceptual (mainly visual) skills
  - + Cognitive skills
  - Psycho-motoric skills
  - Physical and basic technical skills

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Tasks, skills, and competencies of future high-speed train drivers

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Item	Domain	Mean Rating
Dependability	Interactive/social	6.43
Perseverance	Interactive/social	5.86
Far vision	Sensory/ perceptual	5.81
Night vision	Sensory/ perceptual	5.76
Reaction time	Psycho-motoric	5.57
Control precision	Psycho-motoric	5.57
Selective attention	Cognitive	5.48
Problem sensitivity	Cognitive	5.43
Speech clarity	Interactive/social	4.86
Near vision	Sensory/ perceptual	4.67



Source: DLR e.V.



# Effects of GoA2 tasks on train drivers in the simulator

- In comparison to GoA1:
  - **Task- induced fatigue** remains critical issue [4]
    - Monotony and sustained attention...
    - How do we alleviate the continuous visual monitoring strain?
  - **Response times** to unexpected critical stimuli increase [5]
    - Out- of the loop/ situation awareness (SA)...
    - How can we highlight critical situations/ train for better anticipation of those?
  - **Workload** in routine task drops to suboptimal level [6]
    - Low task- load/ complacency/ task disengagement...
    - Can we preserve the meaningful/ holistic nature of train driving?

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Source: DLR e.V.

# Skill retention in GoA2 – On-the-job measures

- **Mandatory manual driving periods** (counter fatigue/ low workload)
  - Perceptual skills
    - Routine information acquisition
    - Feeling of traction
  - Cognitive skills:
    - Problem sensitivity
    - Selective attention
- **Enhance standardized communication with track side** (counter fatigue/ low workload)
  - Interactive/ social skills
    - Dependability
    - Speech and information clarity
    - Safety culture (team attitude)
- **Intensify check of technical display during station stops** (heighten SA)



Source: DLR e.V.



# Skill retention in GoA2 – Training to enhance SA

- **Frequent simulator training** (manual driving and disruptions)
  - Perceptual skills
    - Routine information acquisition
  - Cognitive skills:
    - Selective attention
    - Problem sensitivity
    - Mental models of disruption processes
- **Joint regular disruption debriefings** (e.g. analyse anonymous videos or logs)
  - Cognitive skills:
    - Problem sensitivity
    - Mental models of disruption processes
  - Technical skills
    - Diagnosis capability

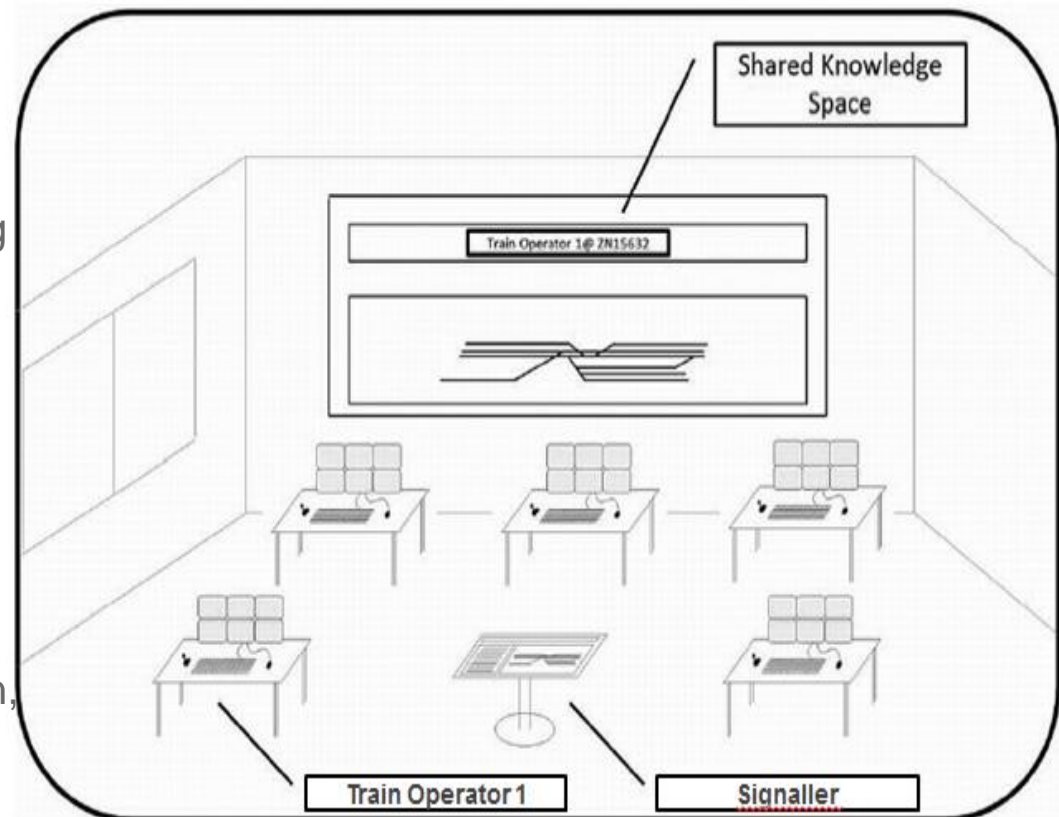


Source: DLR e.V.

# Train Operator (TO) Workplace – GoA3

## Potential development of the train driver's role in the context of automation

- **Approach** [7], [8]:
  - Occasional request of the (autonomously driving) train for the TO in critical operational situations (e.g., animals on the track -> driving on sight)
  - TO takes over the train via remote control (e.g., in a control room)
  - TO hands train back to automation when situation is solved
  - Train is driving autonomously again, TO documents his intervention



TO workplace in a control room [7]

[7] Brandenburger, N. & Naumann, A. (2018). Enabling automatic train operation through human problem solving. *Signal + Draht* 3/2018, S. 6-13.

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## *Train Operator*

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# Call for Contributions

## **Special issue for Cognition Technology & Work journal: The role of human factors for sustainable and resilient rail systems**

**Keywords:** railway, guided transport, design, operation, maintenance, supervisory, driving, infrastructure, human support system, safety, reliability, security, energy consumption, human factors, sustainability, resilience, dissonance, autonomous driving, accidentology, degree of automation, impact of automation, human-machine cooperation

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### **Contact:**

F. Vanderhaegen, University of Valenciennes, LAMIH UMR CNRS 8201, France,  
[Frederic.vanderhaegen@univ-valenciennes.fr](mailto:Frederic.vanderhaegen@univ-valenciennes.fr)

J.-M. Burkhardt, IFSTTAR, France, [jean-marie.burkhardt@ifsttar.fr](mailto:jean-marie.burkhardt@ifsttar.fr)

W. Fang, Beijing Jiaotong University, China, [wnfang@bjtu.edu.cn](mailto:wnfang@bjtu.edu.cn)

A. Naumann, DLR, Germany, [Anja.Naumann@dlr.de](mailto:Anja.Naumann@dlr.de)

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**Thank you very much for your interest!**

**Dr. Anja Naumann**

[Anja.Naumann@dlr.de](mailto:Anja.Naumann@dlr.de)

**Niels Brandenburger M.Sc.**

[Niels.Brandenburger@dlr.de](mailto:Niels.Brandenburger@dlr.de)

**Institute of Transportation Systems, Human Factors Department**

[www.DLR.de](http://www.DLR.de)

