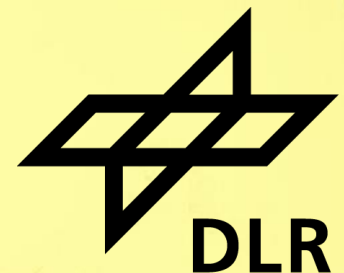


THE IMPACT OF INCREASING AUTOMATION ON RAILWAY STAFF AND THEIR WORK

Dr. Jan Gripenkoven

Human and Organisational Factors Conference, 2022

Valenciennes, 6-7 December 2022



A high-speed train with a white, black, and green livery is shown in motion on a track, crossing a bridge over a valley. The background consists of rolling green hills and golden-yellow fields under a clear blue sky. The train is moving from left to right, and the background is blurred to indicate speed.

INTRODUCTION

Introduction: Braunschweig 1966



Braunschweig Hbf Gleis 1. Mit dem Dampfzug durch die Winternacht nach Goslar – Alltag 1966.

Foto: Bebensee, Slg. Stiftung Eisenbahn Archiv Braunschweig

Source: Bebensee, Stiftung Eisenbahn Archiv Braunschweig

jan.grippenkoven@dlr.de, 06.-07.12.2022



Source: DLR



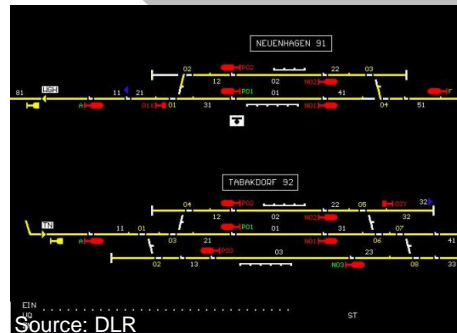
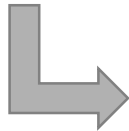
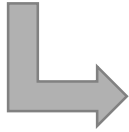
Source: DLR



Source: DLR



Introduction: Braunschweig 1966



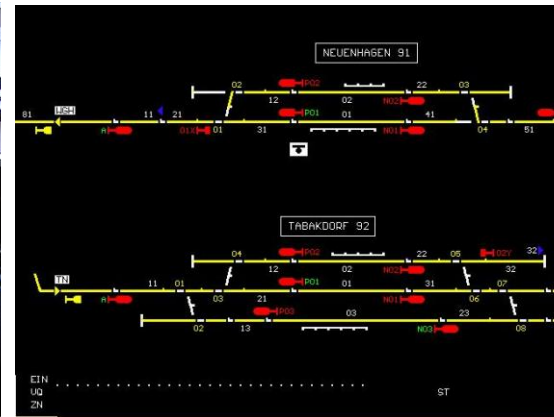
Source: ETR-Eisenbahntechnische Rundschau, 1961

Trends in Work



- Some trends that were already on their way were accelerated during the last years
 - Mobile office
 - Remote collaboration and even conferences
 - Working in online-teams
 - ...

Trends in Workplace Design



- Highly Digital
 - Automated
 - Remote
 - Transition in work from active steering towards more and more supervision
- What is next?

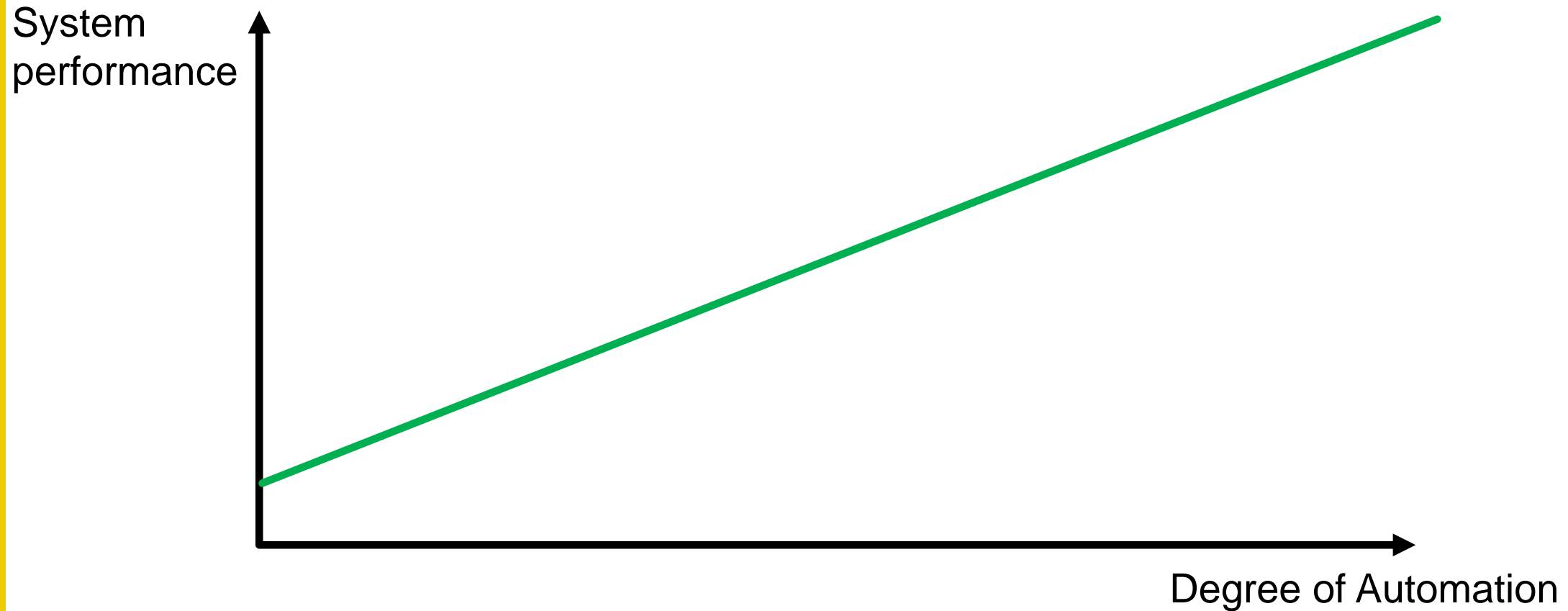
What is next?



The future of work does not happen somewhere far in the future – in the planning of future workplaces we are creating future work right now!

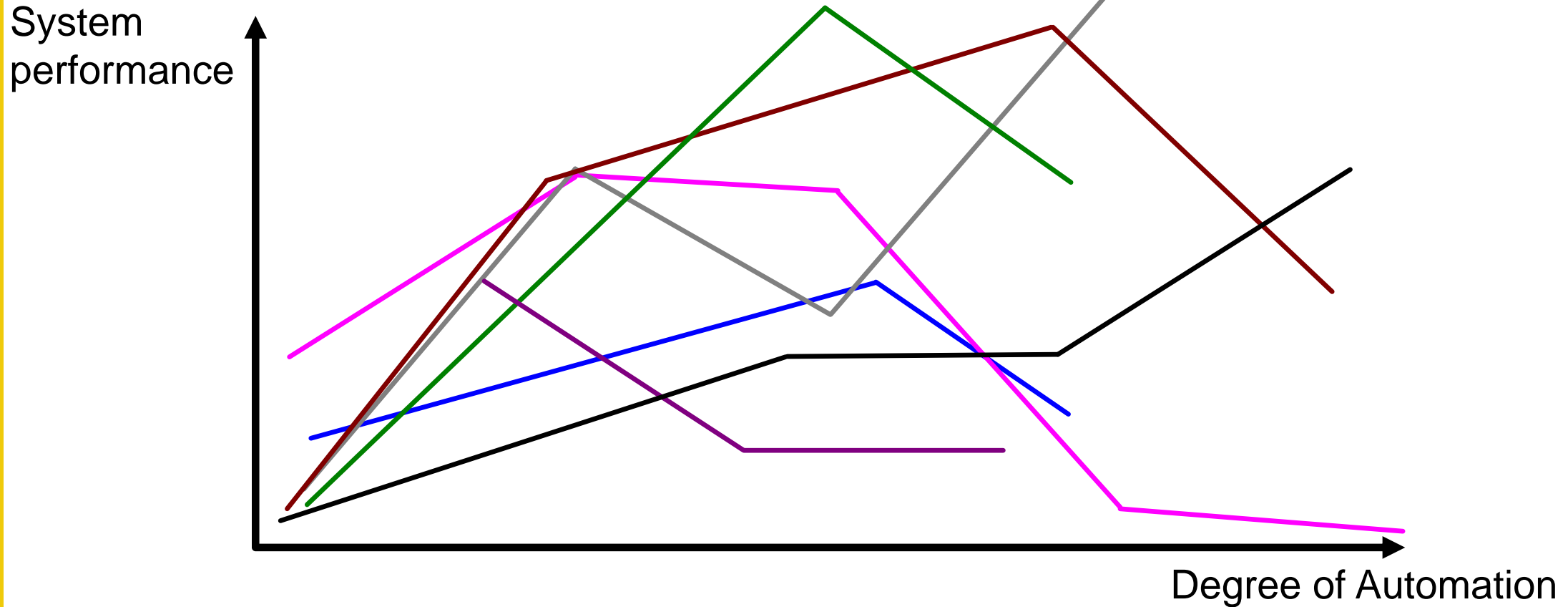
AUTOMATION

Automation in human-machine interaction: The Assumption



„The higher the degree of automation, the more pressure is taken off the operator. As a result, the overall system performance will increase.“

Automation in human-machine interaction: The facts



Confirmation of inconsistent effects in meta-analyses

(Onnasch et al., 2014; Wickens et al., 2010)

A high-speed train with a white, black, and green livery is shown in motion on a track, crossing a bridge over a valley. The background consists of rolling green hills and golden-yellow fields under a clear blue sky. The train is moving from left to right, and the background is blurred to indicate speed.

EVIDENCE FROM DLR - EXPERIMENTS

DLR – Studies in the train driving simulator RailSet



Grade of Automation (GoA)1:

- Manual operation by train driver

GoA2:

- Driver supervises train, automated regulation of speed and stopping

GoA3/4:

- Driver does not have to be in the cab anymore, someone has to intervene in case of irregularities

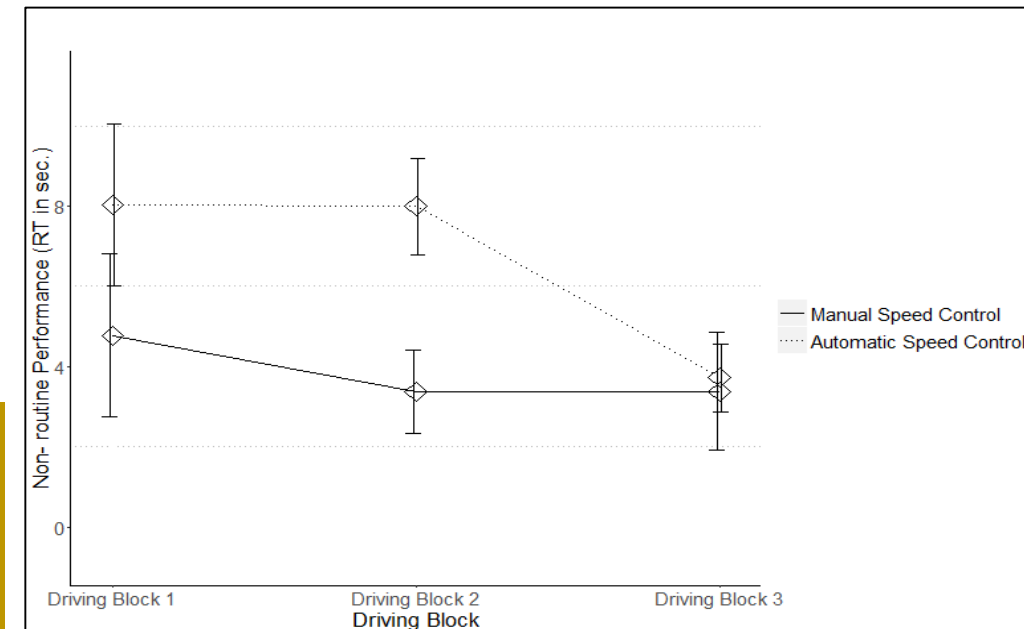
Grade of Automation	Type of train operation	Setting the train in motion	Stopping train	Door closure	Operation in event of Disruption
Grade of Automation 1	ATP with driver	Driver	Driver	Driver	Driver
Grade of Automation 2	ATP + ATO with driver	Automatic	Automatic	Driver	Driver
Grade of Automation 3	Driverless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

Source: International Association of Public Transport, 2012

- What do the different grades of automation mean for the train train driver?

Human Performance in GoA 2

- In three simulator studies the influence of ATO over ETCS Level 2 (GoA2) was investigated from the perspective of the train driver, compared to German PZB (GoA1).
- 75 train drivers took part in the studies.
- **Tasks** of drivers in GoA2:
 - Relatively few speed adjustments
 - Visual supervision of environment and displays
 - Few but critical diagnoses and interventions
- **Results:**
 - Level of workload was reduced to a suboptimal level in routine activities
 - Fatigue increased significantly
 - Reaction time was significantly longer (=worse) compared to baseline condition (GoA1)



- Further Reading: [Brandenburger, Niels \(2021\) Remote Control of Automation: Workload, Fatigue, and Performance in Unattended Railway Operation.](#)
- [Grippenkoven, J., Rodd, J., & Brandenburger, N. \(2018\). DLR-WAT: Ein Instrument zur Untersuchung des optimalen Beanspruchungsniveaus in hochautomatisierten Mensch-Maschine-Systemen.](#)

Out of the Loop Performance Problem

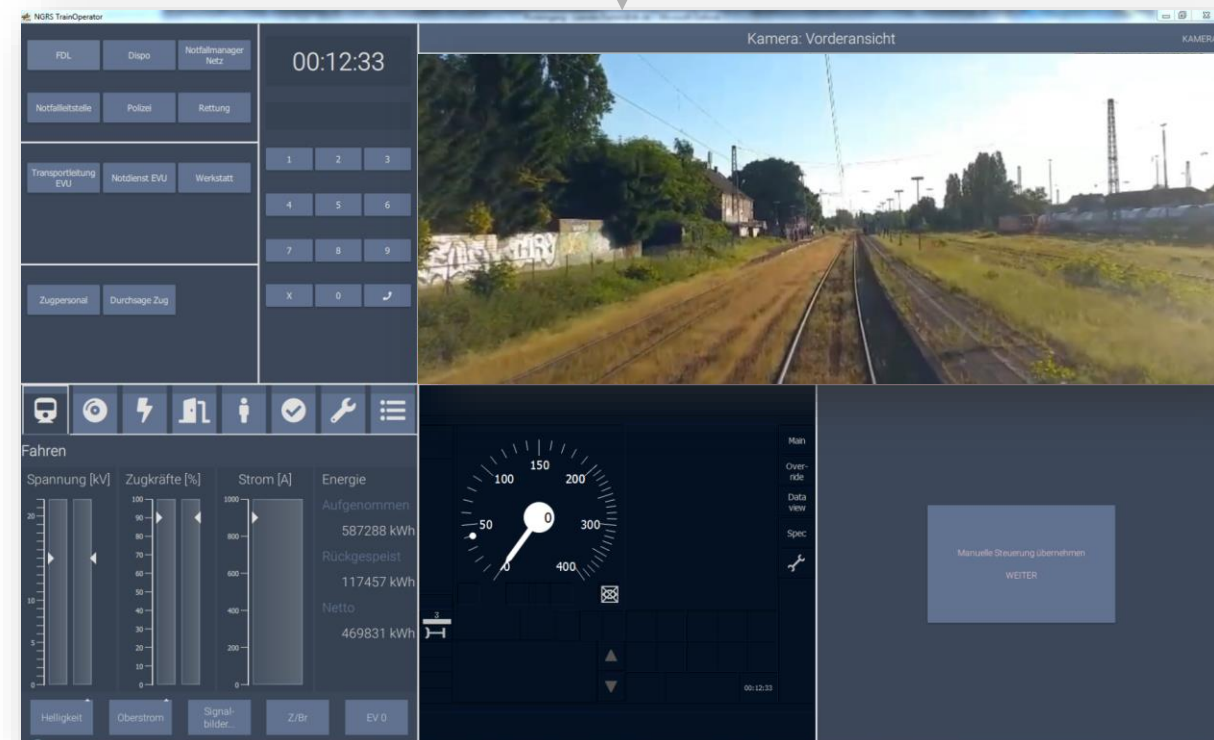


- The probability of a mistake is increased, when the human operator has no own, active role in human-machine interaction anymore. (Bainbridge, 1983)
- In the case of the train driver this problem does already occurs in relatively low Grades of Automation!

Ongoing Work: Project ATO-Cargo



- Design and testing of a human centered working environment for remote train operations
- Functional demonstration on Betouweroute in 2025



- Links for further reading:
- [Jacob \(2022\) – Project ATO Betouweroute](#)
- [DLR \(2021\) - Projekt ATO-Cargo: Erprobung automatisierter Güterzüge](#)

Source: Brandenburger & Naumann (2019)

**HOWEVER: HOW DO WE WANT TO WORK IN THE FUTURE?
HOW MIGHT WE ENSURE HUMANE, SATISFACTORY AND PERSONALITY
ENHANCING WORK IN HIGHLY AUTOMATED AND DIGITAL RAILWAY WORKING
ENVIRONMENTS?**

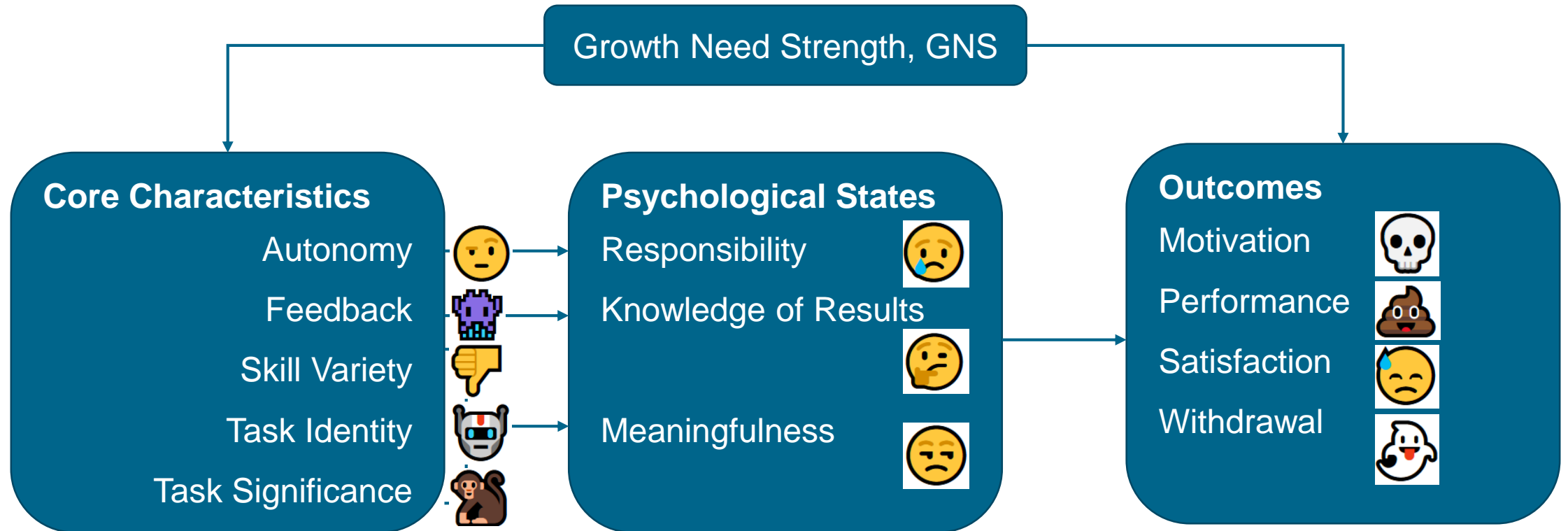
Job Characteristics Model

(Hackman and Oldham, 1976)



Job Characteristics Model → Risks of Automation

(Hackman and Oldham, 1976)



- A decrease in automation of railway systems and parts of it is changing job characteristics
- Job profiles that might be arising should be analysed and optimized regarding potential *characteristics* and *outcomes* that can be anticipated.

Credits: Gina Schnücker

Conclusions



1. Automation has the potential to enhance the efficiency of railway operations, but it entails a great risk to lead to horrific job-profiles, e.g. train“driving“ in GoA2
 2. Expertise from the field of Work and Organisational Psychology should be taken into account to create meaningful workplaces
 3. Human Factors need to be taken into account in the design of tasks and interfaces to counteract overload and underload as well as job-induced fatigue
- Outlook: The Human Factors and Ergonomics Society (HFES) published a Human Readiness Level Scale for the System Development Process. This HRL-Scale might be of great value as a quality to ensure human readiness parallel to technological readiness in developments

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Thank you!

Contact:

Dr. Jan Grippenkoven
Institute of Transportation Systems
jan.grippenkoven@dlr.de
0531 295 3507