



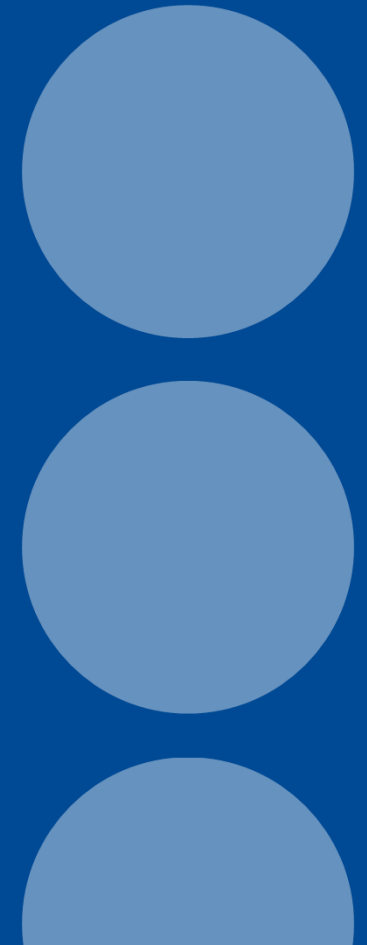
**IFA**

Institut für Arbeitsschutz der  
Deutschen Gesetzlichen Unfallversicherung

# Virtual Reality Support for Human Factors in Human-System Interaction

Peter Nickel

OSH InnoTech Conference  
Novel Technological Innovations for Occupational Safety and Health  
CIOP-PIB, Warsaw, Poland, 15/10/2019



## Agenda

- DGUV and IFA
- Virtual Reality
- Human Factors, Human-System Interaction
- VR projects
- Application areas
- Conclusions



[Photo: Nickel]

## German Social Accident Insurance – Independent Institutions



## German Social Accident Insurance – Research Institutes



**Research / Consultation / Testing**

**Carrier: DGUV**

**Focus:** Technology, chemical/biological hazards

- Accident prevention
- Machine safety
- Personal protective equipment
- Substance and exposure data



**Research / Lecturing / Advice**

**Carrier: DGUV + BG RCI**

**Focus:** Occupational medicine

- Medicine
- Epidemiology
- Allergology / Immunology
- Toxicology
- Molecular medicine



**Research / Consultation / Qualification**

**Carrier: DGUV**

**Focus:** Qualification in OSH

- Psychological damage and health
- Work design and demographics
- Evaluation
- Learning and use of electronic media
- Road safety
- Profitability and business management

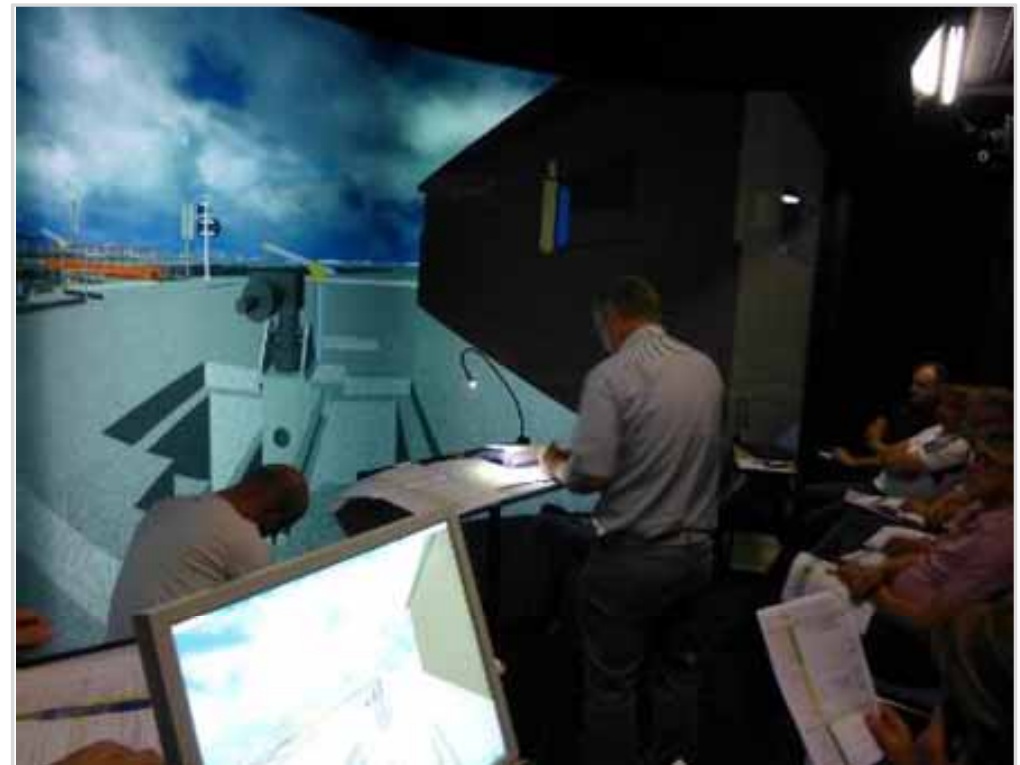
## VR support for Human Factors in Human-System Interaction

### Virtual Reality and OSH

- Simulation technique to support research into OSH
- Allows to study in hazardous and future environments

### Human Factors in Human-System Interaction

- Research and application of human requirements to improve working conditions
- Information exchange processes referring to task, interaction and information interfaces

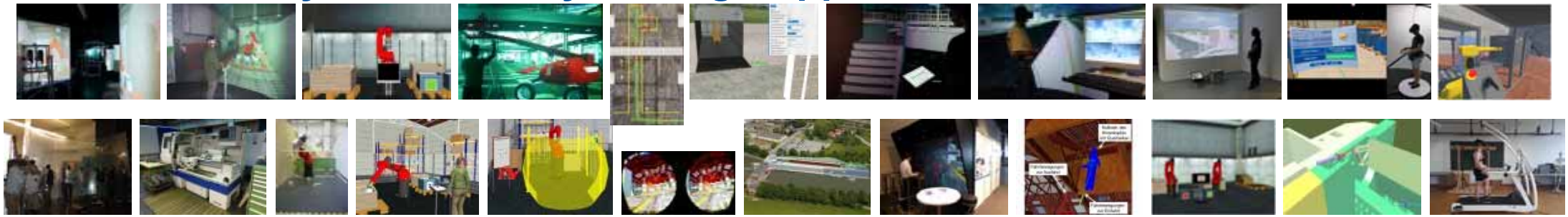


[Photo: Nickel/IFA]

# Human-System Interaction in OSH

[www.dguv.de/ifa/sutave](http://www.dguv.de/ifa/sutave)

## SUTAVE – Safety and Usability Through Applications in Virtual Environments



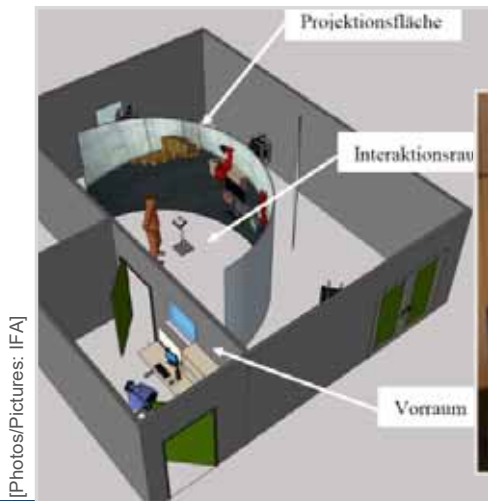
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**HF/E,  
EngPsy**



# SUTAVE – Safety and Usability Through Applications in Virtual Environments

- Design of work processes and products (simulation technique, research tool, testing environment)
- Training (medial support)
- Visualisation (design reviews)



[Photos/Pictures: IFA]

[Photos: Nickel/IFA]



Home > Technical Information > Virtual reality

## Virtual reality in human-systems

What is virtual reality?

In VR (virtual reality) with a simulated experience, simulated work equipment, virtual environments, from it through to this information, turn change the workers are all work environments.

**SUTAVE**  
Safety and Usability through Applications in Virtual Environments

Virtual reality in occupational safety and health  
An IFA service

[www.dguv.de/ifa/sutave](http://www.dguv.de/ifa/sutave)

## VR support for Human Factors in Human-System Interaction

- ... through Development and Design Reviews of Safety Concepts (e.g. protecting future workplaces using 3D zone monitoring)
- ... in Future Work Environments Not Yet Available (e.g. human information processing in human-robot interaction)
- ... in Hazardous Work Environments (e.g. usable safety measures for elevating work platforms)
- ... by Prevention Through Design (e.g. risk assessments during river lock planning stage)
- ... when supporting Training in OSH (e.g. qualification modules for risk assessment of machinery)



[Pictures: IFA]

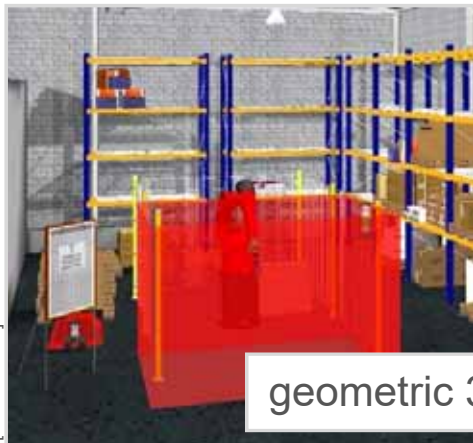


[Photo: Lungfiel/IFA]

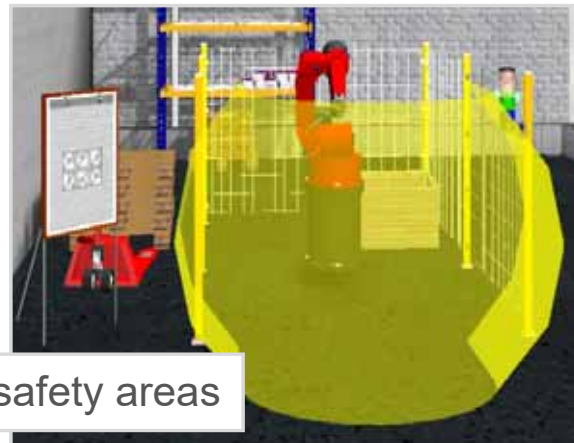


## Assessing New Technologies and Developing Safety Concepts

- Human perception and processing of 3D safety areas of Electro-sensitive protective equipment (ESPE) in context of use
- Minor differences in safety distances when using 2D and 3D safety areas
- Use of VR for development of safety concepts e.g. in manufacturing
- Project IFA5116 (DGUV Expert Committee “Woodworking and Metal Industries“, BGHM)

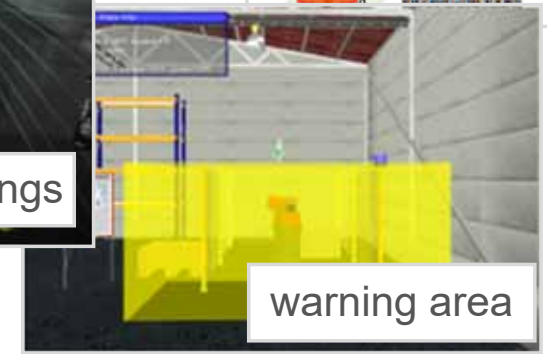


geometric 3D safety areas



floor markings

[Photo: Lungfiel / IFA]

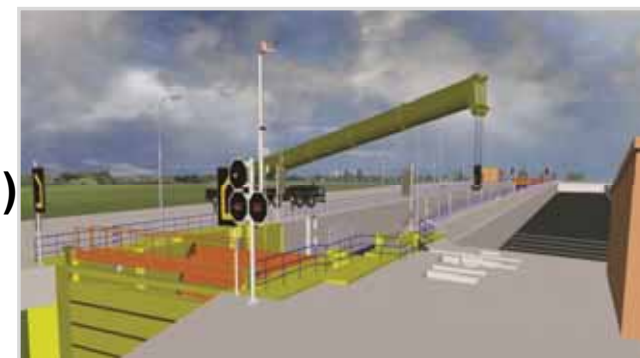


warning area

[Bilder: © IFA]

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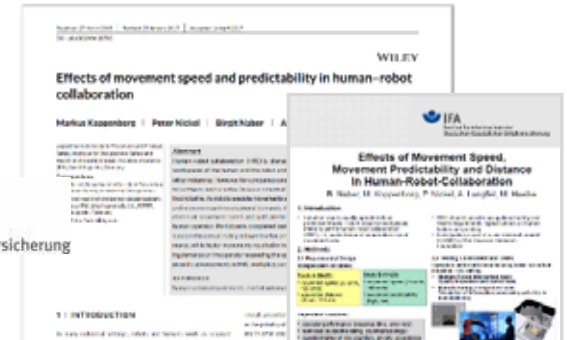
[Pictures: IFA]



[Photo: Lungfiel/IFA]

# Human Information Processing in Human-Robot Interaction

- Human Factors design requirements in human-robot interaction
- VR simulation for design of collaboration/interaction areas
- Behavioural effects of robot speed, distance and trajectory
- Behavioural effects of human-robot task-fit and indication of interaction demand
- MSc thesis (Psychology, University of Bonn)



[Koppenberg et al. 2017, HumFacMan]



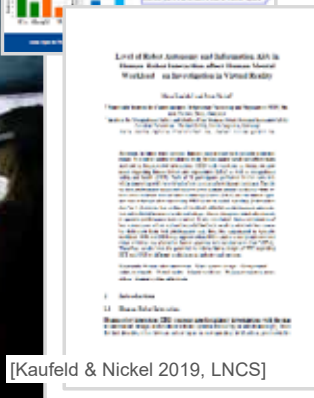
[Picture: IFA]



[Photo: Naber/IFA]



[Naber et al. 2014, WorldOSH]



[Kaufeld & Nickel 2019, LNCS]

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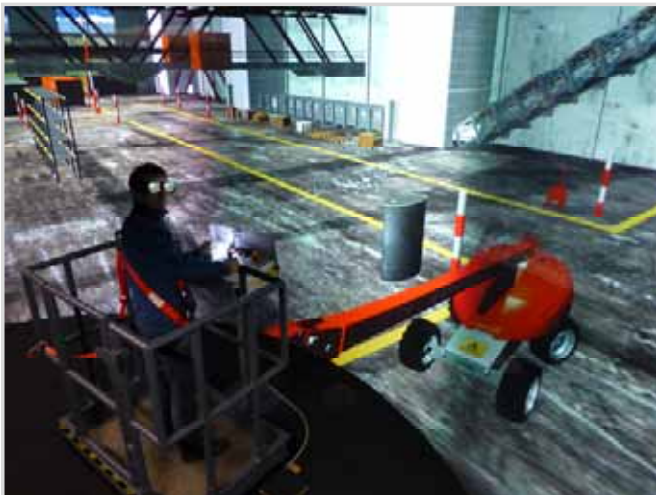
[Pictures: IFA]



[Photo: Lungfiel/IFA]

# Product Safety and Usability in Hazardous Situations

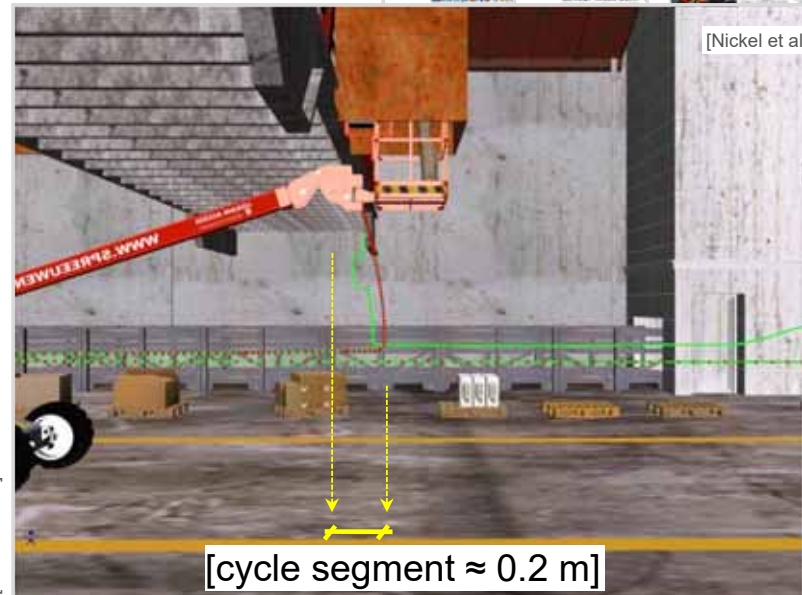
- Usability evaluation of additional safety measures before marketing; investigations in hazardous situations without placing operators in danger
- Recommendation: redesign of safety measures built into joysticks
- Project IFA5118 (DGUV Expert Committee „Trade and Logistics“, BGHM, BGHW)



[Photo: Naber/IFA]



[Photo: Nickel/IFA]



[Pictures: IFA]

[Nickel et al. 2015, WOS]

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[Pictures: IFA]



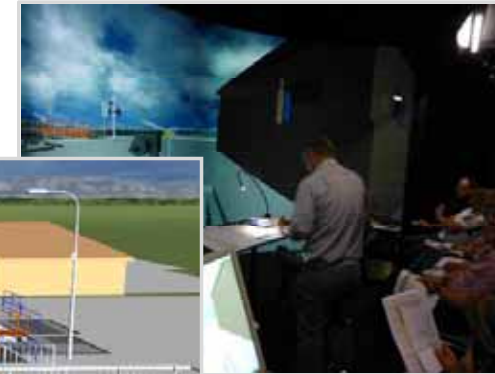
[Photo: Lungfiel/IFA]

# Prevention Early in Planning and Development

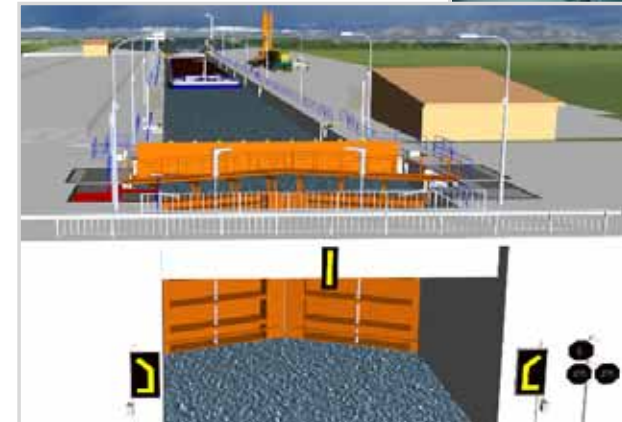
- Risk assessment support early in design
- Assessments according to EU Directives
  - Machinery Directive 2006/42/EC
  - OSH Framework Directive 89/391/EEC
  - Construction Site Directive 92/57/EEC
- Design improvements and template development for assessments in reality
- OSH by PtD in river lock standardisation
  - dynamic VR simulation of future river lock
  - OSH assessments in context of use
  - risk reduction during planning stage
- Project IFA5135 (UVB, BMVI, BG Verkehr etc.)



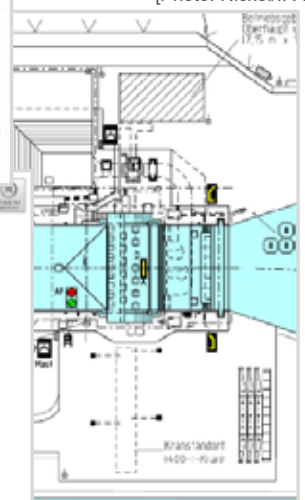
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[Photo: Nickel/IFA]



[Picture: IFA / FVT]



[Picture: WNA Dateien]



## Shaping Future Work Systems by OSH Risk Assessments Early On

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**Abstract.** With future work systems becoming more interactive, dynamic, and flexible, occupational safety and health (OSH) calls for prospective assessments of hazards and risks to facilitate prevention through design (PtD) more early in the design process. For this purpose, standardized objects representing a high level of OSH. A research project aimed at conducting risk assessments of river locks of the future, early in their planning stage, with standardized objects and referring to different EU Directives addressing safety and health at work. About 150 work scenarios across operational states and variations in river lock standardization have been compiled and supplemented for interacting risk assessments. They also covered design requirements for setting up dynamic virtual reality (VR) planning models in future contexts of use. Initial feedback about VR simulation use for scenario-based risk assessments, as well as a design review supported minor adjustments before the final design review can be conducted that should facilitate OSH improvement in the future assessment. The project motivates...

**Keywords:** OSH, Risk assessment, Modeling and simulation, Design requirements, Virtual reality

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[Pictures: IFA]



[Photo: Lungfiel/IFA]



# Systematic Development of VR Training Environments

- Develop, integrate and evaluate VR module in training courses on risk assessment
  - VR media support for qualification contents
  - foster self-directed and experience-based learning
  - Risk identification, assessment and reduction
- Project IFA5146 (BGN, HSK)
- Human Factors concept for SDVE: Structured Development of Virtual Environments



[Photos: Nickel/IFA]



[Pictures: IFA]

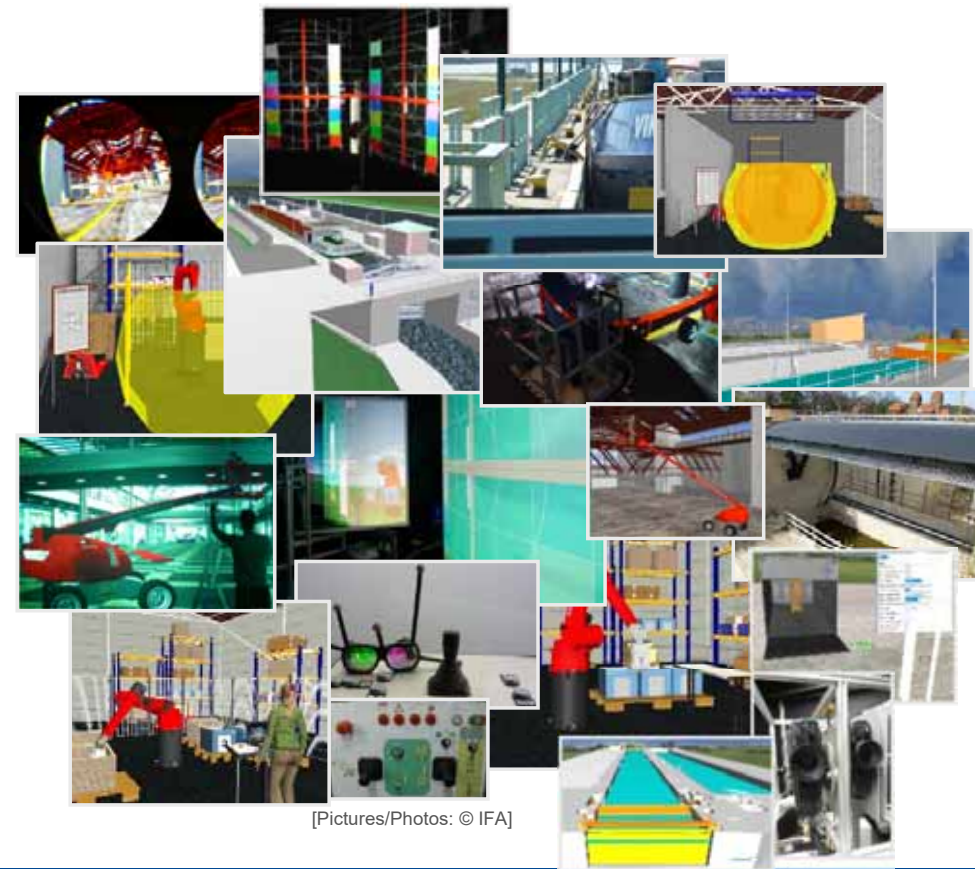


[Gomoll et al. 2019 GfA]  
[Gomoll et al. 2018 SIAS]



## Conclusions

- Safety and Usability Through Applications in Virtual Environments (SUTAVE)
- VR is a tool that becomes alive through the application context
- Human Factors concept on SDVE is crucial for prevention in OSH context
- VR support for training calls for simulation plus an educational concept
- VR extends the effective range of prevention through design (PtD)



Thank you very much for your attention!

**Virtual reality in human-systems interaction**  
**What is virtual reality?**



Zoom Image 🔍

Study of the efficacy of a protective measure in realistically simulated

In VR (virtual reality) users are immersed in a simulated environment with a simulated experience. They are submerged in a simulated environment, and through their sensors receive information with which they can change the virtual environment. Workers are able to interact with the environment, and to



[Pictures/Photos: © IFA]

[www.dguv.de/ifa/sutave](http://www.dguv.de/ifa/sutave)



**SUTAVE**  
Safety and Usability through Applications in  
Virtual Environments

**Virtual reality in  
occupational safety and health**  
An IFA service