imk ERGONOMIE

Dr. Lars Fritzsche

Diversity Management for the Ageing Workforce

Ergonomic Work Design as Precondition for Effectively Integrating the Aging Workforce in Production Tasks

Contents

Cross-industry Consulting and Engineering Services

Engineering

Product Development
Ronny Göpfert

- Mechatronic Systems
- Structural Components

Production Planning
Carsten Otto

- Production and Assembly
- Body in White

Information Technology
Dr. Jens Trepte

- Software Development
- Support and Service

Gerson Heuwieser
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Consulting

Ergonomics
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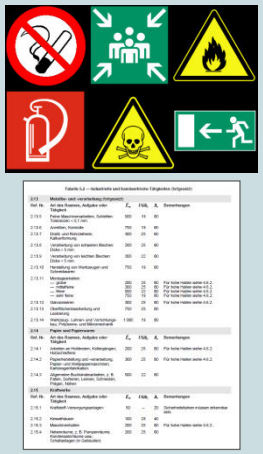
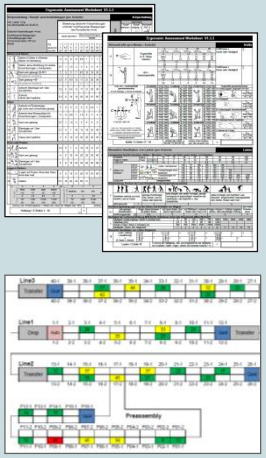
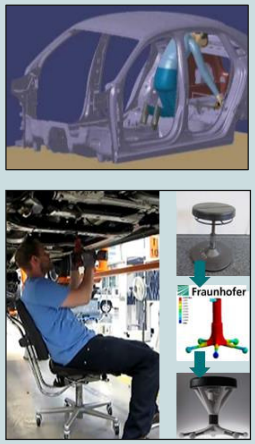
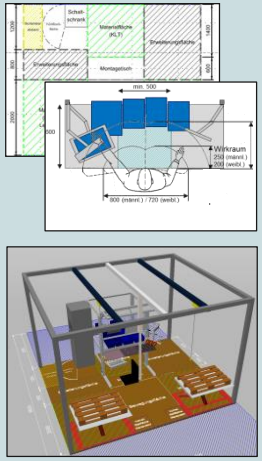
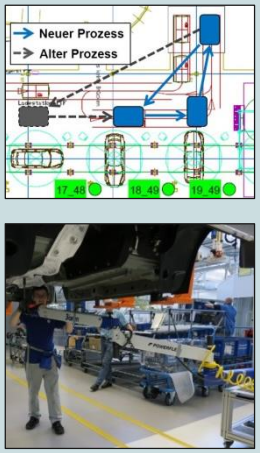
- Ergonomic Work Design
- Qualification and Training

Consulting
N.N.

- Production Strategies
- Product and Production Optimization

Strategic Development
Dr. Wolfgang Leidholdt

Ergonomic Work Design for the Entire Product Lifecycle

Work Safety Assessment	Ergonomic Assessment	Ergonomic Product Design	Production Planning	Production Optimization	Consulting & Training
- Work safety assessment according to federal law - Development of measures for risk reduction	- Use of customer specific methods - Standard methods (EAWS, RULA, etc) - Visualization on Ergonomic Map	- Concepts for product design (assembly parts, auxiliary tools, etc) - Analysis of reachability and buildability	- Work design - Workshops with employee participation - Work design for employees with restrictions	- Development of improvement measures - Workshops to improve ergonomics and efficiency	- Corporate ergonomics program design - Standard methods training - On-the-Job training
					

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MIKOMI Innovation. Bildung. Transfer.

"Good Ergonomics is Good Economics!" (H. Hendricks, 1996)

Economic benefits of good ergonomic work design:

- **reduces costs** for sick leave caused by work-related muscular-skeletal disorders (WRMSDs),
- **improves quality** due to less errors and fatigue in uncomfortable working conditions,
- **increases valued-added work** due to the reduction of unnecessary motions (bending, etc.)
- **amplifies motivation** among employees and their commitment to the company
- **increases flexibility of personnel deployment** by providing more suitable work places for older employees, females and disabled/partially restricted people

Ergonomic Work Design and Diversity Management are closely connected:

- Increased workforce diversity requires more effort in ergonomic design
- Good ergonomic design allows to deploy diverse workforce effectively

Relevant Facets of Workforce Diversity in Production Tasks

Diversity attributes that are most important in production tasks:

- **Age:**
  - collaboration between young and old colleagues is crucial for success by using the strength and experience of each other and for transferring knowledge and skills
  - age diversity is growing due to prolonged working and increases in regular age of retirement → employees are between 16 to 67 years old
- **Gender:**
  - gender diversity is growing because more and more females are nowadays working in traditionally male jobs like car assembly, logistics, etc.
- **Physical abilities**
  - due to the growing demographical diversity, the differences in employees' physical abilities are also increasing (healthy, strong people collaborate with disabled people)
- **(Cultural Background / Nationality)**

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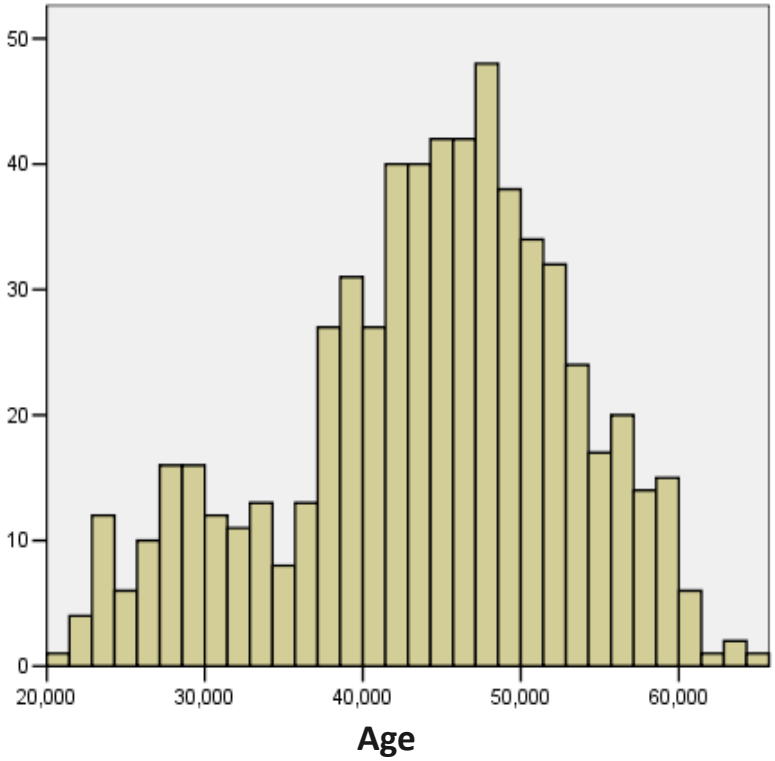
Field study in Mercedes-Benz car assembly (Fritzsche, 2010; Fritzsche et al., 2014)

What is the influence of ergonomic work strain and team diversity on productivity outcomes such as sickness absenteeism and assembly errors?

Sample:

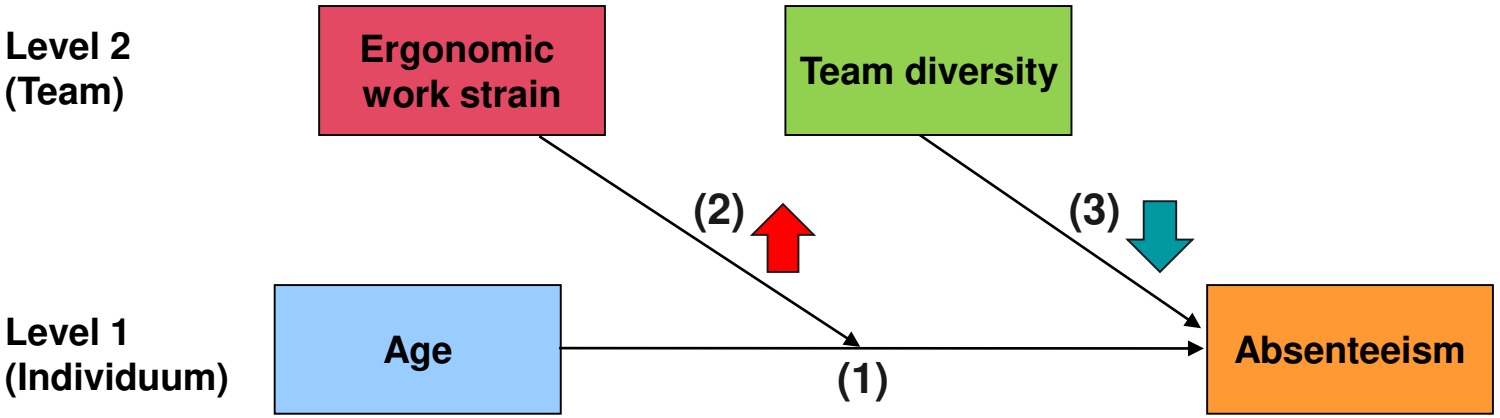
- 56 teams in car assembly
- objective data collected in a 1-year period (10/2007 to 11/2008)
- 623 workers, only 36 females
- Age: M = 44.10 (SD = 9.10)
- Job tenure: M = 19.23 (SD = 7.21)



Summary of Study Results (Fritzsche, 2010)

Multi-Level Analysis*:

* *HGLM-Model with Poisson-Distribution*

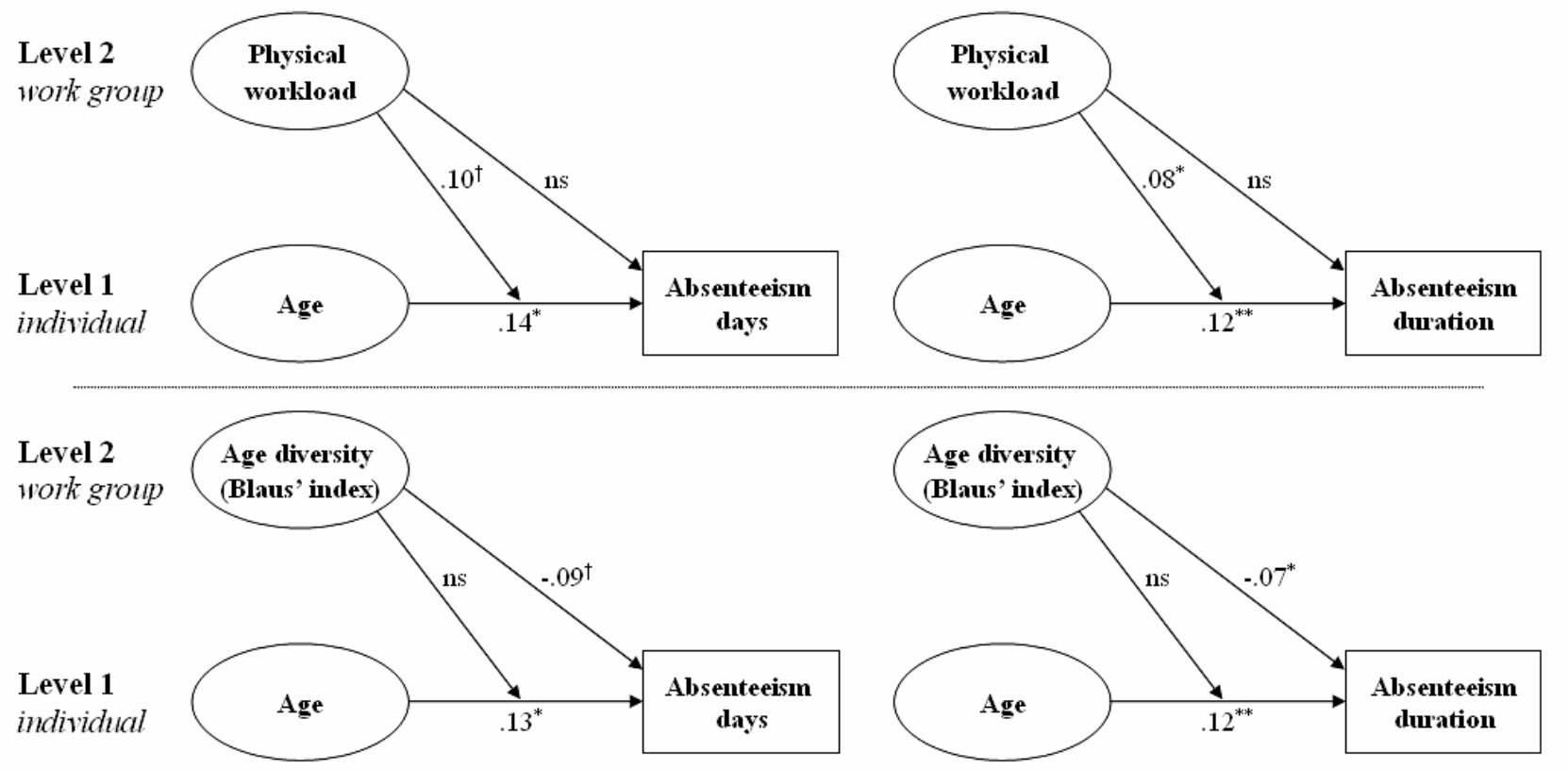


(1) **Sickness absenteeism increases** significantly with growing age, especially the absenteeism duration per case (but not the number of cases).

(2) **High ergonomic work strain amplifies** this (1) association: the higher the work strain, the strong the relation between age and absenteeism.

(3) **Age and gender diverse teams have a very positive effect:** both attributes are associated with less absenteeism and less errors in assembly (not shown here).

Summary of Study Results (Fritzsche, 2010)



Fritzsche, L. (2010). *Work Group Diversity and Digital Ergonomic Assessment as New Approaches for Compensating the Aging Workforce in Automotive Production.* Dissertation, Technische Universität Dresden.

Summary of Study Results (Fritzsche et al., 2014)

Regression Analysis:

Table 2. Regression – ergonomics and diversity as predictor for absenteeism duration.

Predictors	Model 1	Model 2	Model 3a	Model 3b	Model 4
Control variables					
Sampling period[a]	−0.51**	−0.50**	−0.45**	−0.51**	−0.47**
Team size	0.07	0.08	0.09	0.10	0.11
Physical workload	0.22*	0.29**	0.32**	0.30**	
Age mean		0.25*	0.17†	0.24*	0.16†
Age diversity (Blau)			−0.27*		−0.25*
Gender diversity (Blau)				−0.17†	−0.14
Physical workload					0.33**
Adjusted R^2	0.25	0.30	0.35	0.31	0.36
ΔR^2	0.29**	0.06*	0.06*	0.03†	0.10**

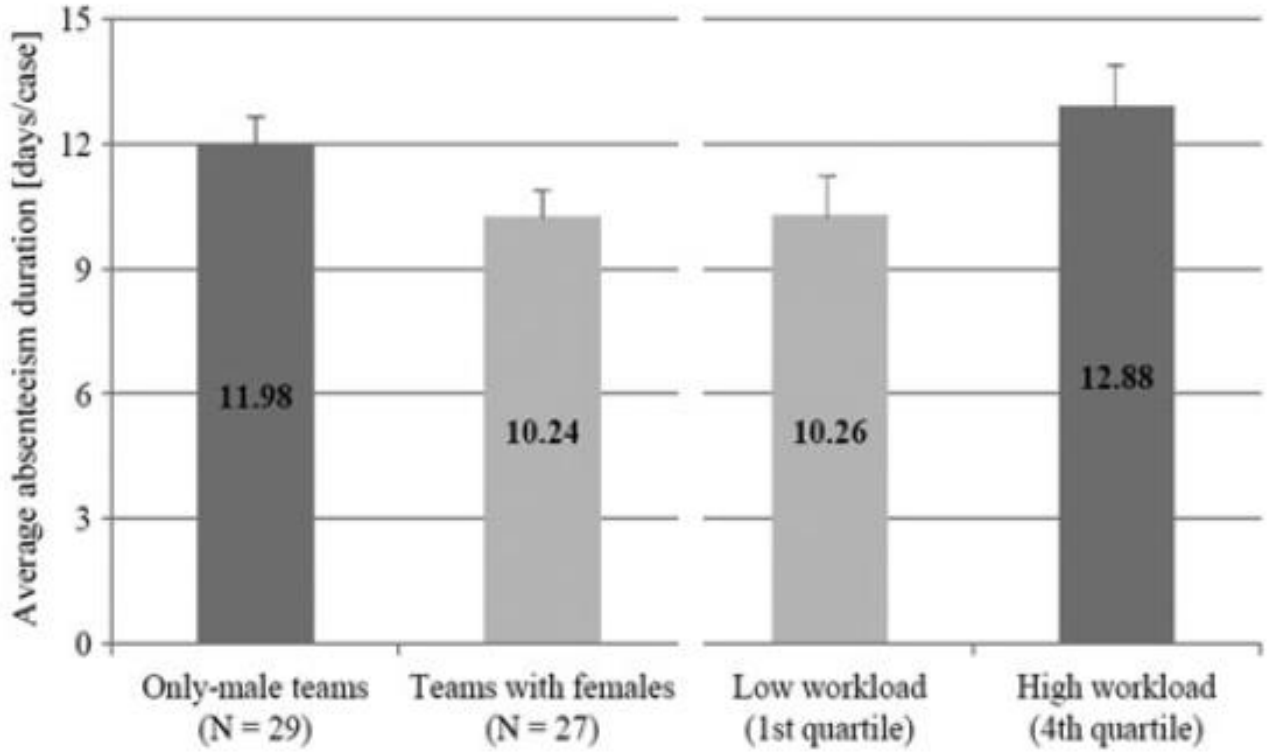
Note: $N = 56$ teams with 623 individuals.
†$p < 0.10$, one-tailed. *$p < 0.05$, one-tailed. **$p < 0.01$, one-tailed.
[a] Dummy coded: 0 = 254 days, 1 = 74 days.

Fritzsche, L., Wegge, J., Schmauder, M., Kliegel, M. & Schmidt, K.-H. (2014). *Good ergonomics and team diversity reduce absenteeism and errors in car manufacturing.* Ergonomics, 57 (2), 148–161.

Summary of Study Results (Fritzsche et al., 2014)

ANCOVA Analysis*:

* *Control variables: sampling period, team size, age mean and team diversity*



team differences are significant at p < .05 level.

Fritzsche, L., Wegge, J., Schmauder, M., Kliegel, M. & Schmidt, K.-H. (2014). *Good ergonomics and team diversity reduce absenteeism and errors in car manufacturing.* Ergonomics, 57 (2), 148–161.

Contents

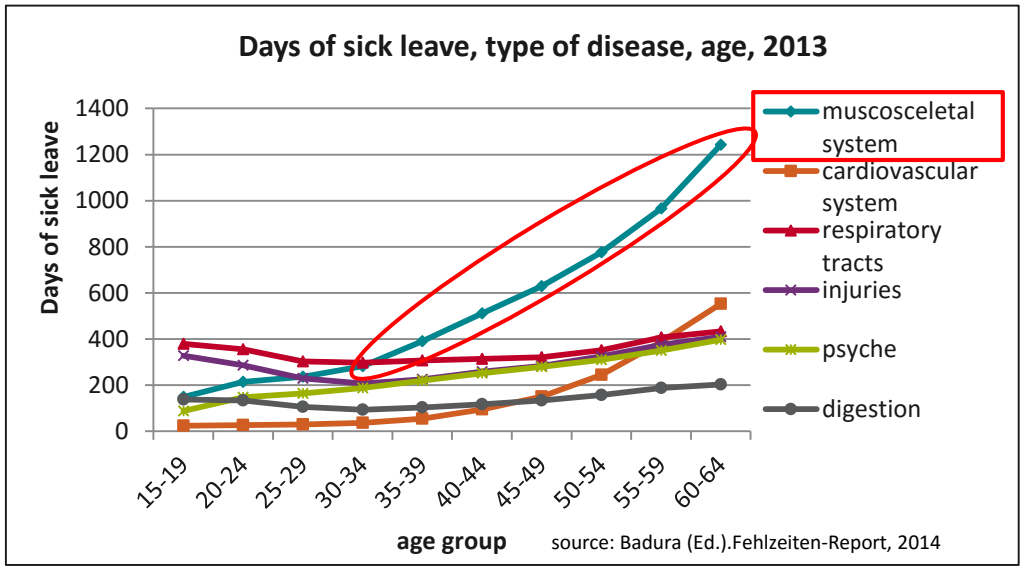
Work Design for Employees with Impaired Abilities

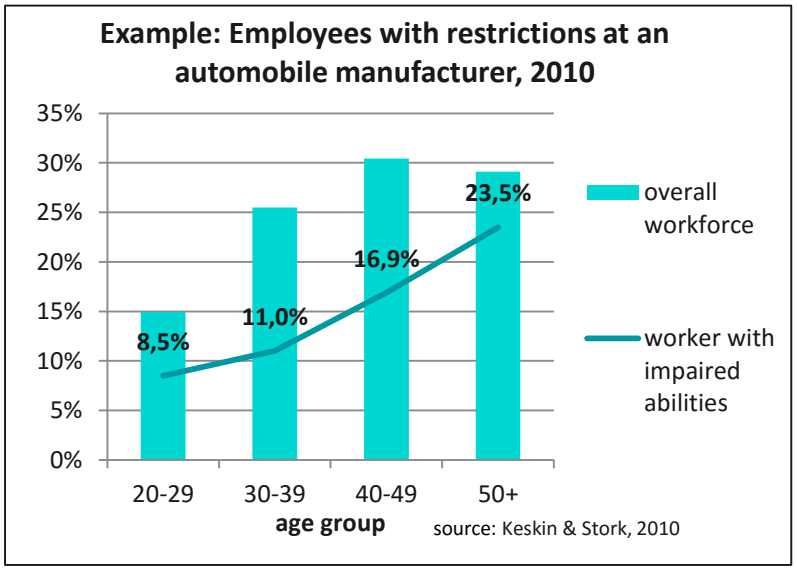
Employees with impaired abilities are people with **temporary** or **long-term** restrictions in their **physical or mental** performance

- They cannot perform their regular job anymore, which results in **productivity losses**.
- To ensure a value-adding work task it is necessary to provide these employees with a **job/workplace that is adapted** to their specific abilities and needs.
- Challenge: many **different types** of restrictions that mostly occur in **combinations.**

Level of work design	Typical restrictions
Work organization	• N/A night shifts • N/A rotating shift systems • N/A cycled production lines
Work place	• N/A manual load handling • N/A trunk bending • N/A over shoulder work • N/A force application (hand/arm)
Work environment	• N/A exposure to noise/vibration

Current Challenges in Production Industries





- increasing average **age** of workforce in Europe
- increasing share of **musculoskeletal diseases** with growing age
- increasing proportion of employees with **impaired abilities** with growing age

Project Application: Concept of a Modular Work Station for Restricted Employees

- Design of work station layout and components suitable for employees with impaired abilities
- Universal design that can be used for any employee, independent of his/her individual physical impairment
- Working heights can be adjusted to individual needs (standing or sitting operation; 5th percentile female to 95th percentile male)
- Technical specification based on current standards and guidelines and including recommendations for state-of-the art technologies
- Analysis of possible suppliers and cost estimation
- Simulation and analysis of an exemplary assembly process using the ema software

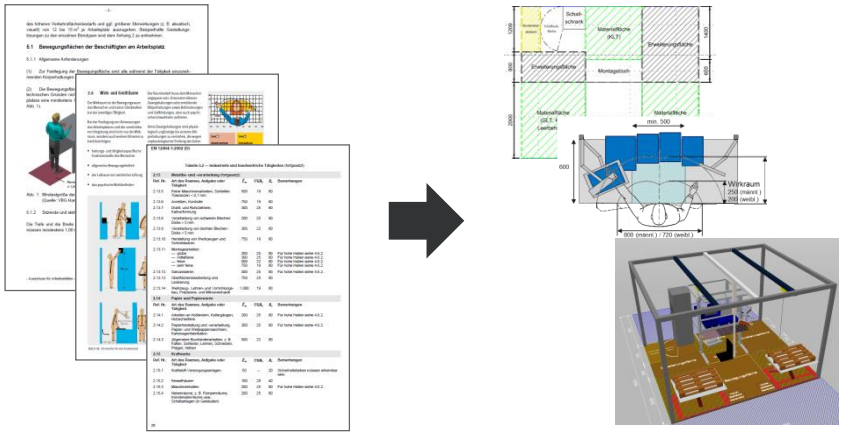


Fig.1: Concept design and technical specification based on current standards

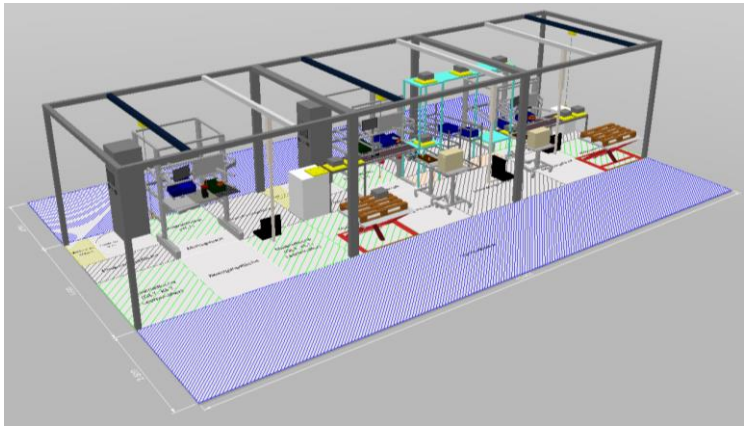
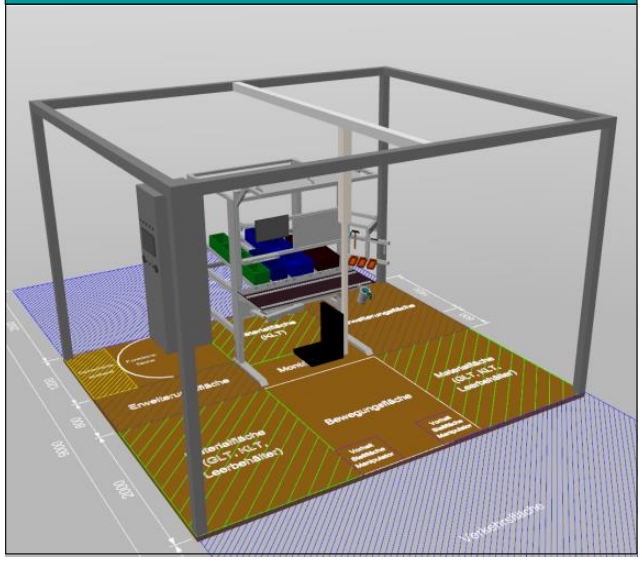


Fig. 2: Implementation and simulation of an exemplary assembly process

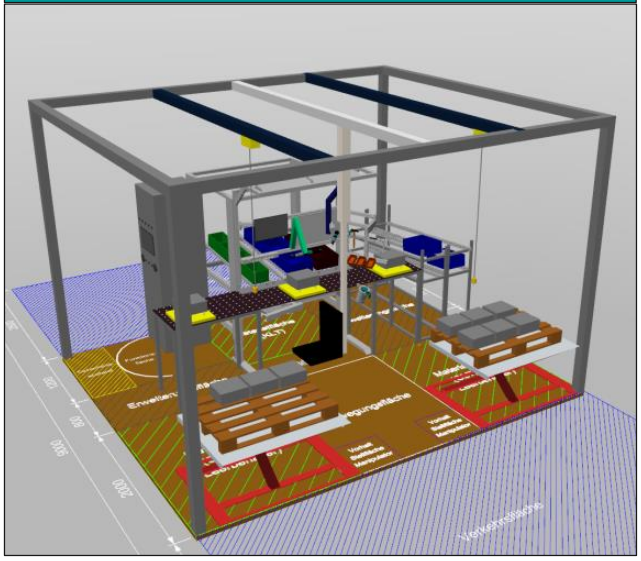
All employees can perform the work task, **regardless of their individual limitation**

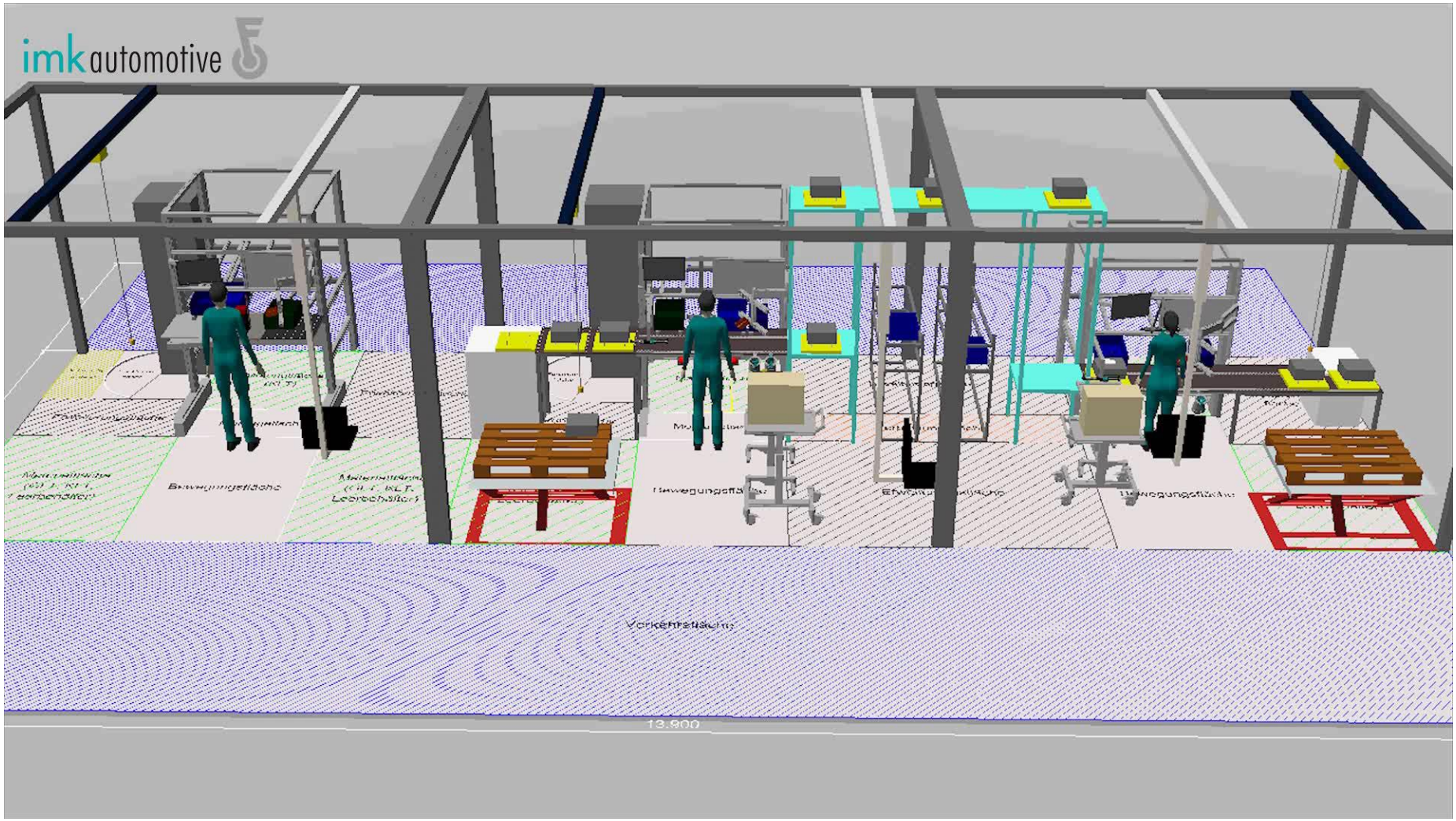
- Height-adjustable workbench enables switching between **standing and sitting**
- Manipulators, lifting tables, balancers and pivot arms are used to **eliminate loads and forces**
- All parts are provided in optimal height to **avoid bending and over-shoulder** picking
- Individual buffers allow to **decouple** the work cell from cyclic production (reduced mental stress)
- Layout allows to use **separated or interconnected** workstations

Standard work cell



Extension of the standard work cell

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Station 1:
95th percentile male

overall score summation:	5.5
posture score summation:	**5.5**
posture scores	2
twist score	0.7
bend score	0
reach score	2.8
force score summation:	**0**
finger forces	0
body forces	0
load score summation:	**0**
repositioning	0
holding	0
carrying	0
pushing & pulling	0
extra score summation:	**0**
influences by working on moving parts	0
accessibility	0
vibrations, momentum, forces	0
joint postures	0
other stesses and strains	0

Station 2:
50th percentile male

overall score summation:	5
posture score summation:	**5**
posture scores	2
twist score	2.1
bend score	0
reach score	0.6
force score summation:	**0**
finger forces	0
body forces	0
load score summation:	**0**
repositioning	0
holding	0
carrying	0
pushing & pulling	0
extra score summation:	**0**
influences by working on moving parts	0
accessibility	0
vibrations, momentum, forces	0
joint postures	0
other stesses and strains	0

Station 3:
5th percentile female

overall score summation:	5
posture score summation:	**5**
posture scores	2.2
twist score	0.9
bend score	0
reach score	1.6
force score summation:	**0**
finger forces	0
body forces	0
load score summation:	**0**
repositioning	0
holding	0
carrying	0
pushing & pulling	0
extra score summation:	**0**
influences by working on moving parts	0
accessibility	0
vibrations, momentum, forces	0
joint postures	0
other stesses and strains	0

(Ergonomic evaluation with ema based on EAWS V1.3.3)

Contents

VirtualAging

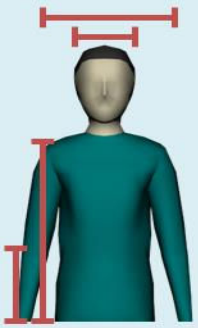
Simulation of age-related changes in relevant abilities for virtual product and production process design

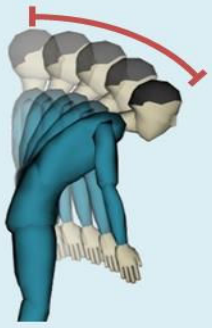
Product

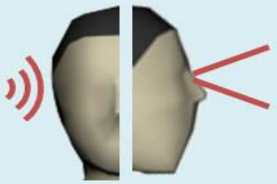
Production process

Age-related ability changes

Anthropometrics	Biomechanics	Sensory







GEFÖRDERT VOM

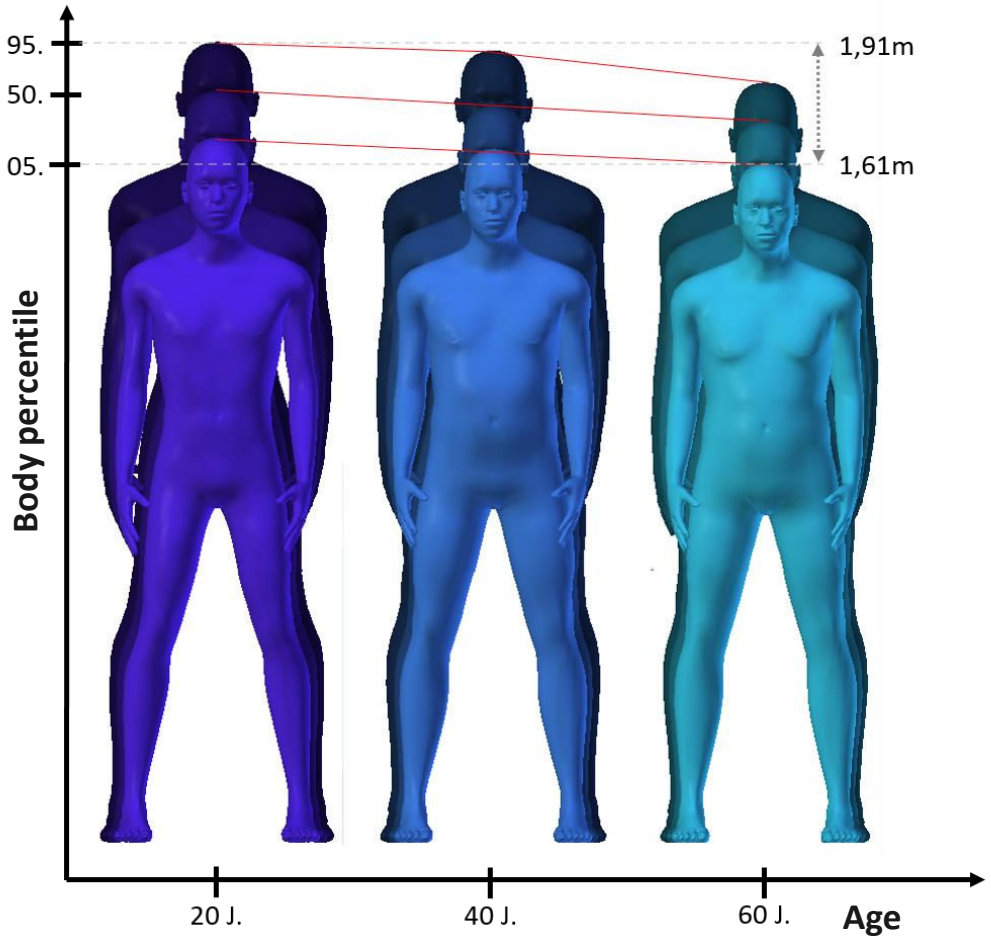
DLR Projektträger

Bundesministerium für Bildung und Forschung

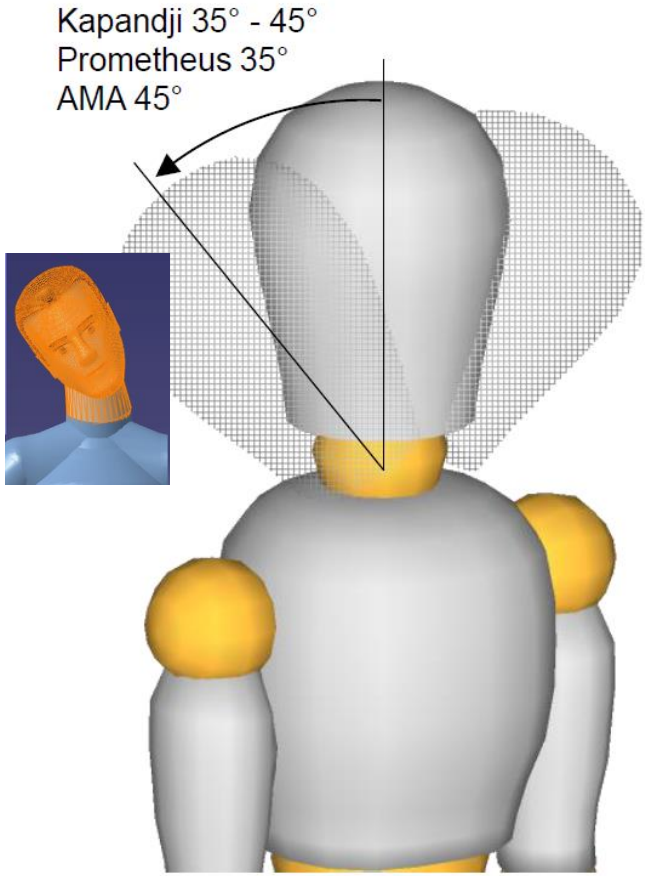
Project Partner:

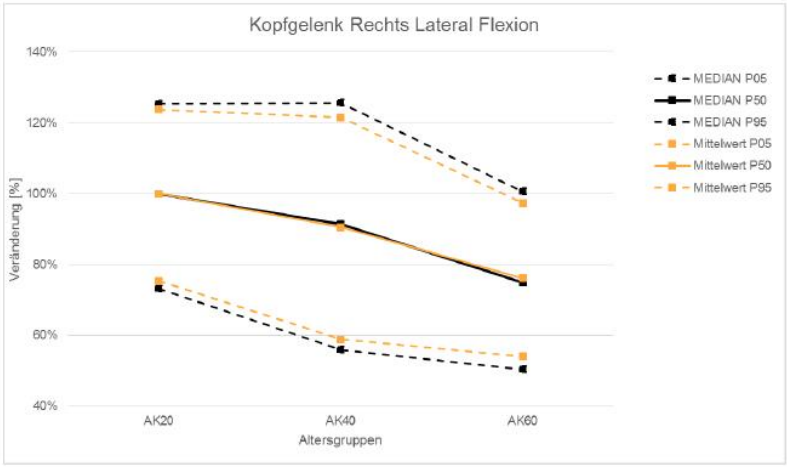
Example 1: Age-related Changes in Anthropometry

- Shorter body height
- Bigger body volume
- Proportions unchanged



Example 2: Age-related Changes in Body Flexibility





		AK20	AK40	AK60
MEDIAN	P05	73%	56%	50%
MEDIAN	P50	100%	91%	75%
MEDIAN	P95	125%	126%	101%

→ **Median P50 40° 36° 30°**

General Conclusions

- **Growing diversity** in age, gender and physical/mental abilities of the workforce **requires enhanced ergonomic work design**

- **Economic benefits** of ergonomic work design are well documented, especially due to reduced sickness absenteeism, improved work quality and higher flexibility

- **Virtual simulation tools** can help to design such workplaces proactively in order to reduce implementation costs and facilitate worker participation and acceptance

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