

Assessment of risks related to employee-cobot interaction

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Internet & Further Information / Tools: www.institut-aser.de



EUROSHNET Conference 2019

12-14 June

2019 Dresden, Germany

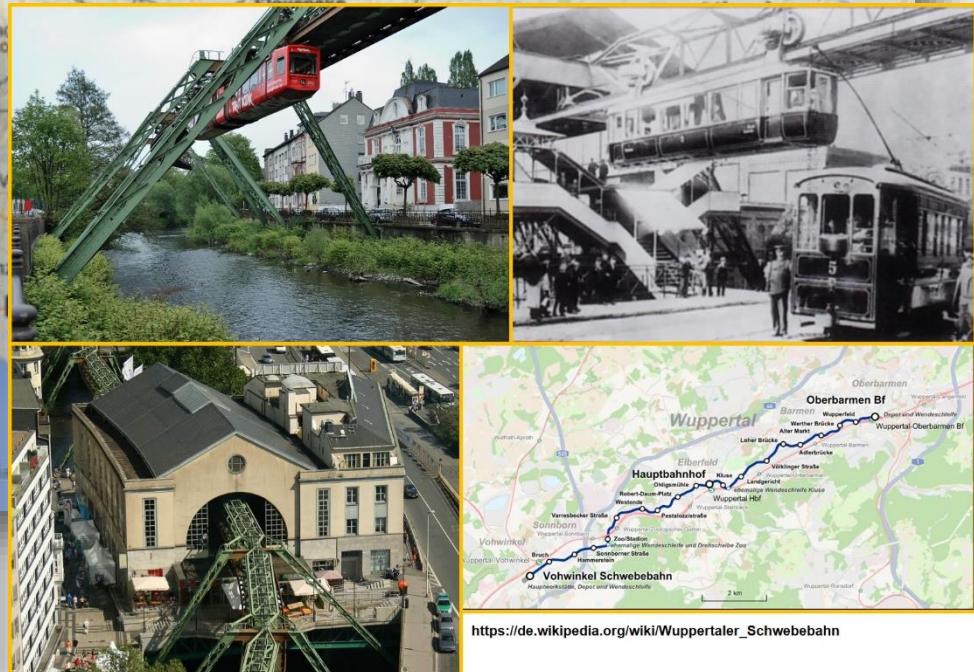
Be smart, stay safe together - innovative products and workplaces

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- 1. Introduction**
 - 2. Methods**
 - 3. Results**
 - 4. Discussion**

Institute of Occupational Health, Safety and Ergonomics (ASER e.V.)

Our Location in Wuppertal (NRW), Germany

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https://de.wikipedia.org/wiki/Wuppertaler_Schwebebahn

Research



Methods

Belastungsintensität bzw. Beanspruchungsintensität	Einsatzgruppe	Arbeitsenergieumsatz AU [W]	Normal-Effektivtemperatur NET [°C]							Effektive Bestrahlungsstärke E_{eff} [W/m²]	Lärm-Beurteilungspegel L_T [dB (A)]	Arbeitspulsfrequenz AP [1/min]
			40	36	33	30	28	26	25			
Überbelastung sehr wahrscheinlich VII		[W] > 280 [m] > 420	40	36	33	30	28	26	25	$E_{eff} > 300$	$L_T > 95$	AP > 52
Überbelastung bzw. wahrscheinlich VI		> 250 < 280 > 380 < 420	37	33	29	26	23	21	19	$260 < E_{eff} \leq 300$	$90 < L_T \leq 95$	$48 < AP \leq 52$
Überbeanspruchung möglich V		> 220 < 250 > 330 < 380	33	31	27	23	19	15	11	$220 < E_{eff} \leq 260$	$85 < L_T \leq 90$	$42 < AP \leq 48$
Toleranzschwelle Grenzbereich (DLG)	Akzeptanzschwelle IV	> 180 < 220 > 270 < 330	31	29	25	21	17	13	9	$160 < E_{eff} \leq 220$	$80 < L_T \leq 85$	$34 < AP \leq 42$
belastend bzw. beanspruchend III		> 130 < 180 > 200 < 270	25	22	19	16	14	11	8	$95 < E_{eff} \leq 160$	$75 < L_T \leq 80$	$26 < AP \leq 34$
gering belastend bzw. gering beanspruchend II		> 80 < 130 > 130 < 200	19	17	15	13	11	9	7	$35 < E_{eff} \leq 95$	$65 < L_T \leq 75$	$17 < AP \leq 26$
sehr gering belastend bzw. sehr gering beanspruchend I		[W] < 80 [m] < 130	I	II	III	IV	V	VI	VII	$E_{eff} \leq 35$	$L_T \leq 65$	AP < 17

* a.a. DIN 33403-3 (1998-09); Klima am Arbeitsplatz und in der Arbeitsumgebung; Klimateigenschaften des Klimas im Erreichbarkeitsbereich.

Müller, B.H. (1981): Ergonomie - Bestandteile der Sicherheitswissenschaft. REFA, Berlin, 1989

Müller, B.H. (1982): Synthetische Arbeitsplatz - Verfahren zur Erstellung von arbeitsplatzspezifischen Belastungs-Beanspruchungs-Profilen. Diss., Wuppertal, 1982

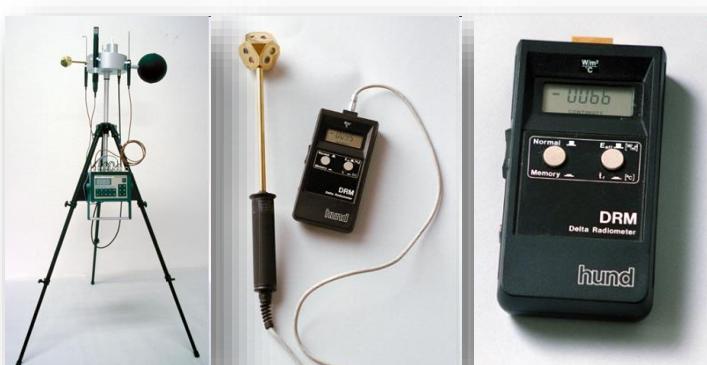
Übersichtstabellen zur Belastungsklassifizierung am Arbeitsplatz. 2. Aufl. (Grundlagen und Methoden, Bd. II Eisen- und Stahlindustrie, BAU, Dortmund, 1990)

Arbeitswissenschaftliche Bewertung von Belastungs- und Beanspruchungsgrößen (nach ASER*, 1981)

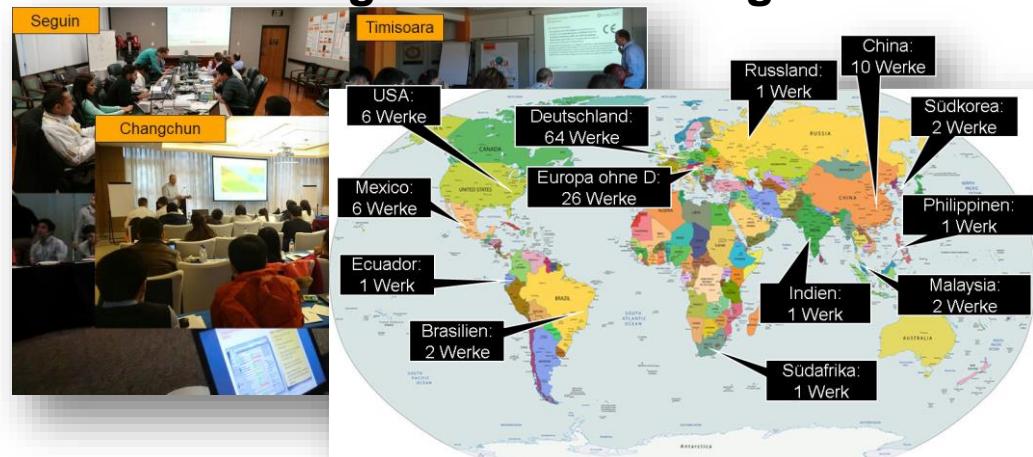
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Measuring Devices Development



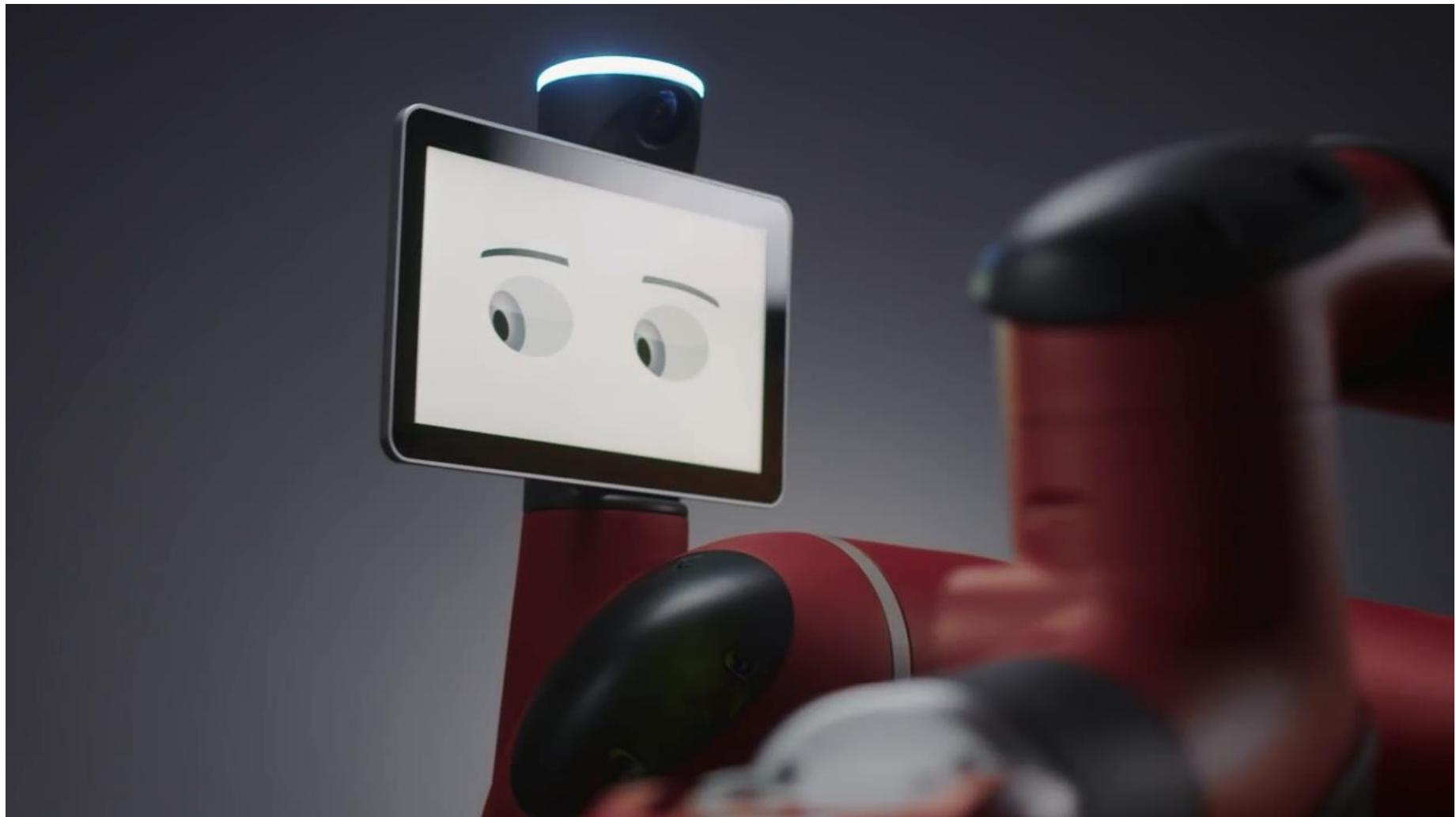
Worldwide Instrument Implementation & Ergonomics Trainings



Do safe innovations lead to healthy workplaces?

What has been studied
for this purpose?

Aspect	Specification
workplace area	shopfloor / logistics
workplace status	existing / already implemented
industry 4.0 type	inherently safe cobot
impact type	safe product → safe use (accidents) → guarantees a healthy use (short, mid & long-term health effects)?



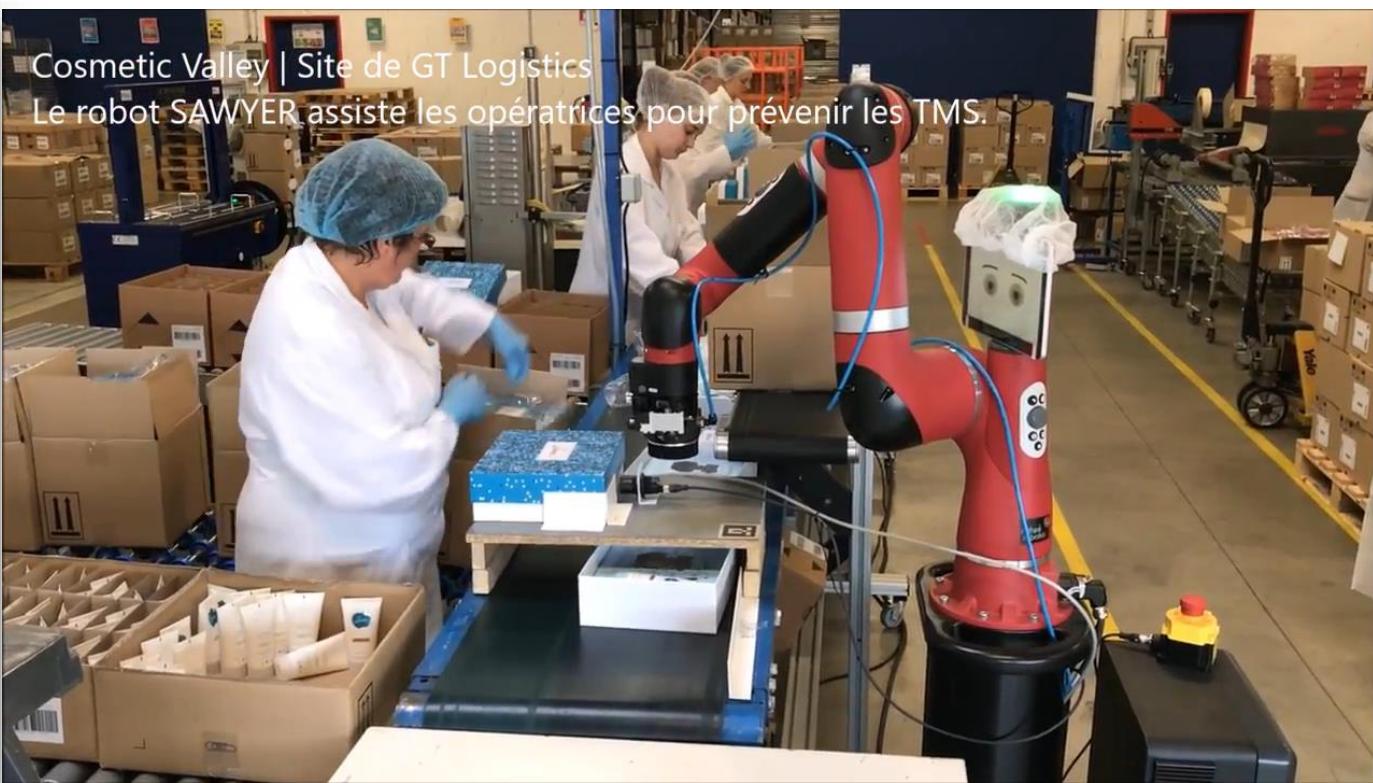
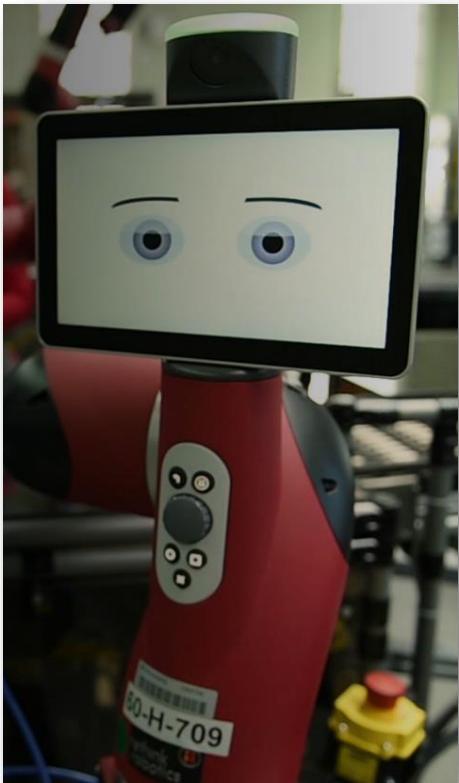
Source: rethinkrobotics

Cobot-Interaction in Logistics

- Sawyer Lightweight Robot
- 1 jointed-arm
- Display with stylized eyes

Implementation:

- Industrial Hall (Logistics)
- Re-packaging of tubes on the assembly line
- Shift system: 3 x 8h



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BDS-Instrument – Holistic Approach Results & Modular System

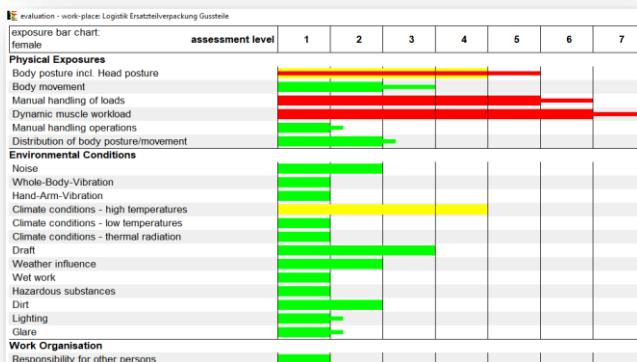
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BDS = Multilingual Instrument for Production Ergonomics, Risk Assessment with Expert Functions

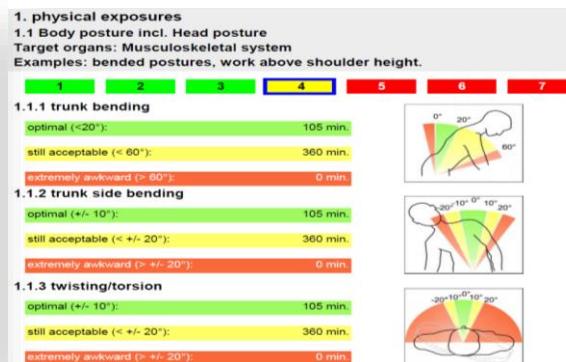


Results & Expert BDS-Functions for Industrial Engineering & Ergonomists

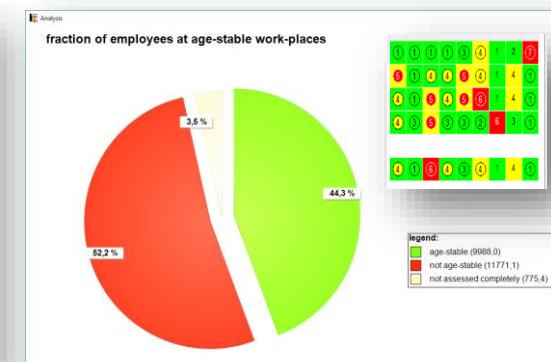
Assessment Profiles



Ideas for Improvement & Simulation



Statistics, KPIs, Reports, Expert Analysis, cadasters



Thematic BDS-Modules for Holistic Approach

Physical Exposures

Environmental Conditions

Risk Assessment

Occupational Health Care

Measures incl. effectiveness check

Mental Exposures

PPE

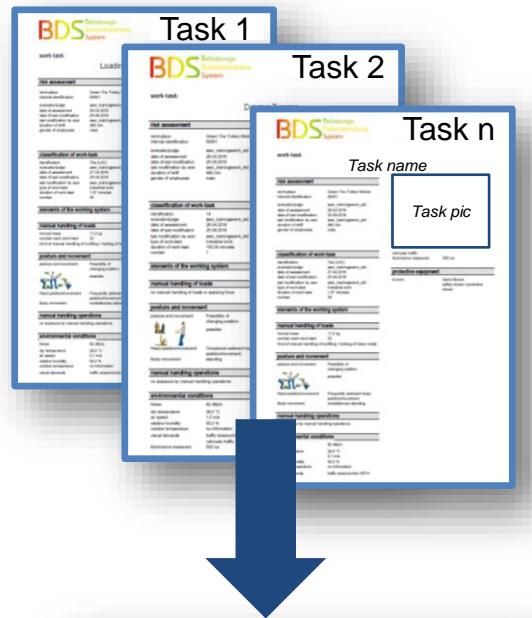
Maternity Protection

Collective Bargaining Agreement

- BDS-Instrument's Production Ergonomic Module was used to check, if the cobot guarantees a healthy use
- Main focus were the Physical Exposures & Mental Exposures
- BDS-Instrument's Simulation Functions were used to compare the initial situation (human only) with the employee-cobot interaction

BDS-Instrument – Basic Methodical Background

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level	meaning of bars / assessment
1	Exposures overall harmless to health
2	
3	
4	Work-place with limit values
5	The work-place is only suitable to well trained and healthy workers.
6	
7	The limit values of reasonable exposures are exceeded. Need for Action.

BDS Belastungs-Dokumentations-System

work-place :

Workplace name

Risk assessment

work-place	internal identification	date of creation	date of assessment	date of last modification	last modification by user	Green Tire Trolley Worker	duration of shift	gender of employee	number of similar work-places
0000	0000	2016-08-26	2016-08-26	2016-08-26	user_trainingware_std	480 min	male	4	
						shift factor:			
						3,7			

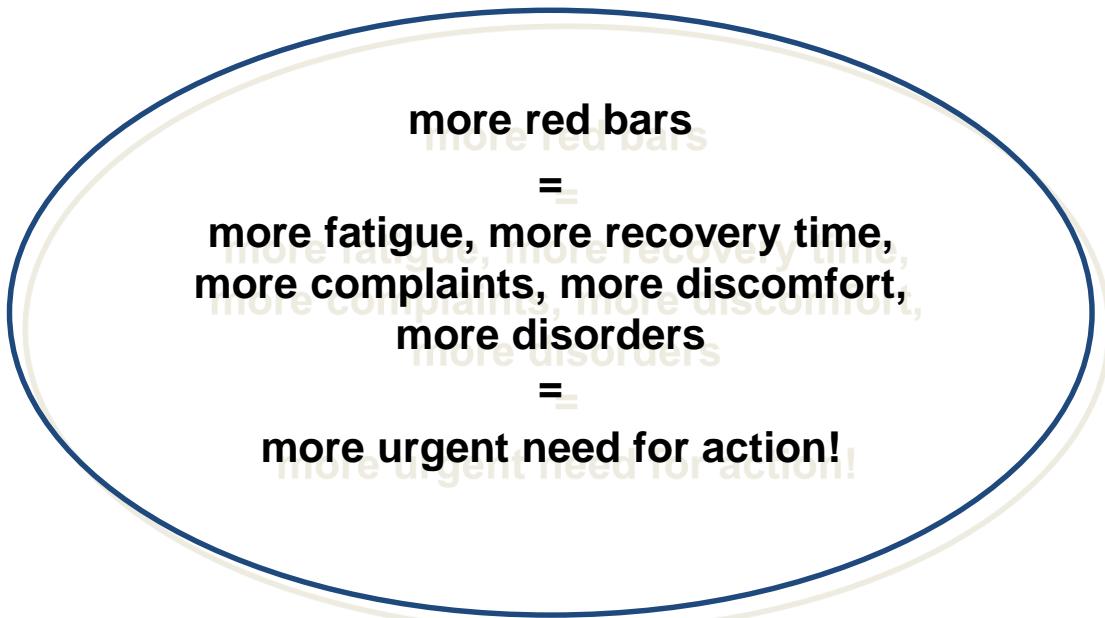
exposure per object

Physical Exposures	assessment level	1	2	3	4	5	6	7
Body posture		green	yellow	red				
Body movement		green	yellow	red				
Manual handling of loads		green	yellow	red				
Manual handling operations		green	yellow	red				
Distribution of body posture / movement		green	yellow	red				
Environmental conditions		green	yellow	red				
Work		green	yellow	red				
Whole-Body vibration		green	yellow	red				
Hand-arm vibration		green	yellow	red				
Chemical conditions - high temperatures		green	yellow	red				
Chemical conditions - low temperatures		green	yellow	red				
Chemical conditions - thermal radiation		green	yellow	red				
Weather influence		green	yellow	red				
Work tasks		green	yellow	red				
out		green	yellow	red				
Upstairs		green	yellow	red				
Work Organization		green	yellow	red				
Responsibility for other persons		green	yellow	red				
Requirement of cooperation		green	yellow	red				
Requirement of concession		green	yellow	red				
Underlaying work		green	yellow	red				
Work tasks		green	yellow	red				
other tasks		green	yellow	red				
other material risks		green	yellow	red				
Contribution to the technical process		green	yellow	red				
Contact with colleagues		green	yellow	red				
PNG		green	yellow	red				
Special exposure due to personal protective equipment		green	yellow	red				

distri. of body posture / movement

real	ideal
7% sitting	45 - 65%
74% standing	0 - 25%
19% moving	10 - 55%

optimal is equivalent to assessment level 1



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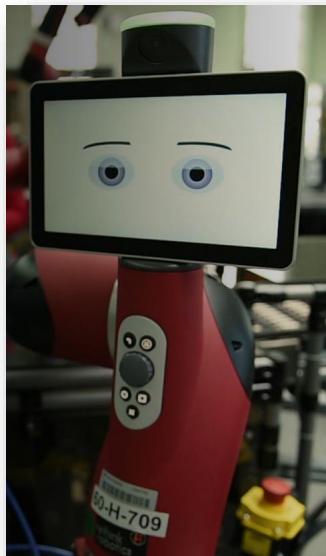
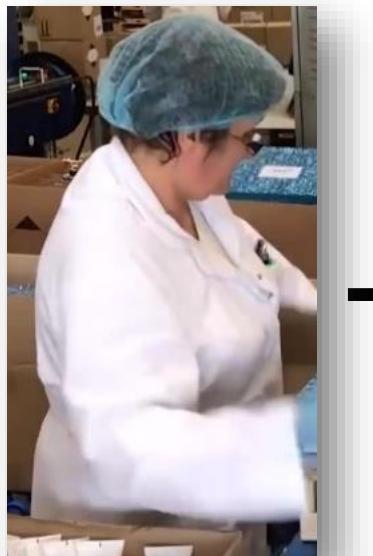


- Permanent trunk torsion > 10° (left/right)
- 54.000 hand movements for both hands in total / shift
- 7 hours continuous static standing
- ...

BDS Assessment level 1 2 3 4 5 6 7

Physical exposures





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BDS Assessment level

Physical exposures

1 2 3 4 5 6 7



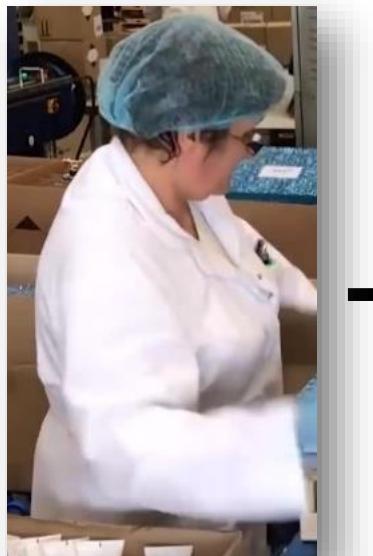


- 7 sec cycle time
- only displacing tasks, no rotation
- cycle dependend w/o buffer
- ...

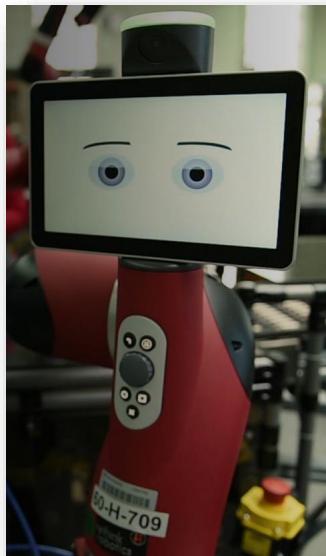
BDS Assessment level 1 2 3 4 5 6 7

Mental exposures

Responsibility for other persons	1	2	3	4	5	6	7
Responsibility for the process	1	2	3	4	5	6	7
Requirement of concentration	1	2	3	4	5	6	7
Unchallenging work	1	2	3	4	5	6	7
Visual space	1	2	3	4	5	6	7
Visual acuity	1	2	3	4	5	6	7
Fine motor skills	1	2	3	4	5	6	7
Repetition of work-tasks	1	2	3	4	5	6	7
Connection to the technical process	1	2	3	4	5	6	7
Contact with colleagues	1	2	3	4	5	6	7



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BDS Assessment level

1 2 3 4 5 6 7

Mental exposures

Responsibility for other persons	1	2	3	4	5	6	7
Responsibility for the process	3	4	5	6	7		
Requirement of concentration	3	4	5	6	7		
Unchallenging work	6	7					
Visual space	1	2	3	4	5	6	7
Visual acuity	1	2	3	4	5	6	7
Fine motor skills	2	3	4	5	6	7	
Repetition of work-tasks	6	7	8	9	10	11	12
Connection to the technical process	6	7	8	9	10	11	12
Contact with colleagues	3	4	5	6	7	8	9

BAB BDS BDS Results, KPIs & Reports	Workplace	w/o cobot	cobot- interaction
KIM-MHO result (risk score)		50,3	53,6
Physical Overload factor / employee (BDS report)		6	6
Cycle time (duration)		7s	5s
Repetition of work tasks (BAB level)		7	7
Connection to the technical process (BAB level)		4 (5)	6 (7)
Age stability (BDS KPI)		no	no
Mental Overload factor / employee (BDS report)		6	7
MSD risk (AMR 13.2 criteria)		yes	yes
Ordinance on Occupational Health Care – Sect. 5		optional	optional
Irresponsible Risk (§9 MuSchG criteria)		yes	yes
Production Ergonomics Rank	1 of 2	2 of 2	
Generally recommended for shopfloor	no	no	

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- Cobot-implementation increased upper extremity risk (hand-/arm-injuries, CTS, ...) → necessary surgeries increase!
- New inherently safe technology can worsen exposures!
→ no cobot-manufacturer problem, but an end-user problem
- Cobots ≠ Manipulators (LHC success) in terms of ergonomics
→ method/process training for industrial engineering
- Improvement Implementation gets more & more complicated
→ extended improvement management required → Methods
- Always the same: Worldwide approaches & limits, more qualification in companies, more stringent control, higher penalties
→ holistic research is needed, e.g. for providing borders for Law & Standardization, development of innovative ergonomic solutions, ...

Benefits

- Cost savings
- Financial benefits
- ...

Costs

- Investment costs
- Ongoing costs
 - sick leave
 - follow-up costs



Time

- TIMWOODS
- ...

Risks

- Project realization risks
- Financial risks
- Business risk
- Initiation risk
- Safety and Health risks

Thank You for you Attention!

Do you have questions / ideas? (voxr!)

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