Chancen für gesundes Arbeiten durch Exoskelette

14.9.2022, Basi Berlin

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Schweissen mit Exoskeletten, EXOWORKATHLON Hamburg 8.9.2022

Wearable Technologies (2022), 3, e17
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REVIEW ARTICLE

Influence of exoskeleton use on welding quality during a simulated welding task

Marco Schalk[1,2]*, Ines Schalk[1,2], Thomas Bauernhansl[1,2], Jörg Siegert[2], Alexander Esin[3] and Urs Schneider[1,2]

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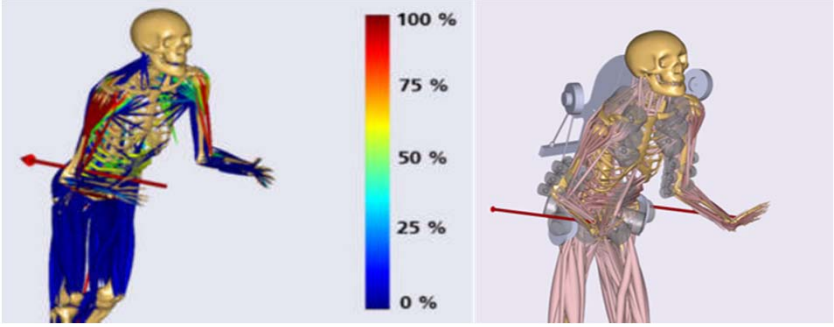
Exoskelett-Forschung am Fraunhofer IPA

Übersicht unserer Aktivitäten und Kompetenzen

Ergonomische Bewertung u. biomechanische Analyse
(im Feld und im Labor)



Analyse u. Konzeption
mittels Mensch-Exoskelett-Modellen

Konzeption u. Entwicklung
von passiven und aktiven Exoskelett-Systemen

Evaluationen im Feld und im Labor
und Human-in-the-Loop Experimenten

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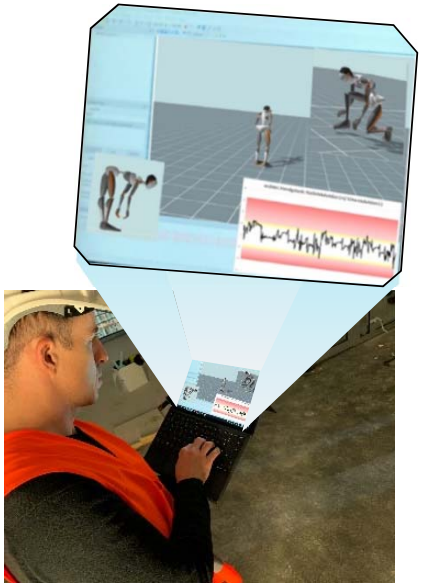
Wir testen Exoskelette im Feld

Ergonomie

Usability

Produkt-Anpassung



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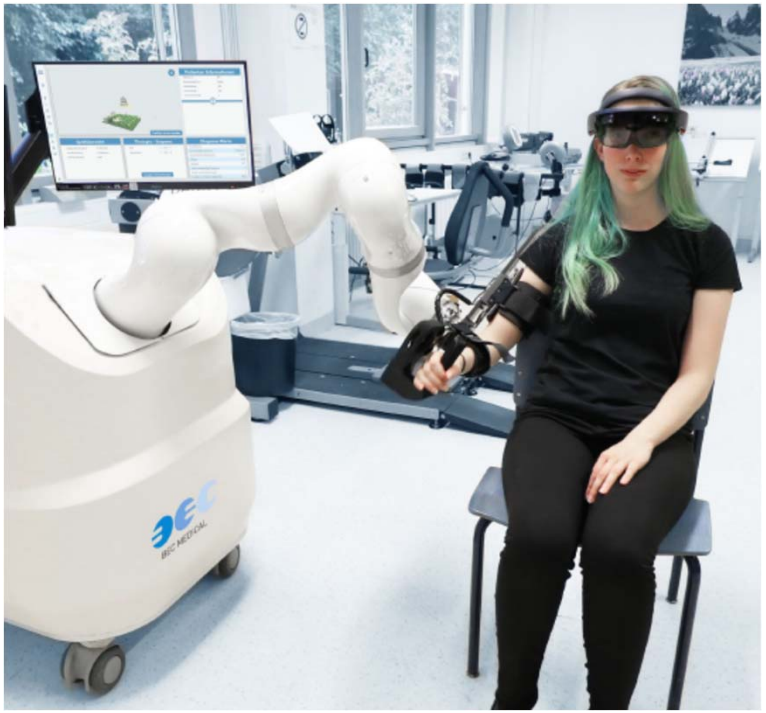
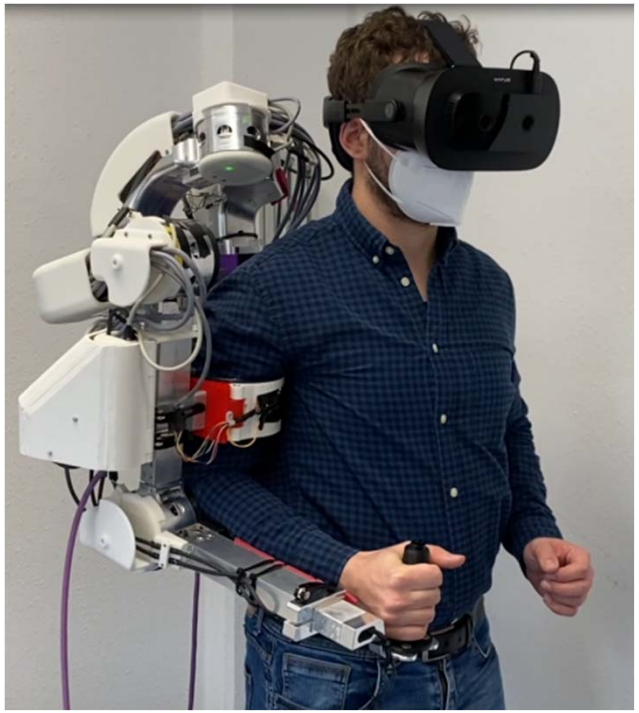
Exoskelette für Training und Rehabilitation – Beispielprojekte



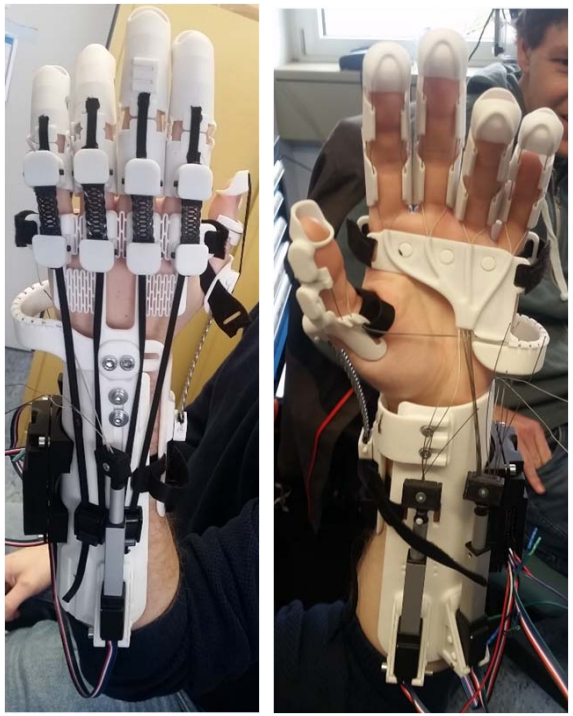
Platform Cora Care

(im BMBF RobExReha Projekt)



Exoskelett-System für haptisches Feedback

(im BMBF EXOHAPTIK Projekt)



Hand-Exoskelett

(im KONSENS-NHE Projekt)
(IFF, Uni. Stuttgart)

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Industrielle Exoskelette Forschung

Herausforderungen und aktuelle Themen

Sicherstellung der biomechanischen Wirksamkeit

angesichts (1) der Vielfältigkeit an Bewegungsabläufen
und (2) der anthropometrischen Variabilität

Intuitive belastungssituative Unterstützung

angesichts der Variabilität der zu handhabenden Lasten,
ohne die Handhabungsflexibilität einzuschränken

Simulative Ansätze

für die Auswertung der

biomechanischen

Wirksamkeit

Automatische

Erkennung des

Unterstützungsbedarfs

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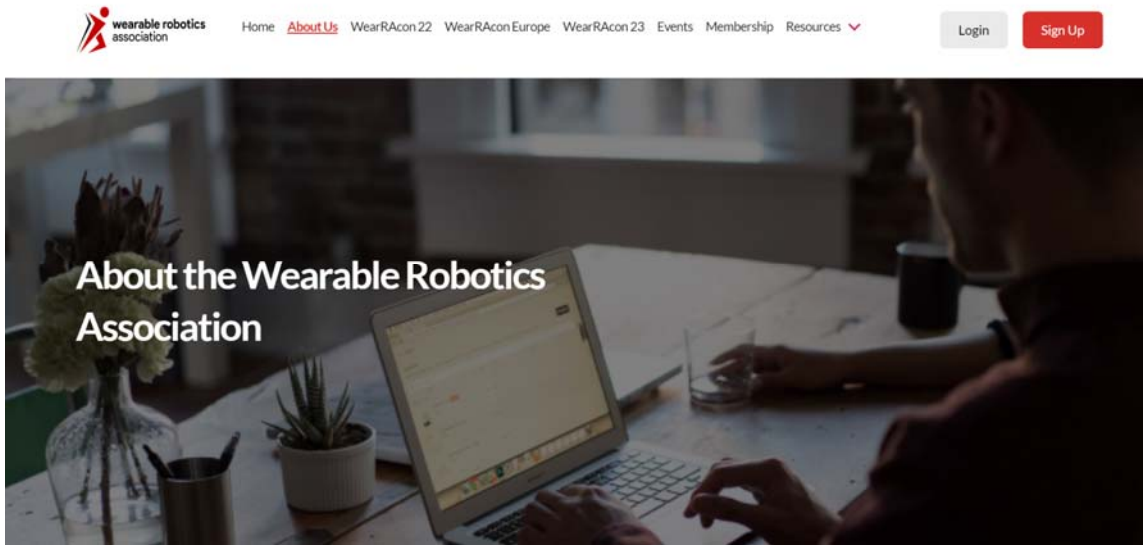
Wearrable Robotics Association WearRa



www.wearablerobotics.com

- The Wearable Robotics Association (WearRA) is the only professional association dedicated to the entrepreneurs, businesses and academics fueling the wearable robotics industry.
- WearRA provides a forum for the wearable robotics community to share ideas and collaborate in a way that expands and improves the ecosystem of technologies and participants.

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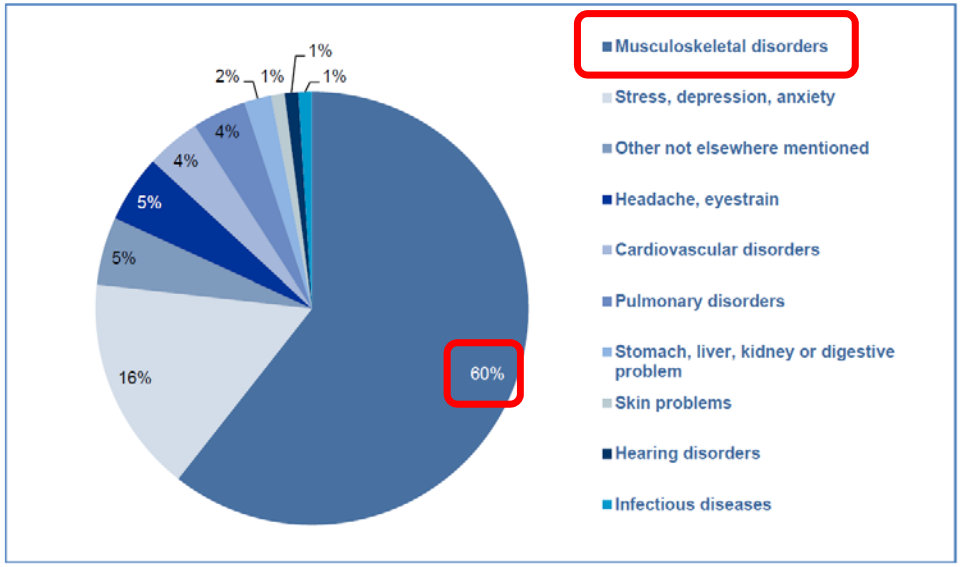
Hintergrund and Motivation

arbeitsbedingte Muskelskeletterkrankungen (MSE)

Muskelskeletterkrankungen (MSE) machen einen Großteil der arbeitsbedingte Krankheiten aus [1] und verursachen erhebliche Kosten durch den Produktionsausfall [2].

Schätzung der Weltgesundheitsorganisation (WHO): In 20 Jahren wird die Anzahl Personen mit MSE verdoppelt sein! [3]

Percentage of workers reporting a work-releated health problem, by type of problem, EU-27 [1]



Ursprung und Ursache von Muskelskeletterkrankungen

schwere körperliche Arbeit
Haltung, Lasten, Wiederholung

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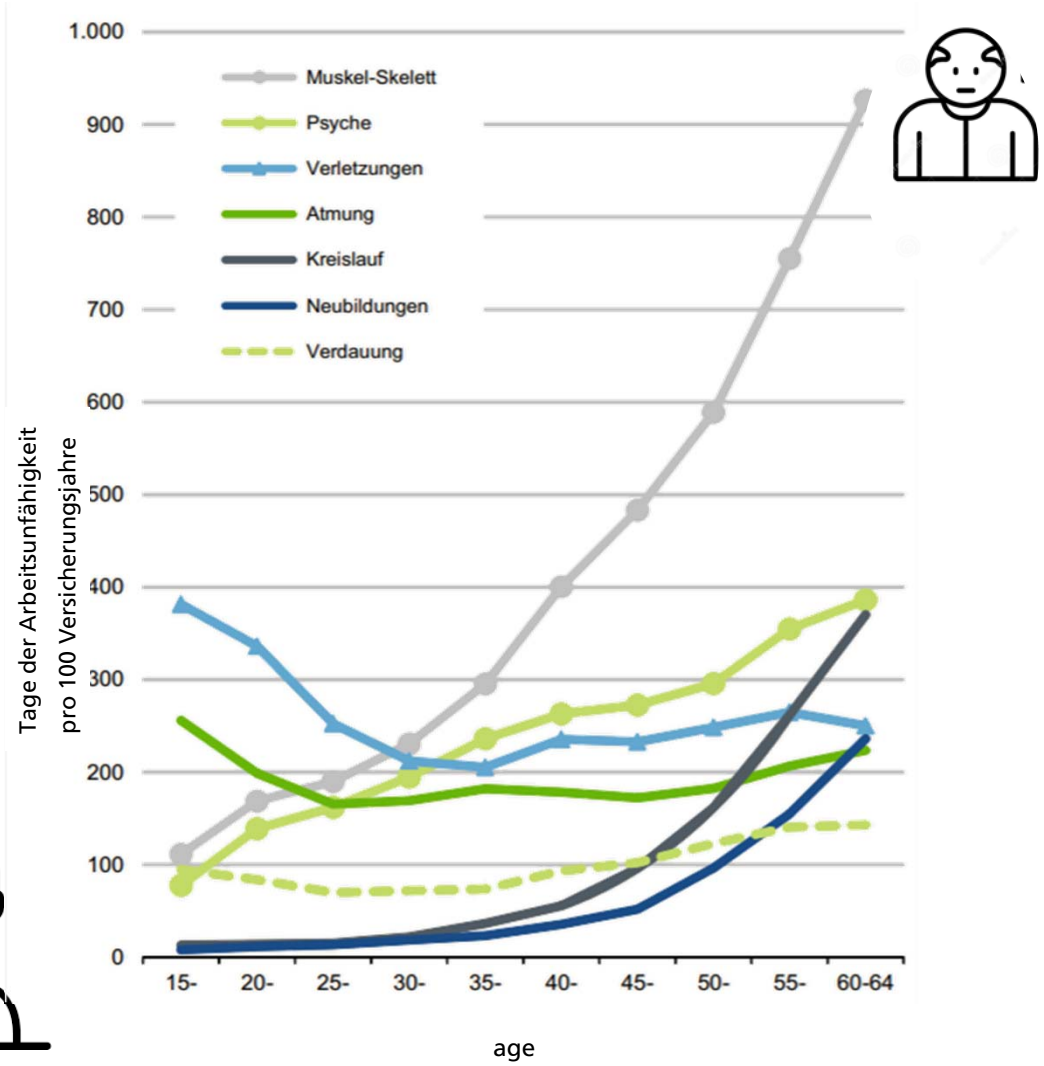
[1] EU-OSHA, Work-related musculoskeletal disorders: prevalence, costs and demographics in the EU, 2019
[2] https://www.rki.de/DE/Content/Gesundheitsmonitoring/Themen/Chronische_Erkrankungen/Muskel_Skelett_System/Muskel_Skelett_System_node.html
[3] S. Brenscheidt, A. Siefer, H. Hinnenkamp, and L. Hünefeld, "Arbeitswelt im Wandel, Ausgabe 2018," 2018.

Hintergrund and Motivation

MSE und junge Arbeiter:innen

Muskelskeletterkrankungen sind auch eine häufige Ursache für Arbeitsunfähigkeit bei jungen Arbeiter:innen [1,2]

Präventive Maßnahmen sollten frühzeitig ergriffen werden!



Arbeitsunfähigkeitstage je 100 Versicherungsjahre der Männer nach Alter, Deutschland 2014 [1]

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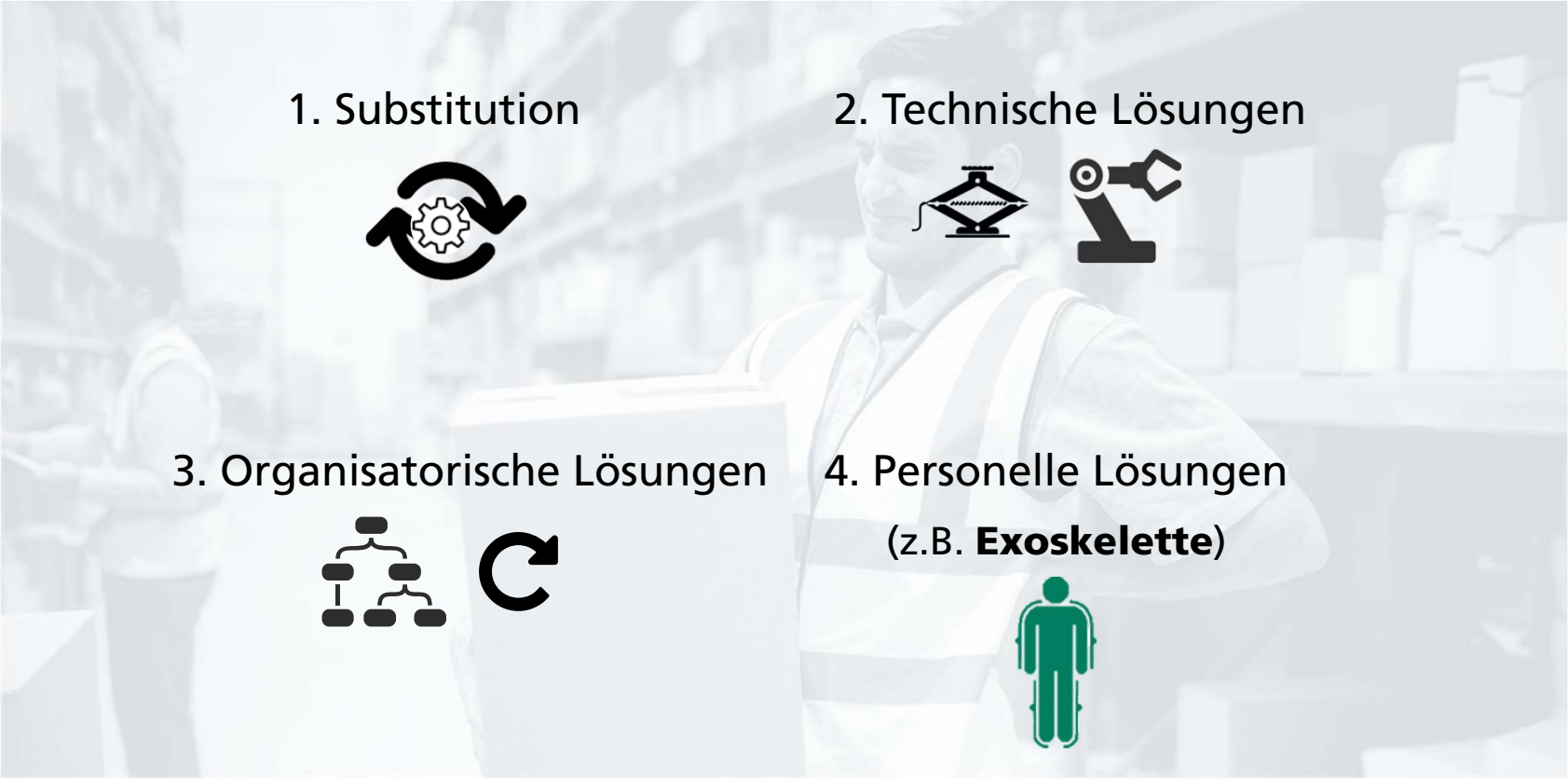
[1] Grobe, T., Steinmann, S. & Gerr, J. 2015. Gesundheitsreport 2015 Nordrhein- Westfalen / Demografischer Wandel – Perspektiven und Chancen, Wuppertal, BARMER GEK.
[2] European Agency for Safety and Health at Work (2020): Work-related musculoskeletal disorders: why are they still so prevalent? Evidence from a literature review. European Risk Observatory Report. With assistance of Joanne O. Crawford, Alice Davis. Institute of Occupational Medicine (IOM), Edinburgh – United Kingdom.

Hintergrund and Motivation

körperliche Belastung am Arbeitsplatz – mögliche Anwendungsbereiche von Exoskeletten



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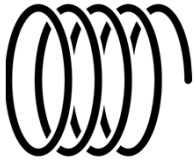
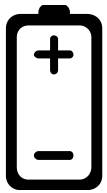
Exoskelette
Unterteilung passiv / aktiv



Passiv

- Feder-Dämpfer-System
- Elastische Bänder
- …



Aktiv

- Externe Energiezufuhr
- v.a. Elektromechanisch
- …

Beispiele:

Soft

© Kinetic Edge, FlexLift

Hartschalen

© Ottobock, Paexo Shoulder

© Laevo

Beispiele:

© German Bionic, CrayX

© RB3D, BackUp

© Fraunhofer Stuttgart Exo-Jacket 2.0

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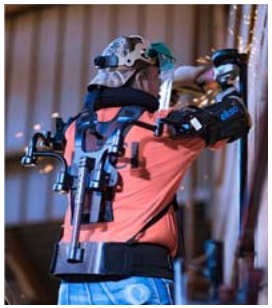
© Comau Mate

© Lockheed Martin, Fortis


© Ekso Bionics, EksoVest

© Ottobock, Paexo Shoulder / Paexo Neck

© Skelex, Skelex 360

© Bioserve, Ironhand

© Tilta, Armor Man

© Herowear, Apex

© Atoun, Atoun-Model-Y

© Rakunie, Morita Group

© Hunic, BackUp

© SuitX, LegX

© Ottobock, Paexo Thumb

© Noonee, Chairless Chair

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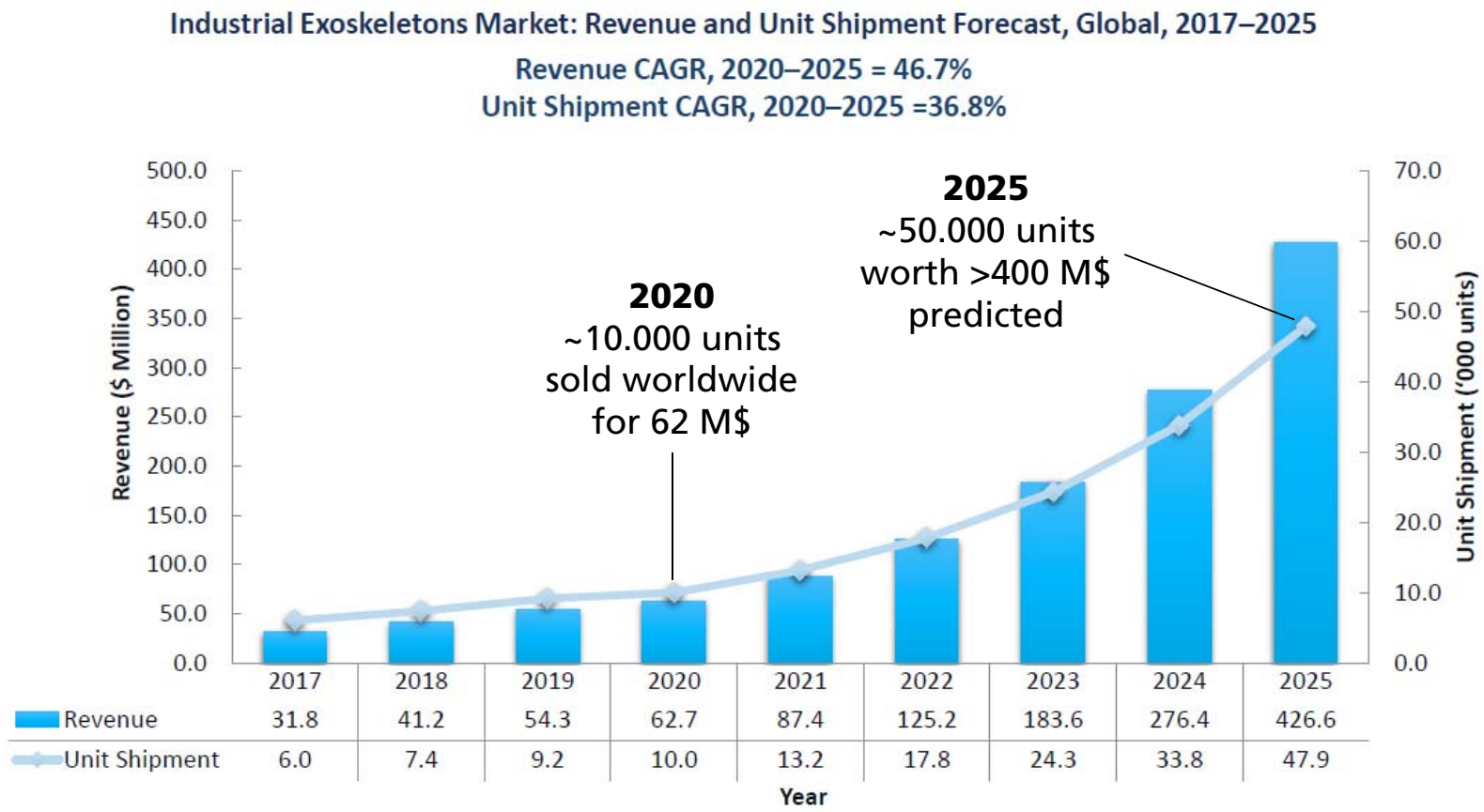
Global Industrial Exoskeletons Market
Revenue & Volume



	2017	2018	2019	2020	2021	2022	2023	2024	2025
Revenue	31.8	41.2	54.3	62.7	87.4	125.2	183.6	276.4	426.6
Unit Shipment	6.0	7.4	9.2	10.0	13.2	17.8	24.3	33.8	47.9

© Fraunhofer IPA

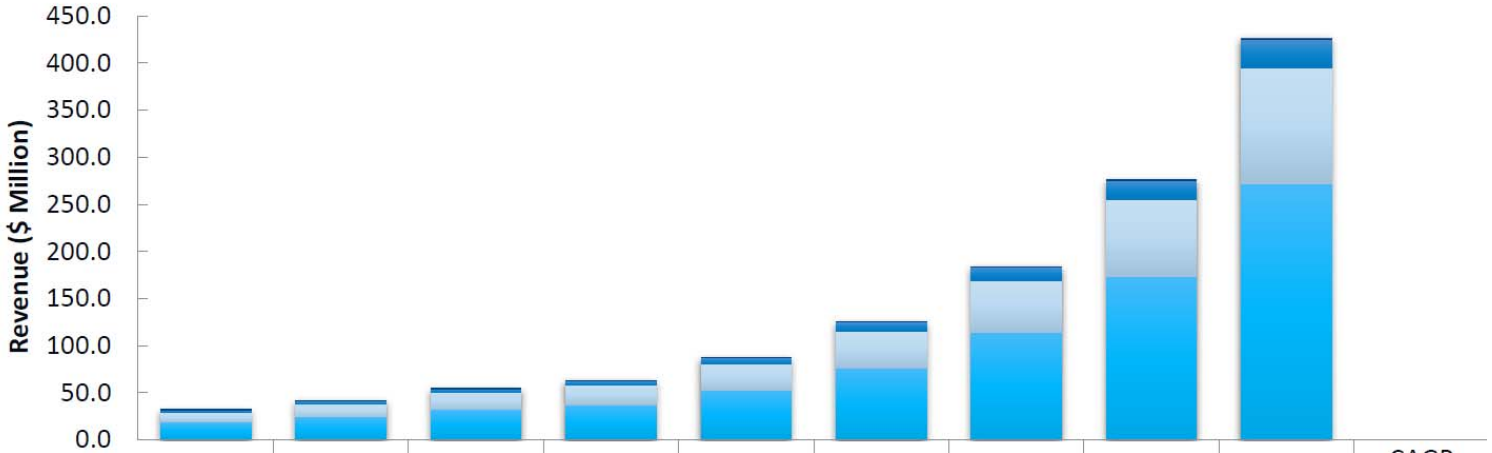
Frost & Sullivan, "The Global Industrial Exoskeletons Market is Driven by the Aging and Shrinking Skilled Labor Force", Feb 2021

Fraunhofer IPA

Global Industrial Exoskeletons Market

Revenue by end-use industry

Industrial Exoskeletons Market: Revenue Forecast by End-Use Industry, Global, 2017–2025



	2017	2018	2019	2020	2021	2022	2023	2024	2025	CAGR (20–25)
Total	31.8	41.2	54.3	62.7	87.4	125.2	183.6	276.4	426.6	46.7%
Others	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.1	35.8%
Construction	2.6	3.3	4.3	4.9	6.7	9.4	13.7	20.3	30.8	44.7%
Transport	10.7	13.7	17.9	20.4	27.8	39.0	55.8	82.0	123.3	43.3%
Manufacturing	18.5	24.1	31.9	37.2	52.5	76.4	113.5	173.4	271.4	48.8%

Year

2025:
up to 30 M$
for Construction

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Frost & Sullivan, “The Global Industrial Exoskeletons Market is Driven by the Aging and Shrinking Skilled Labor Force”, Feb 2021

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Global Industrial Exoskeletons Market

Passive vs Active Exoskeletons

Passive Exoskeletons

Passive Industrial Exoskeletons Market: Key Growth Metrics, Global, 2020

Life Cycle Stage	Revenue	Units	Average Price per Unit	Revenue for Last Year of Study Period
Growth	$22.1 M (2020)	6.5 K (2020)	$3,388 (2020)	$128.6 M (2025)

Europe
~2200 units

Base Year Growth Rate	Compound Annual Growth Rate	Number of Competitors	Degree of Technical Change
12.7% 2020	42.3% (2020–2025)	30+ (Active competitors in 2020)	6 (Scale: 1 [low] to 10 [high])

Increasing Stable Decreasing

Note: All figures are rounded. The base year is 2020. Source: Frost & Sullivan

Active Exoskeletons

Powered Industrial Exoskeletons Market: Key Growth Metrics, Global, 2020

Life Cycle Stage	Revenue	Units	Average Price per Unit	Revenue for Last Year of Study Period
Growth	$40.6 M (2020)	3.5 K (2020)	$11,624 (2020)	$298.0 M (2025)

Europe
~1200 units

Base Year Growth Rate	Compound Annual Growth Rate	Number of Competitors	Degree of Technical Change
17.2% 2020	49.0% (2020–2025)	20+ (Active competitors in 2020)	8 (Scale: 1 [low] to 10 [high])

Increasing Stable Decreasing

2020. Source: Frost & Sullivan

2025: **Europe** ~ 5300 Units ~16,500$ / Unit

The commercialization of exoskeletons in Japan is at a more advanced stage than other countries. Innophys became the **world's best-selling powered exoskeleton supplier by selling 10,000 units of its Muscle Suit® as of March 2, 2020**.

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Frost & Sullivan, "The Global Industrial Exoskeletons Market is Driven by the Aging and Shrinking Skilled Labor Force", Feb 2021

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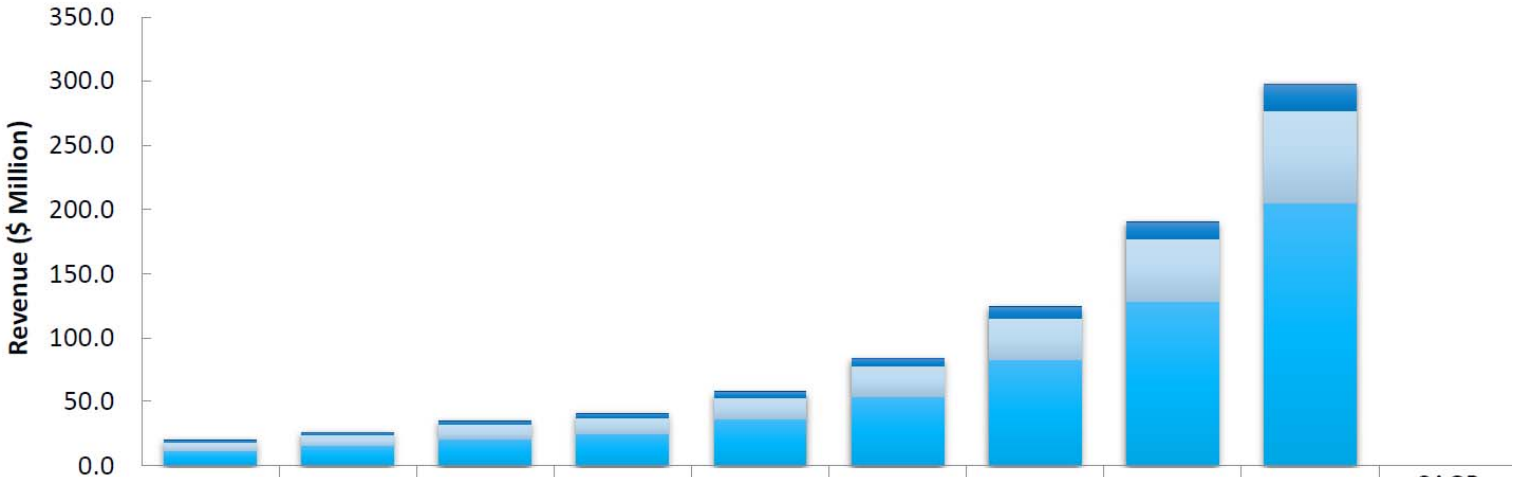
Global Industrial Exoskeletons Market

Revenue for active exoskeletons by end-use industry

Powered Industrial Exoskeletons Market: Revenue Forecast by End Use Industry, Global, 2017–2025



	2017	2018	2019	2020	2021	2022	2023	2024	2025	CAGR (20–25)
Total	19.6	25.8	34.7	40.6	57.5	83.7	124.6	190.5	298.0	49.0%
Others	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.7	36.3%
Construction	1.6	2.1	2.7	3.1	4.3	6.0	8.8	13.1	20.0	45.2%
Transport	6.5	8.4	10.9	12.5	16.9	23.5	33.3	48.6	72.5	42.2%
Manufacturing	11.4	15.3	20.9	24.9	36.2	54.0	82.2	128.3	204.9	52.4%

Year

2025:
~1200 units
for Construction

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Frost & Sullivan, “The Global Industrial Exoskeletons Market is Driven by the Aging and Shrinking Skilled Labor Force”, Feb 2021

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Hintergrund and Motivation

Exoskelette werden entwickelt und eingesetzt, um bestimmte Arbeitsfunktionen zu erleichtern und Muskelskeletterkrankungen vorzubeugen. In einigen Fällen können sie sogar die Qualität der Arbeitsleistung verbessern.

- Verschiedene Studien haben entsprechende Auswirkungen auf körperliche Parameter durch das Tragen eines Exoskeletts nachgewiesen
- Mangel an standardisierten Studien unter realen Arbeitsbedingungen, professionellen Mitarbeitern und großen Stichprobengrößen
- Andere Ansätze: EUROBENCH als Methode und Rahmen für Unternehmen, um die Leistung ihrer Roboterprototypen auf standardisierte Weise für ein Benchmarking zu testen

Alemi, Madinei, Kim, Srinivasan, & Nussbaum, 2020; Crea et al., 2021; Kim, & Nussbaum, 2019; Koopman et al., 2020; Grazi, Chen, Lanotte, Vitiello, & Crea, 2019; EUROBENCH, 2022; Torricelli & Pons, 2019

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… hat das Ziel Exoskelette in realistischen Anwendungsfällen zu beurteilen und diese in ihrer Gesamtheit neutral zu bewerten.

… ist kein Exoskelett-Wettbewerb, sondern die Arbeitstätigkeit mit versus ohne Exoskelett wird intraindividuell verglichen.

… möchte Daten prospektiv sammeln, sowie den Austausch zwischen Entwicklern, Wissenschaftlern und Endnutzern stärken.

Parcours von Exoworkathlon müssen entscheidende Aspekte erfüllen

- definiert in Zusammenarbeit mit Fachleuten aus den entsprechenden Industrien/Branchen und Gesundheitssektoren
- realistisch und umsetzbar sein (1h function with limited variability)
- relevante Aufgaben für den Gebrauch von Exoskeletten
- Versuchspersonen sind Fachkräfte

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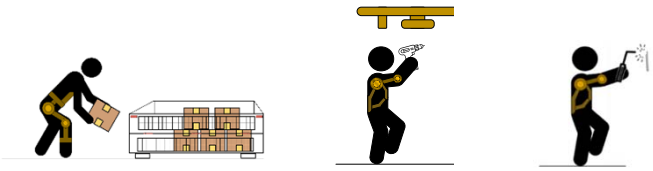
Überblick der Parcours

Drei Parcours bisher getestet und ausgeführt

Parcour 1: Rückenunterstützende Exoskelette in der Logistik

Parcour 2: Exoskelette für die obere Extremität in der Automobilmontage

Parcour 3: Exoskelette für die obere Extremität beim Schweißen



- Die Parcours werden zweimal pro Versuchsperson durchgeführt – einmal **mit** und einmal **ohne** Exoskelett.
- Für einen intra-individuellen anonymen Vergleich werden verschiedene Assessments bei den unterschiedlichen Parcours angewendet.

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Überblick über die verwendeten Assessment-Methoden

Benutzerfeedback
(Fragebogen, Body Discomfort)

Qualität
(Dauer der Aktivität, Genauigkeit in der Aufgabe)

Muskelaktivität in Kombination mit der Bewegung (Rücken- oder Schultermuskulatur)
(EMG eines ausgewählten Muskel + Bewegungserfassung)

Metabolic
(Impedanzkardiographie)

Kardiovaskuläre Belastung
(GoX Labs Boost)

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Parcour 1

Parcour 2

Parcour 3

Erste Ergebnisse der ersten Umsetzungen in Europa

HM [2]20

© Fraunhofer IPA

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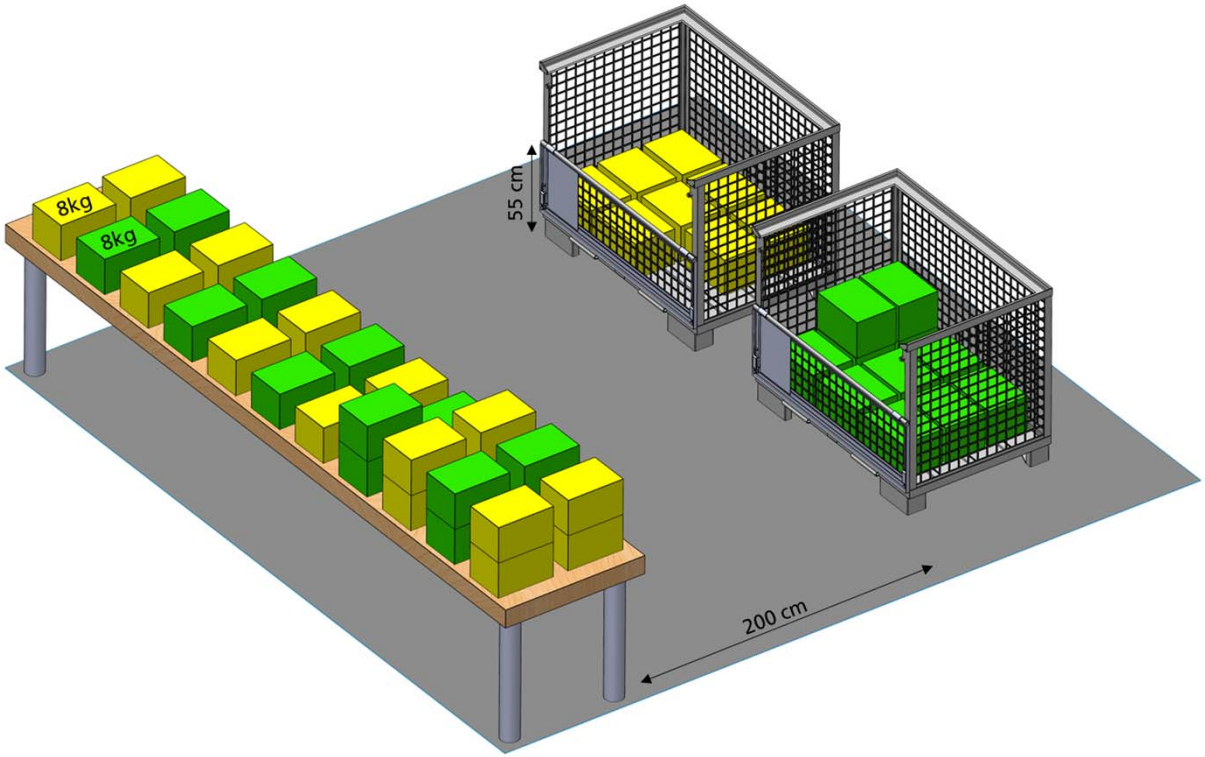
HM [2]20 First results of the first implementations in Europe

Holl, Mirjam; 02.07.2022

Parcour 1
Rückenunterstützende Exoskelette in der Logistik

realistische, repräsentative Logistiktätigkeit
(in einem Automobilwerk*)

- Sortieren von 48 Paketen (8kg) von einer Produktionsband in Gitterboxsen und wieder zurück
  - 8min Einsortieren
  - 8min Aussortieren
- Laufende Uhr, die die Arbeitsgeschwindigkeit vorgibt



**in cooperation with Audi*
Hensel, R.; Keil, M.; Mücke, B.; Weiler, S. (2018): Chancen und Risiken für den Einsatz von Exoskeletten in der betrieblichen Praxis. In : Zeitschrift für medizinische Prävention. Available online at https://www.asu-arbeitsmedizin.com/chancen-und-risiken-fuer-den-einsatz-von-exoskeletten/chancen-und-risiken-fuer-den-einsatz-von, checked on 1/27/2021.

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Parcour 1

Rückenunterstützende Exoskelette in der Logistik

14 Versuchspersonen | 7 Exoskelette:

exo BACK by RB>3D
German Bionic
ottobock. PAEXO BACK
laevo exoskeletons
hapo
Japet.
HUNIC

Assessments:

Benutzerfeedback

Aktivität der Rückenmuskulatur beim Vorbeugen

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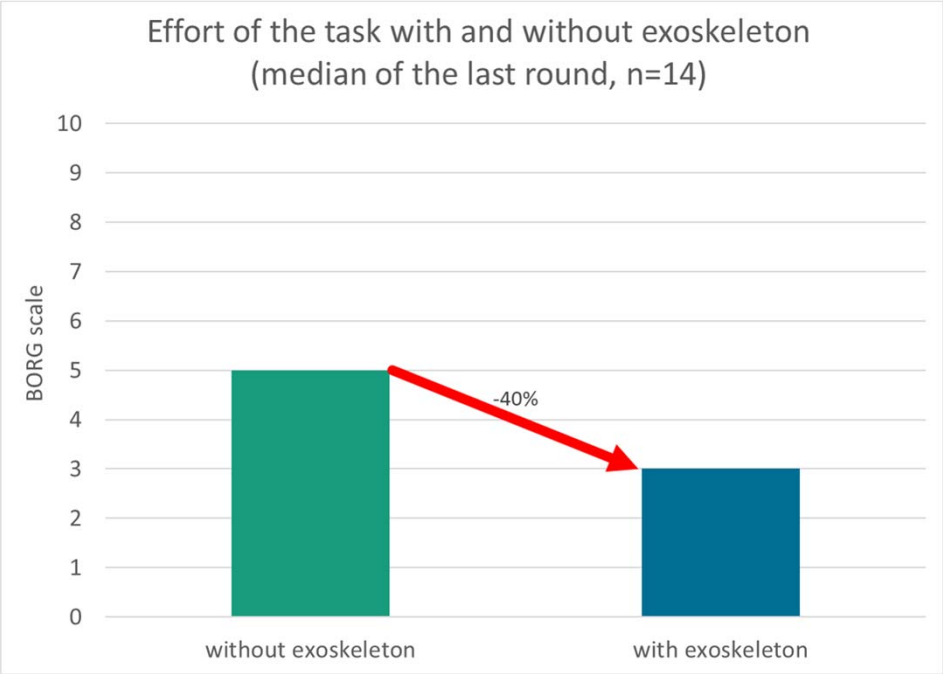
Parcour 1
Rückenunterstützende Exoskelette in der Logistik

Ergebnisse

Subjektives Benutzerfeedback

Median über alle 14 Versuchspersonen

"Wie anstrengend war die Tätigkeit für Sie von 0 (sehr sehr leicht) bis 10 (sehr sehr schwer)?"



0: very, very easy; 1: very easy; 2: easy; 3: moderate; 4: a little exhausting ; 5: exhausting; 6: difficult; 7: very difficult; -- 10: very, very difficult

© Fraunhofer IPA

Parcour 2

Exoskelette für die obere Extremität in der Automobilmontage

14 Versuchspersonen | 3 Exoskelette:

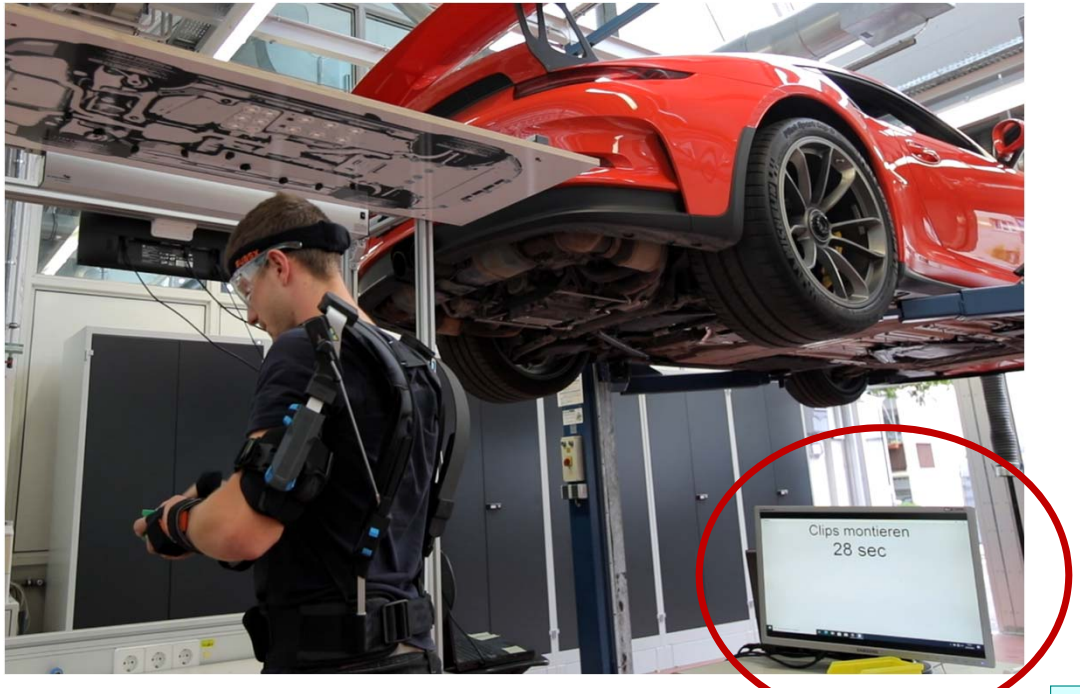
LEVITATE TECHNOLOGIES, INC. AIRFRAME

ottobock. PAEXO SHOULDER

skelex 360-XFR

Assessments:

- Benutzerfeedback
- Aktivität der Schultermuskulatur bei Überkopftätigkeit
- Arbeitszeit
  Genauigkeit während dem Lackieren



Taktzeiten für jede HM [2]22 Aufgabe

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HM [2]22 given cycle times for each task

Holl, Mirjam; 02.07.2022

Parcour 2

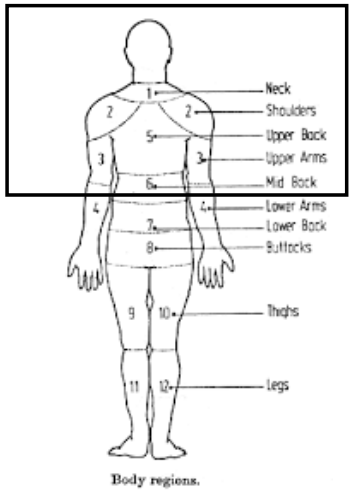
Exoskelette für die obere Extremität in der Automobilmontage

Ergebnisse

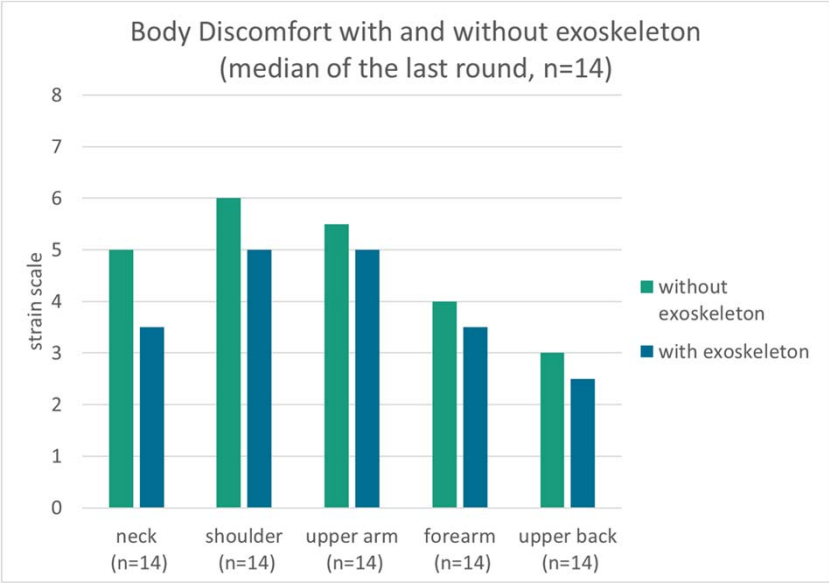
Subjektives Benutzerfeedback

Median über alle 14 Versuchspersonen

Beanspruchung der spezifischen Körperbereiche während der Tätigkeitsdurchführung



Corlett et al.



1: Not al all; 2: Extremely little, 3: Very little; 4: Moderate; 5: little; 6: Strong; 7: very Strong; 8: Extremely strong

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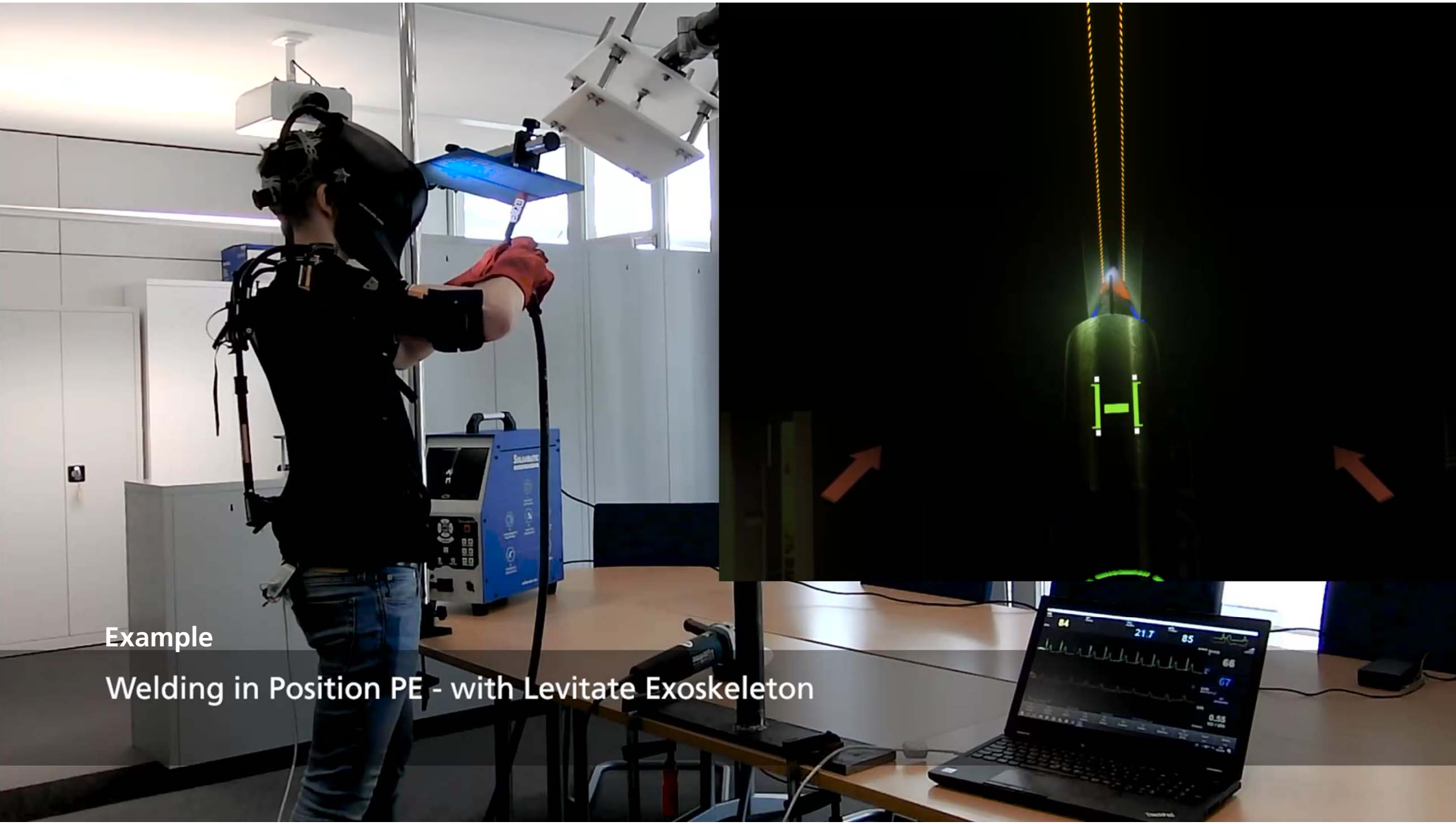


Example

Welding in Position PE - with Levitate Exoskeleton

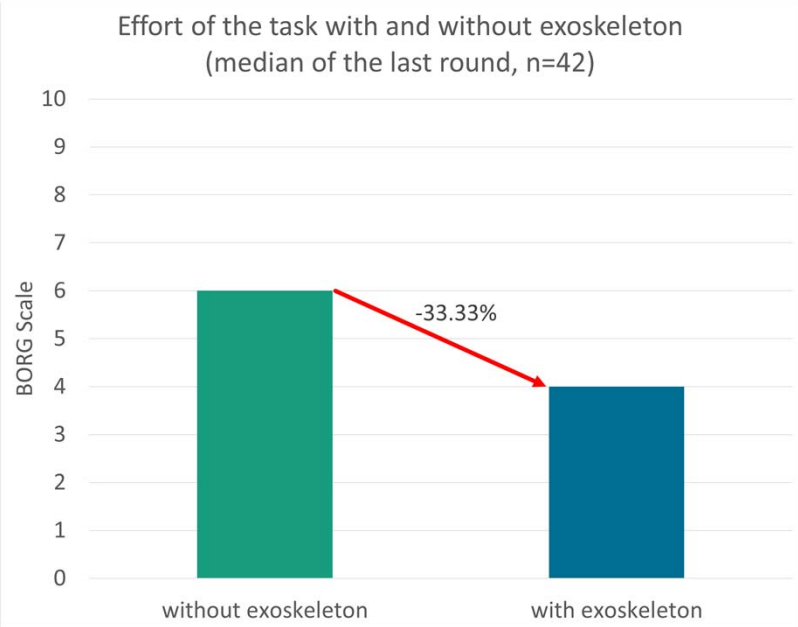
Parcour 3
Exoskelette für die obere Extremität beim Schweißen

Ergebnisse

Subjektives Benutzerfeedback

Median über alle 42 Versuchspersonen

"Wie anstrengend war die Tätigkeit für Sie von 0 (sehr sehr leicht) bis 10 (sehr sehr schwer)?"



0: very, very easy; 1: very easy; 2: easy; 3: moderate; 4: a little exhausting ; 5: exhausting; 6: difficult; 7: very difficult; -- 10: very, very difficult

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Parcours 5

Exoskelette für die oberen Extremitäten in der Baubranche

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Ausblick

- **EXOWORKATHLON** bietet die Möglichkeit, Exoskelette im intra-individuellen Vergleich von Nutzern zu testen und Studiendaten pro Exoskelett-Typ zu generieren.
- **Parcours** wurden mit Experten aus Industrie, Berufsschulen, der Deutschen Gesetzlichen Unfallversicherung und der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin entwickelt und erprobt.
- Auf Grundlage dieses modularen Studienkonzepts sind **prospektive** Studien mit Exoskelett-Herstellern und Endanwendern geplant, um die **Evidenz** der Vorteile bei der Nutzung von Exoskeletten zu bewerten und idealerweise zu stärken.
- Exoworkathlon wird in der **Industrie**, auf **Messen**, **Konferenzen** und in **Berufsschulen** (z.B. am Hamburger Schweißinstitut) durchgeführt.
- Der Parcour soll mit interessierten Fachpartnern aus der Industrie und Arbeitsmedizinern (z.B. Vorwärtsbeugen bei der Lebensmittelernte in der Landwirtschaft) um **weitere relevante modulare Anwendungsfälle und entsprechende Bewertungsmethoden** erweitert werden.
- Partnerinstitutionen sind herzlich eingeladen, diesen Ansatz zu einer **prospektiven multizentrischen Studie** und einer **Datenbank** zu multiplizieren.

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Outlook

EXOWORKATHLON

„At AplusA 2023 EXOSKELETON PARK in Duesseldorf“

- More Exoworkathlon Parcours
- Duesseldorf 24-27.10.2023
- Exo-Manufacturers invited to exhibit.

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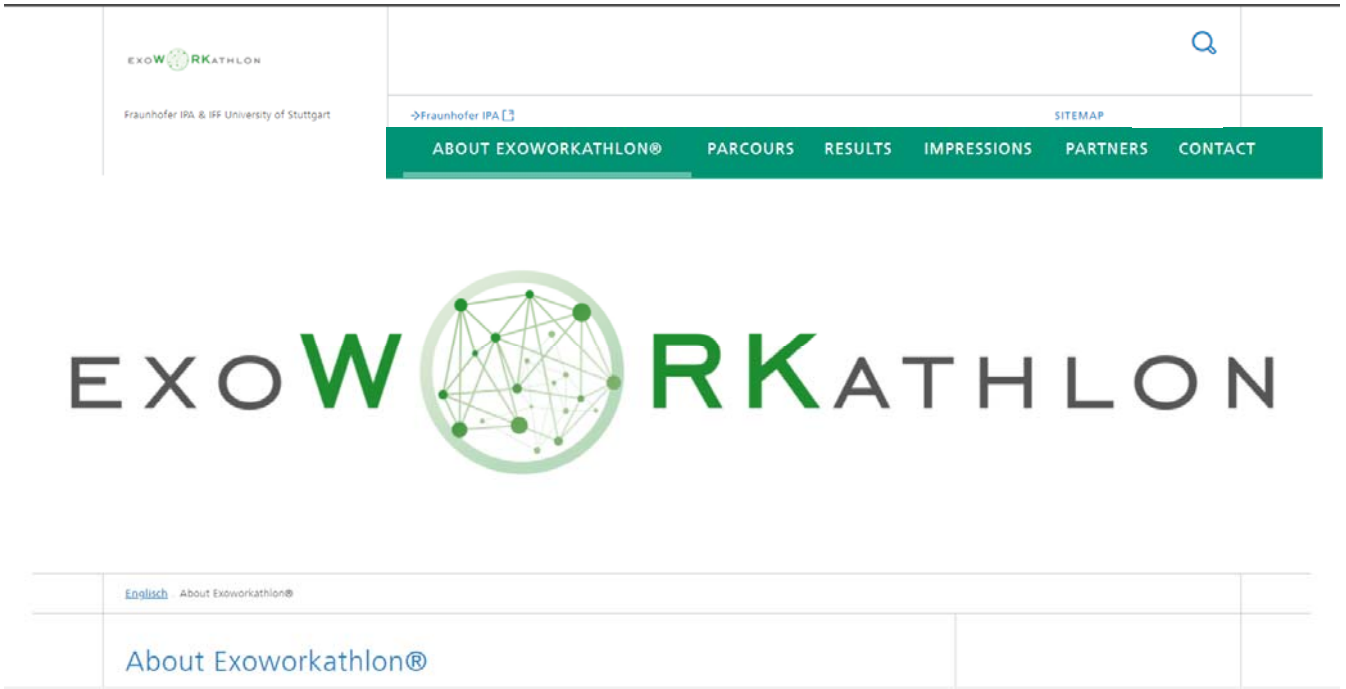
Webpage Exoworkathlon®

Informationen über

- Exoworkathlon® Allgemein
- Beschreibung der *Assessments* und der *3 Parcours*
- Ergebnisse des *subjektiven Benutzerfeedback* und *Qualität*
- Mitwirkende Partner
- Kontaktdaten

www.exoworkathlon.de



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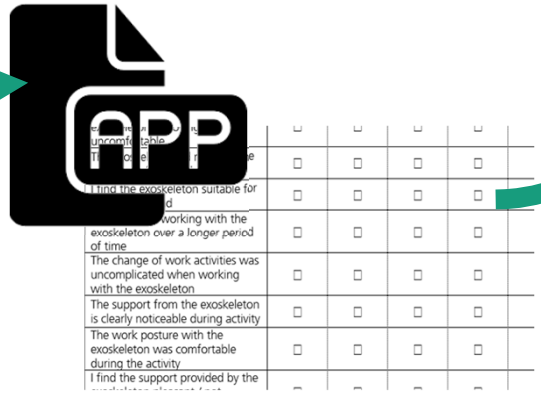
Outlook
The Exoskeleton User Plattform

Strengthening the case for exoskeletons together on a neutral platform

Fraunhofer Exo User Feedback App

- Independent, regular feedback via an app
- Used at various workstations for Exoskeleton evaluation



Exo User Feedback Data

- A critical mass of end user feedbacks is visualized and published jointly continuously.
- Exoskeletons are kept anonymously.
- Anonymous user time trend info is possible through highly safe data base system.

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WearRAcon EUROPE

November 19-20, 2019 • Fraunhofer IPA & University Stuttgart

Presented By: WearRA Wearable Robotics Association · Fraunhofer IPA · University of Stuttgart Institute of Industrial Manufacturing and Management IFF

PROGRAM AT A GLANCE (as of 07.11.19)
Tuesday, November 19, 2019

08:00	Main Hall	Reception and Registration
09:00	Auditorium A+B	Welcome/Opening Remarks: **Joe Hitt, Ph.D.,** *Executive Director, Wearable Robotics Association* **Dr. med. Urs Schneider,** *Division Director Medical Engineering and Biotechnology, Fraunhofer IPA*
09:30	Auditorium A+B	Keynote 1: Exoskeleton Research at the Arizona State University **Prof. Dr. Thomas Sugar,** *Associate Dean, The Honors College, ASU Polytechnic, USA*
10:10	Coffee Break	
10:20	Auditorium A+B	Plenary Session: End-User Experiences and Acceptance Factors" **A1: Diego Torricelli, Ph.D.,** *Spanish National Research Council (CSIC), Spain* **A2: Atilla Pirger,** *Daimler AG, Germany* **A3: Marco Molinari, MD Ph.D.,** *IRCCS Fondazione S. Lucia , Italy* **A4: Noël Keijsers, Ph.D.,** *Sint Maartens Clinic, The Netherlands*
12:00	Lunch	
13:00	Auditorium A+B	Keynote 2: Rehab Exoskeletons Need to Get Simple, Soft and Lightweight **Prof. Dr. Dr. h.c. Robert Riener,** *ETH Zurich & University of Zurich, Switzerland*
13:45	Coffee Break	

PROGRAM AT A GLANCE (as of 07.11.19)
Tuesday, November 19, 2019

14:15	Parallel Sessions Block I	
	Public & Work Insurance Perspective — Auditorium A **A1: Markus Peters,** *Federal Institute for Occupational Safety and Health (BAuA), Germany* **A2: Priv.-Doz Dr. Ulrich Glitsch,** *Institute for Occupational Safety and Health of the German Social Accident Insurance - IFA, Germany* **A3: Andreas Argubi-Wollesen,** *Helmut Schmidt University, Germany*	Medical Exoskeletons - Research — Auditorium B **B1: Jan Veneman, Ph.D.,** *Hocoma AG, Switzerland* **B2: Edwin van Asseldonk, Ph.D.,** *Associate Professor, Department of Biomechanical Engineering, University of Twente, The Netherlands* **B3: Dr. Simona Crea,** *The BioRobotics Institute, Scuola Superiore Sant'Anna, Italy* **B4: Assoc. Prof. Massimo Sartori,** *Department of Biomechanical Engineering, University of Twente, The Netherlands* **B5: Prof. Dr. Heike Vallery,** *Biomechatronics & Human-Machine Control, TU Delft, The Netherlands*
15:45	Coffee Break	
16:00	Parallel Sessions Block II	
	Industrial Exoskeletons - Research — Auditorium A **A1: Prof. Dr. Lars Fritzsche,** *Division Manager, imk automotive GmbH, Germany* **A2: Christophe Maufroy, Ph.D.,** *Group Manager, Fraunhofer IPA, Germany* **A3: Prof. Carmen Constantinescu,** *Fraunhofer Institute for Industrial Engineering IAO, Germany* **A4: Dr. Enrique Bances,** *Institute of Industrial Manufacturing and Management, Uni Stuttgart, Germany* **A5: Dr. Carlos Rodriguez,** *Vrije Universiteit Brussel, Belgium*	Exoskeletons for Military Applications — Auditorium B **B1: LTC Dirk-Michael Heinrichs,** *SO Future Development Branch, German Joint Support and Enabling Service Headquarters, Germany* **B2: Serge Grygorowicz,** *CEO and Technical Director R&D, RB3D, France* **B3: Maj. André Wijnveld,** *Startup Liaison sector Defence, Ministry of Defense, The Netherlands* **B4: Trebsijg van de Wijdeven,** *Chief Technology Officer, InteSpring B.V., The Netherlands* **B5: Maj. Marco Dämaso,** *Head R&D and Training Special Forces Command, Swiss Armed Forces, Switzerland*
19:00	Dinner	

PROGRAM AT A GLANCE (as of 07.11.19)
Wednesday, November 20, 2019

09:00	Parallel Sessions – Block III	
	Industrial Exoskeleton Solutions — Auditorium A **A1: Gaurav Genani,** *CEO, Skelex, The Netherlands* **A2: Boudewijn Wisse,** *CEO & Technical Director Laevo, The Netherlands* **A3: Dr. Sönke Rössing,** *Head of Industrials, Ottobock SE & Co. KGaA, Germany* **A4: Dr. Peter Heiligensetzer,** *Founder & CTO, German Bionic Systems, Germany* **A5: Jonas Mast,** *CEO- Chief Executive Officer, HUNIC GmbH, Germany* **A6: Gaia Salvadore,** *MATE Product Manager, Comau, Italy*	Medical Exoskeleton Solutions — Auditorium B **B1: Tom Taverne,** *Clinical Director, Marsi Bionics, Spain* **B2: Jaime Duarte, Ph.D.,** *Co-Founder & CEO, MyoSwiss AG, Switzerland* **B3: Jean-Louis Constanza,** *Chief Business Officer, Wandercraft, France* **B4: Antoine Noel,** *Japet Medical CEO, France*
10:30	Coffee Break	
11:00	Hands-On Testing Industrial Exoskeletons	Demos · Poster Session · Guided Tours
12:30	Lunch	
13:30	Hands-On Testing Industrial Exoskeletons	Demos · Poster Session · Guided Tours
16:30	Closing Remarks	

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WearRAcon EUROPE

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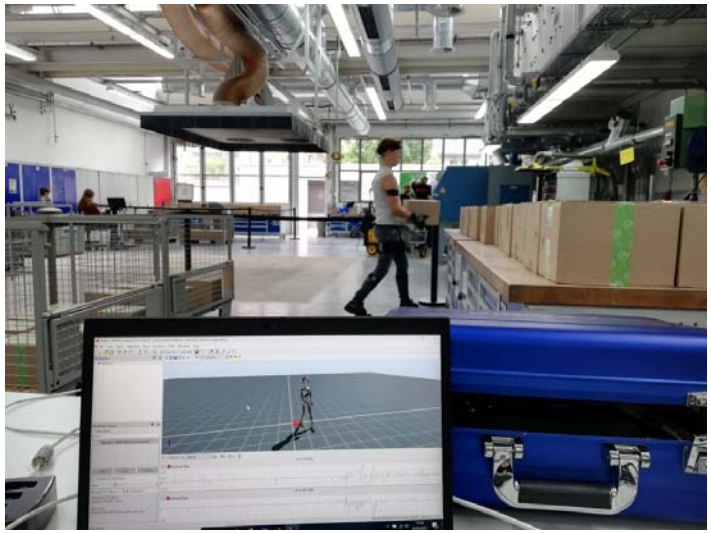

WearRAcon EUROPE

October 5–7, 2021

Virtual

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WearRAcon EUROPE

October 5–7, 2021
Virtual

AGENDA AT A GLANCE
Times are GMT +2. Hyperlinks are shown in LIGHT BLUE.

Tuesday, October 5, 2021

09:00 - 09:15	WELCOME SPEECH: Dr. Urs Schneider, Fraunhofer IPA, Germany
09:15 - 10:15	KEYNOTE SPEECH: Prof. Dr. Michiel de Looze, TNO, The Netherlands Reducing the barriers for implementation of exoskeletons in practice
10:15 - 10:25	BREAK
10:25 - 11:00	LIVE FROM EXOWORKATHLON I: Dr. Urs Schneider, Fraunhofer IPA, Germany: Live report from the Exoworkathlon
11:00 - 11:10	BREAK
11:10 - 12:10	SESSION BENCHMARKING & ASSESSMENT I: Dr. Ulrich Glitsch, Institut für Arbeitsschutz der DGUV, Germany: Challenges in the biomechanical assessment of industrial exoskeletons Dr. Jawad Masood, CTAG, Spain: Benchmarking occupational exoskeleton: Lessons from testbed development for confined industrial space Mathilde Schwartz, INRS, France: Cardiorespiratory effects of using a robotic back-support exoskeleton during a repetitive lifting task
12:10 - 13:00	LUNCH BREAK
13:00 - 13:30	IMPULSE TALK I: Prof. Dr. Klaus Bengler, Technische Universität München, Germany: Assistance Systems – A Challenge for Development and Evaluation
13:30 - 14:10	SESSION HUMAN FACTORS & ACCEPTANCE: Prof. Dr. Cordula Kropp, Universität Stuttgart, Germany I E: reasons and methods for user involvement Jérémy Lefint, KIT-ITAS/Fraunhofer IPA, Germany: WHO accepts WHAT? The dilemma of subjective factors and their integration into product development processes
14:10 - 14:20	BREAK
14:20 - 15:05	LIVE FROM EXOWORKATHLON II
	LIVE SPOTLIGHT DEMO FROM LAEVO: Georg Wagner, StraightWalk GmbH, Germany: Introducing Exxowear: A novel distribution platform for exoskeletons
15:05 - 15:15	BREAK
15:15 - 16:20	SESSION BENCHMARKING & ASSESSMENT II: Terry Butler, Lean Steps Consulting, USA & Prof. Dr. Jason Gillette, Iowa State University, USA: Upper Body Exoskeleton Benchmark and Assessment Best Practices Lennart Ralfs, Universität Innsbruck, Austria: Evaluation of Industrial Exoskeletons - Methodology and Exemplary Results

Wednesday, October 6, 2021

09:00 - 09:10	MORNING GREETINGS: Christophe Maufroy, Ph.D., Fraunhofer IPA, Germany
09:10 - 09:40	IMPULSE TALK II: Jesùs Ortiz, Ph.D., IIT, Italy, Developing exoskeletons for the industry of today and tomorrow
09:40 - 10:40	SESSION EXOSKELETON RESEARCH: Prof. Dr. Simona Crea, Scuola Superiore Sant'Anna, Italy Occupational exoskeletons: challenges, opportunities, and lessons learned Prof. Dr. Carlos Rodriguez Guerrero, VUB, Belgium The Exo4Work project, Methods, Results and lessons learned Mark Tröster, Fraunhofer IPA, Germany: ExoPflege – Development of an active exoskeleton to support the human trunk- and shoulder-arm-system
10:40 - 10:50	BREAK
10:50 - 11:20	LIVE FROM EXOWORKATHLON III: Dr. Urs Schneider, Fraunhofer IPA, Germany: Live report from the Exoworkathlon Dr. David Duwe, Ottobock SE & Co. KGaA, Germany: The Paexo Back Exoskeleton
11:20 - 11:30	BREAK
11:30 - 12:10	SESSION EXOSUIT RESEARCH: Dr. Maziar Sharbafi, Technische Universität Darmstadt, Germany Morphology and compliance roles in designing exosuits Jan Kuschan, Fraunhofer IPK, Germany Realtime Action Recognition as a basis for Smart Exosuits
12:10 - 13:00	LUNCH BREAK
13:00 - 13:30	POSTER PRESENTATION SESSION
13:30 - 13:40	BREAK
13:40 - 14:20	IMPULSE TALK III: Israel Benavides, Ford Europe, Germany Scientific studies on Exoskeletons at Ford
14:20 - 14:50	SESSION EXOSKELETON SYSTEMS: Iturri S.A, Spain: Prexer - protection for the thumb - for the user and for work HeroWear, USA: Asking the right questions about exo technology for your organization Ergoschutz GmbH, Germany: HAPO Posture Harness & Hapo MS Exoskeleton
14:50 - 15:00	BREAK
15:00 - 16:00	SESSION DIGITAL BIOMECHANICS: Prof. Massimo Sartori, University of Twente, The Netherlands Musculoskeletal Modelling for Bio-Protective Robots Prof. Dr. Michael Skipper Andersen, Aalborg Uni, Denmark Design and analysis of exoskeletons with musculoskeletal models Prof. Dr. Lars Fritzsche, imk automotive GmbH, Deutschland Assessing the efficiency of exoskeletons in physical strain reduction by biomechanical simulation with AnyBody Modeling System

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Düsseldorf, 25.-26.10.2023, aplusa Halle 1

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- Synchronisierung durch Dr. Felten, Dr. Schneider und Messe Düsseldorf aplus a-Management
- Mehrwerte und Vernetzung bei Inhalten, Marketing, Programmübersicht, Ticketing, Get-to-gether

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Herzlichen Dank für Ihre Aufmerksamkeit!

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