Exoskeletons assisting workers

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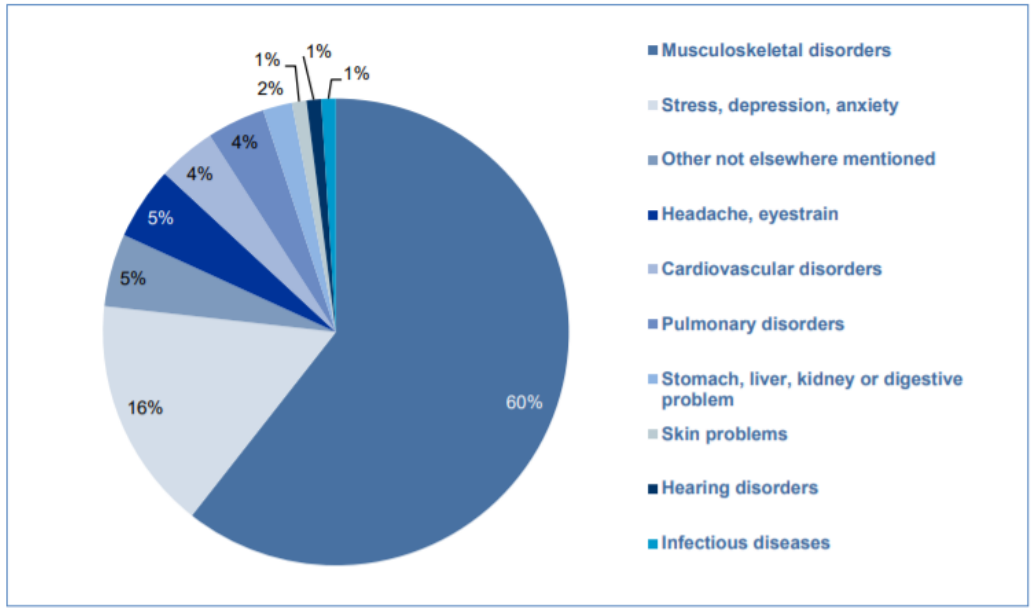
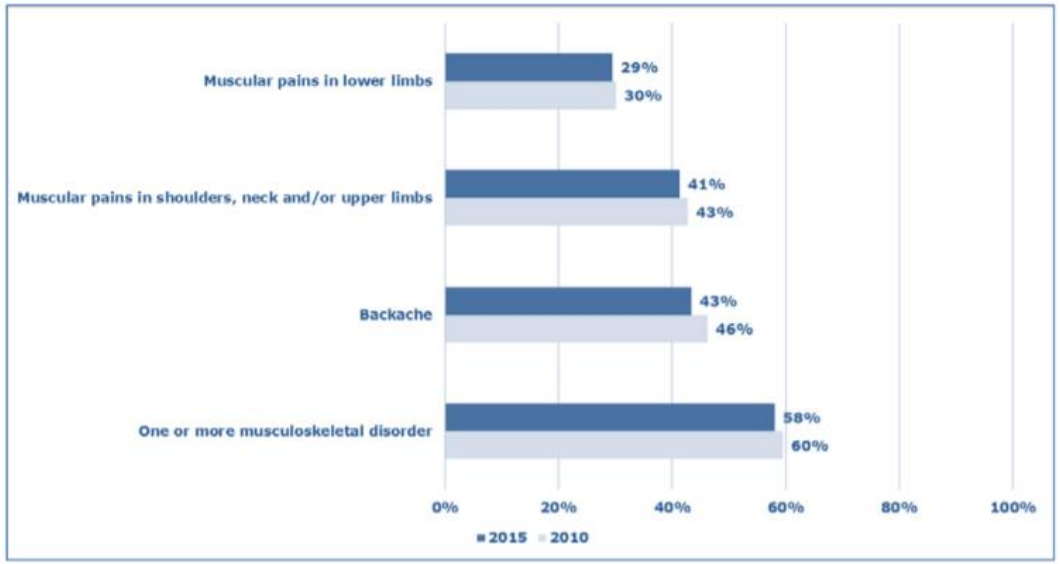
Work-related Musculoskeletal Disorders (WRMSDs)

"Musculoskeletal disorders (MSDs) are **impairments of bodily structures** such as muscles, joints, tendons, ligaments, nerves, cartilage, bones and the localised blood circulation system. If MSDs are caused or aggravated primarily by work and by the effects of the immediate environment in which work is carried out, they are known as **work-related MSDs**."



Note: The population of workers includes everybody aged 15 to 64 who was working or had worked during the past 12 months before the survey took place.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013). All EU Member States participated in this ad hoc module except for the Netherlands.



N = 33,173 (2010); *N* = 31,612 (2015)

Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

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EU-OSHA, 2019. Work-related musculoskeletal disorders: prevalence, costs and demographics in the EU, 2019.

The present of OCCUPATIONAL EXOSKELETONS

Wearable assistive devices intended "to reduce the physical load on workers carrying out demanding activities in several occupational sectors."

Shoulder support

Back support

Tool holding

Mate XT, Comau

Back X, Suit X

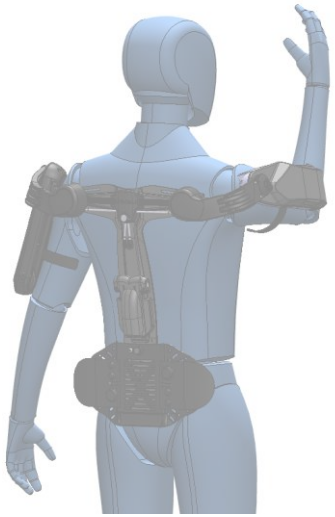
Fortis, Lockheed Martin

In the long term, these technologies are expected to:

- **prevent work-related musculoskeletal disorders**, particularly when other organizational measures are not feasible
- **preserving industry-specific workers' knowledge and skills**
- improve the quality and productivity, enhancing **precision and avoiding fatigue-induced errors**

Exoskeletons for outfitting and assembly tasks

Task 4.1: To design and develop a light and compact **S**emi-active **S**pring-loaded exoskeleton for **S**upport of **S**houlder flexion



MARI4YARD
MARI4ALLIANCE

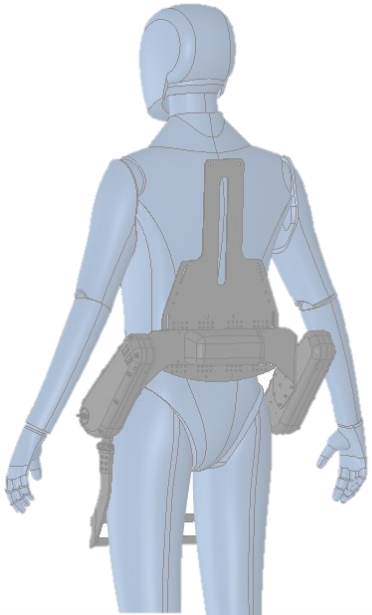
Test Sprint

Shoulder support exoskeleton assisting workers of NODOSA shipyard in overhead activities

Preliminary assessment for the development of the Mary4_Yard exoskeleton

IUVO
WEARABLE TECHNOLOGY, UPLIFTED LIFE

nodosa group



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Task 4.2: To design and develop a **L**ight-weight spring-**L**oaded sensorized exoske**L**eton for **L**umbar support

Challenges in exoskeletons adoption

Adoption of occupational exoskeleton can be targeted:

Building knowledge

Providing clear **evidence of effectiveness** of the devices in the final workplaces

Collection of **clear information to communicate** with all the stakeholders

- Workers
- Unions and workers' associations
- Policy makers
- Ergonomists, kinesiologists, occupational medical doctors, and HSE
- Corporate management
- Company's decision makers
- Insurance companies

User-centric design to **satisfy specific use-case applications requirements**

Example of shipyard environmental needs

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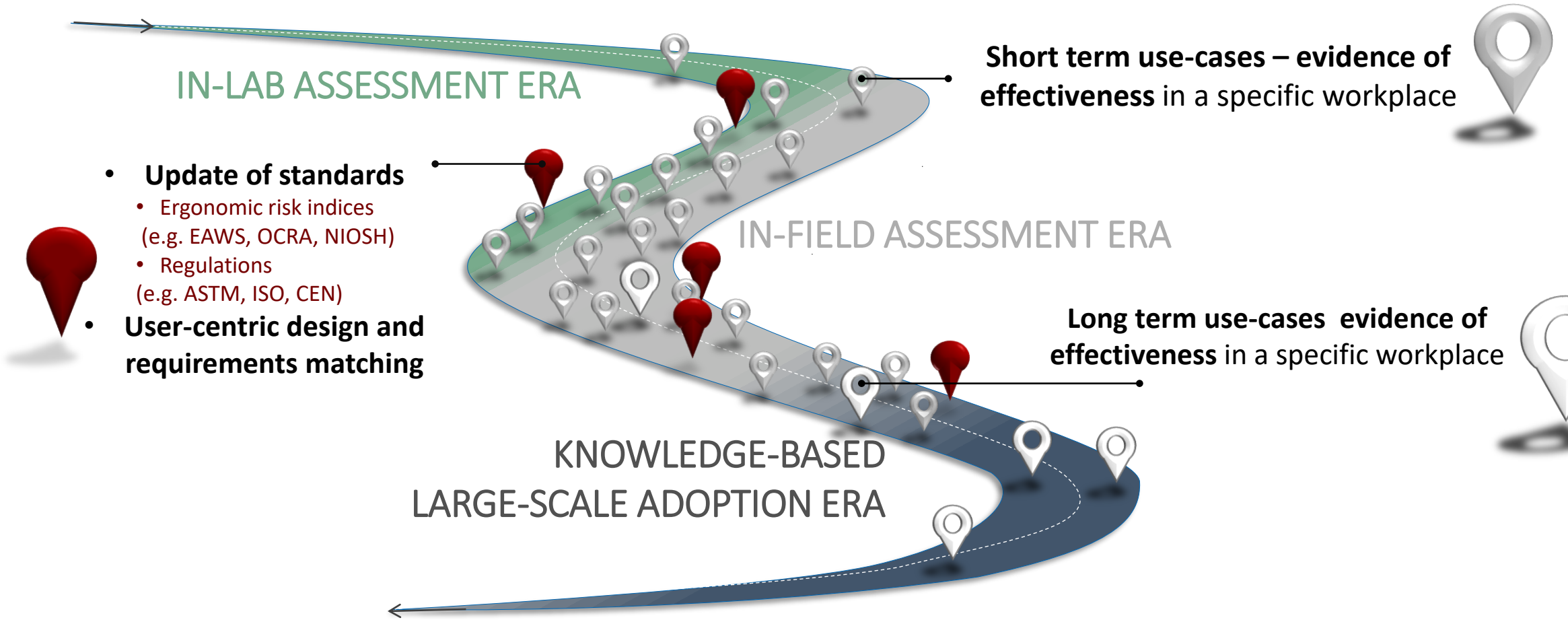
Crea S, et al. (2021). Occupational exoskeletons: A roadmap toward large-scale adoption. Methodology and challenges of bringing exoskeletons to workplaces. Wearable Technologies, 2, e11.

Toward large-scale adoption



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MATEXT

IUVO

COMAU

Active box

- ✓ Smart mechanism for smooth assistance
- ✓ Tuneable assistance (7 levels)
- ✓ Smart combination of simple components

Passive DOFs chain

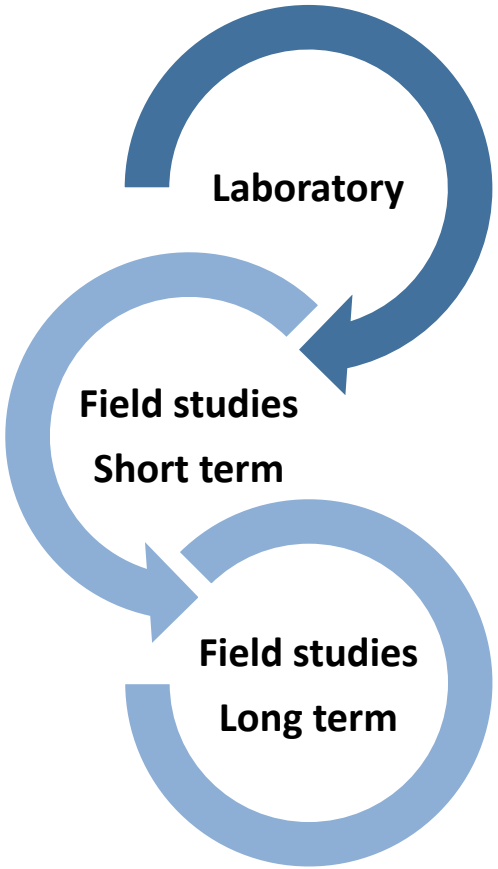
- ✓ Effective transfer of loads
- ✓ Freedom to execute movement

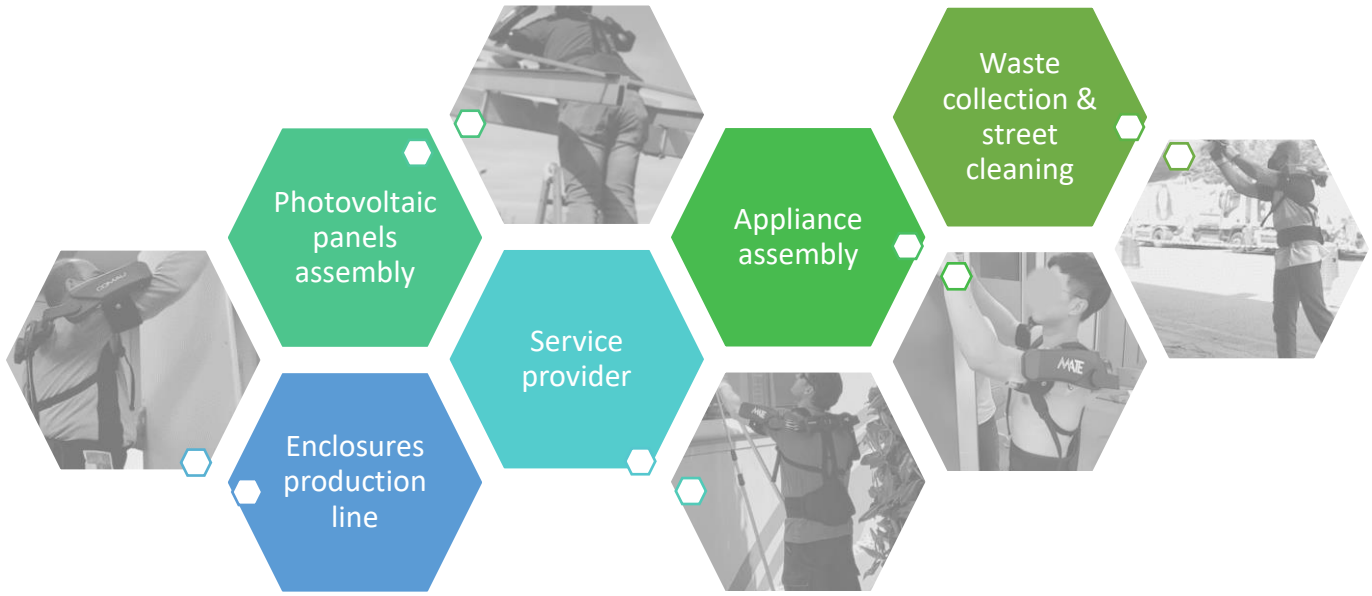
pHRI

- ✓ Wearability
- ✓ Adjustability to different body sizes
- ✓ Pressure distribution
- ✓ Lumbar support and stability

https://mate.comau.com/

IUVO experience in the assessment of occupational exoskeletons





30% ↓ **REDUCED MUSCULAR EFFORT** AT SHOULDER LEVEL

25% ↓ **PERCEIVED EFFORT REDUCTION** PERFORMING ACTIVITIES

POSITIVE IMPACT ON YOUR ERGONOMICS

MATE is certified as an effective tool to reduce the Biomechanical overload using the new release of EAWS

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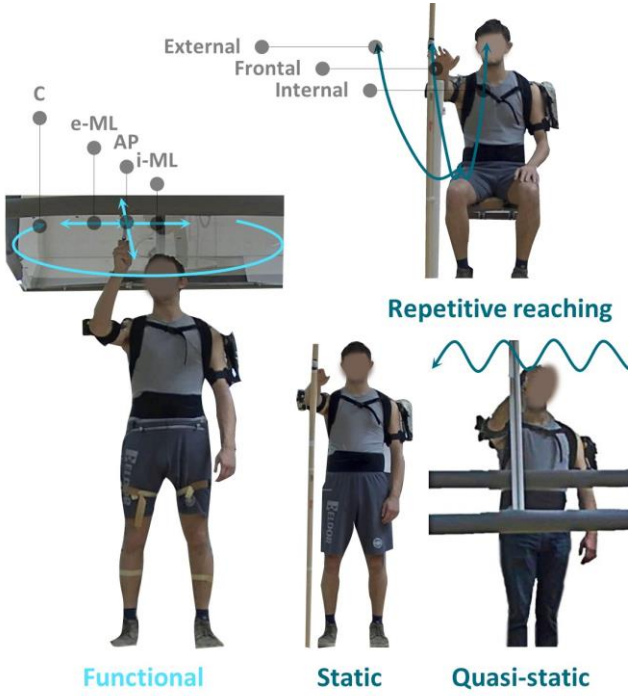
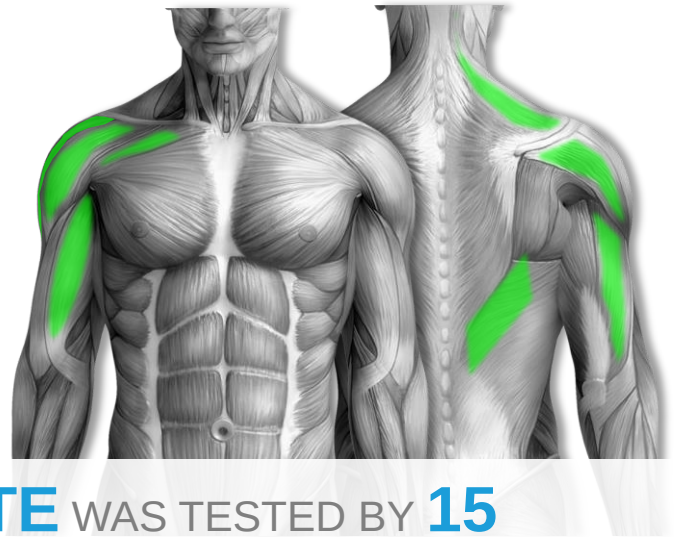
IN-LAB ASSESSMENT ERA





PROTO-MATE WAS TESTED BY **15**
SUBJECTS

ON AVERAGE:

30% REDUCED MUSCULAR EFFORT
AT SHOULDER LEVEL

NO DIFFERENCES IN KINEMATICS

<1mm HMI DISPLACEMENT

I. Pacifico et al., "An Experimental Evaluation of the Proto-MATE: A Novel Ergonomic Upper-Limb Exoskeleton to Reduce Workers' Physical Strain," in IEEE Robotics & Automation Magazine, vol. 27, no. 1, pp. 54-65, March 2020, doi: 10.1109/MRA.2019.2954105.

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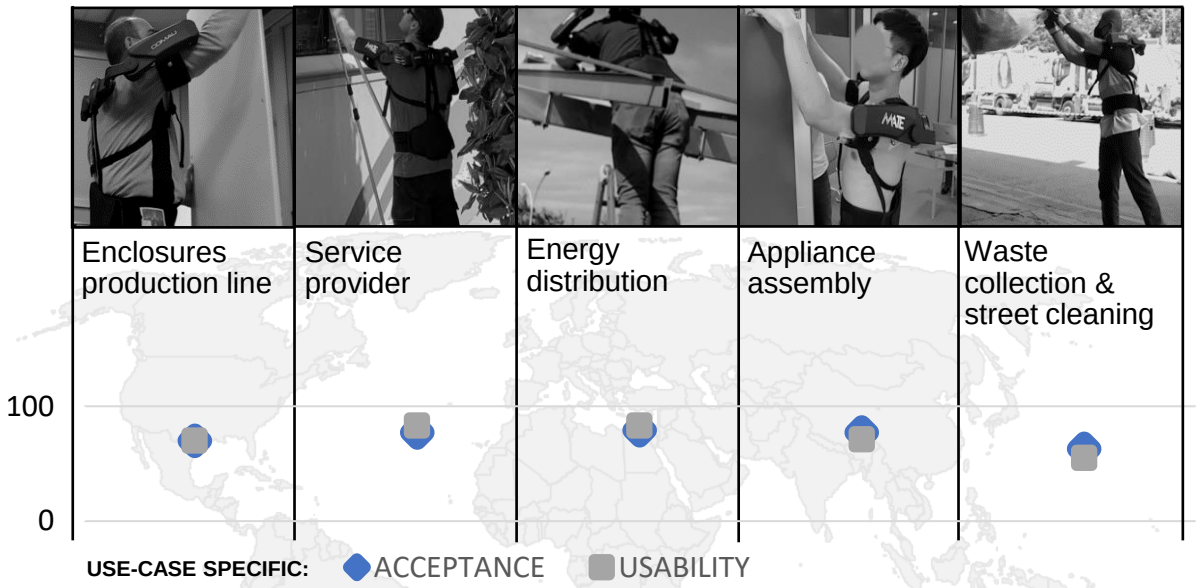
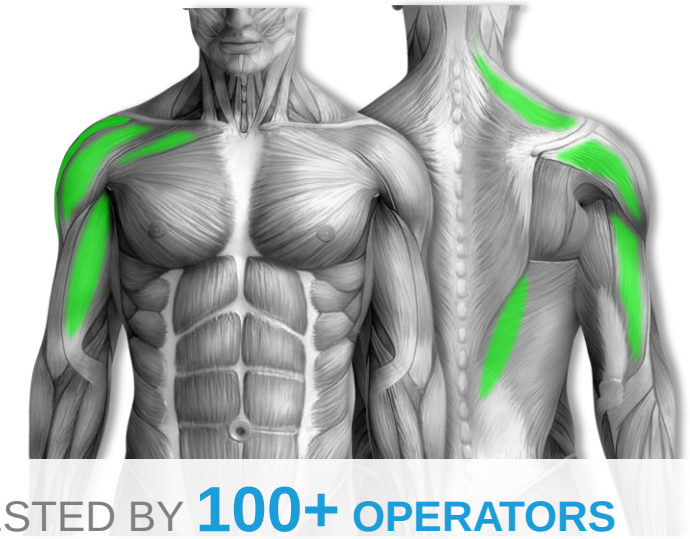
IN-FIELD ASSESSMENT ERA
SHORT TERM STUDIES





MATE WAS TESTED BY **100+ OPERATORS** ON **20+ TASKS** OVER **6 COMPANIES**

ON AVERAGE:

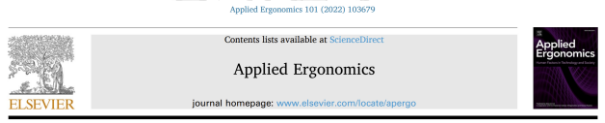
30% REDUCED MUSCULAR EFFORT AT SHOULDER LEVEL

25% PERCEIVED EFFORT REDUCTION

50% BACK SUPPORT RELIEF

73% USABILITY AND ACCEPTANCE IN WORKING ENVIRONMENT

- I. Pacifico, et al. "Using a Spring-Loaded Upper-Limb Exoskeleton in Cleaning Tasks: A Preliminary Study." International Symposium on Wearable Robotics. Springer, Cham, 2020.
- I. Pacifico et al., “Exoskeleton for worker: a case series study in enclosures production line" in Applied Ergonomics, January 2022


Applied Ergonomics 101 (2022) 103679
Contents lists available at ScienceDirect
Applied Ergonomics
journal homepage: www.elsevier.com/locate/apergo
ELSEVIER

Exoskeletons for workers: A case series study in an enclosures production line


Applied Ergonomics 106 (2023) 103877
Contents lists available at ScienceDirect
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Evaluation of a spring-loaded upper-limb exoskeleton in cleaning activities

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Mari4_YARD path

PROTOTYPING OF THE
MARI4_YARD EXOSKELETONS

Early verification of effectiveness in the specific workplace with existing technologies

Example of shipbuilding requirements collection and exoskeletons design

EN ISO 11611 EN ISO 11612 0-1km IP65 EN 1149-1

Long term use-case evidence of effectiveness

BENCHMARCKING, NETWORKING, TRAINING

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Thank you for your attention!

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