UNIVERSITÀ
DEGLI STUDI
FIRENZE

La sfida della standardizzazione degli esoscheletri

part of "AI-based human-centric smart digital ecosystem in Occupational Medicine and Radiation Protection"

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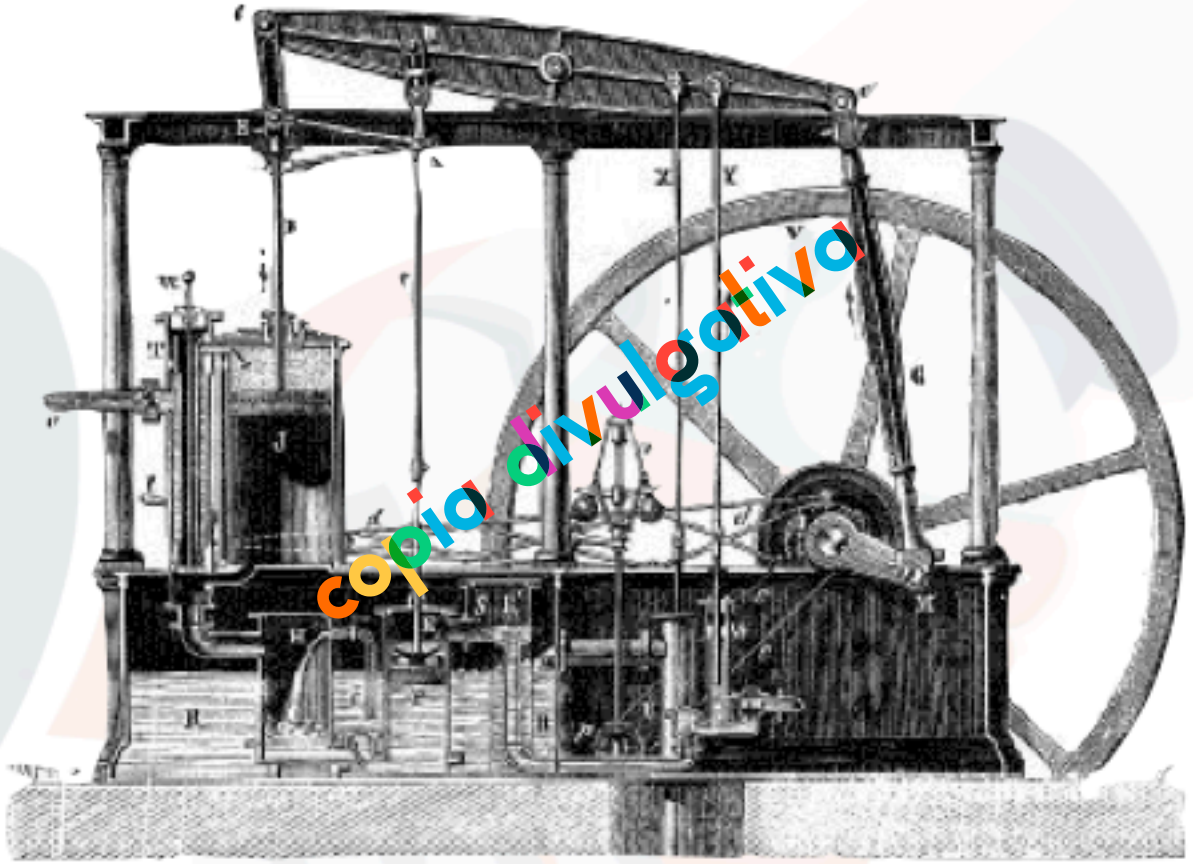
timeline
cópia divulgativa

James Watt

Steam engine

1769



Steam is the first example of Lord who submits to man.

(James Watt)

Henry Ford

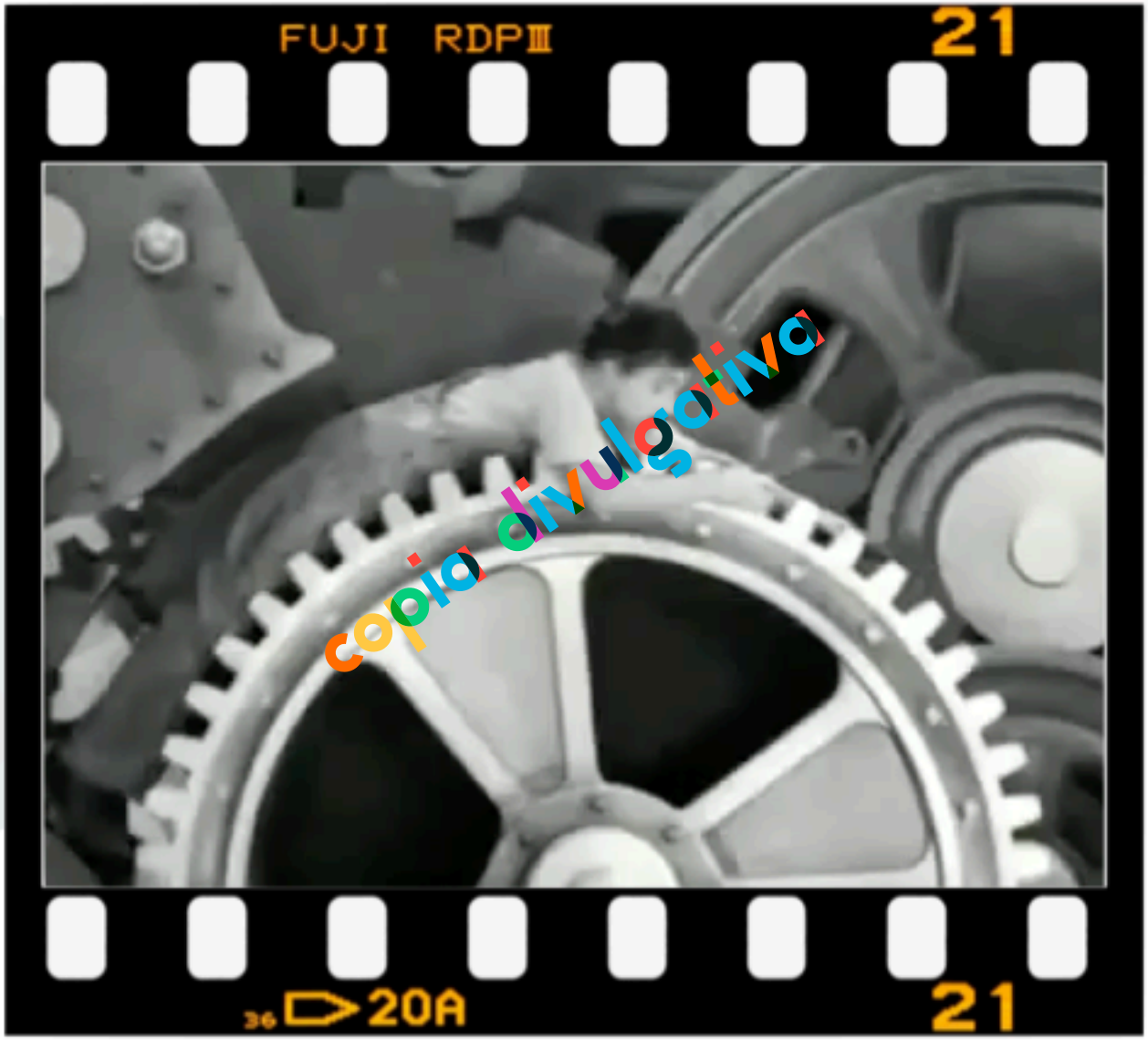
Ford T

assembly line

1908

Milan, 13-16 June 1906

International Commission on Occupational Health



Charlie Chaplin

Modern times

1936

First Internet connection

ARPANET UCLA

October 29, 1969

DATE	METER	PROBLEM & REMEDY	OPERATOR	DOWNTIME
29Oct69	1750	IMPTST RUNNING - TESTING LINE TO UCSB - LINE IS OPEN SO 'B' IMP IS COUNTING ERRORS BUT SHOULD CEASE COUNTING IF TEL-CO GETS LINE FIXED.	T. TAACH	
		CHARLEY PLEASE CALL BEN AT SRI !		
29Oct69	2100	LOADED UP. PROGRAM FOR BBN IMP BBN	CSK	
	22:30	Talked to SRI IMP to Host	CSK	
		Left up. Imp Program running after sending a host dead message to imp.	CSK	
30Oct69	1030	Stopped up. prog Started IMPTST to trace line trouble to TENEX (UCSB)	T. TAACH	

CUSTOMER SERVICE

SDS-S-324

Industry 4.0

- System Integration
- Augmented Reality
- Cloud/Edge Computing
- Additive Manufacturing
- Internet of Things
- Autonomous Robots
- Simulation
- Cyber Security
- Big Data

Industry 4.0

- **Centered around enhanced efficiency** through digital connectivity and artificial intelligence
- **Technology** — centered around the emergence of cyber-physical objectives
- **Aligned with optimization of business models** within existing capital market dynamics and economic models — i.e., ultimately directed at minimization of costs and maximization of profit for shareholders
- **No focus on design and performance** dimensions essential for systemic transformation and decoupling of resource and material use from negative environmental, climate, and social impacts

Industry 5.0

- **Ensures a framework** for industry that combines competitiveness and sustainability, allowing industry to realize its potential as one of the pillars of transformation.
- **Emphasizes impact of alternative modes** of (technology) governance on sustainability and resilience.
- **Empowers workers** using digital devices, endorsing a human-centric approach to technology.
- **Builds transition pathways** towards environmentally sustainable uses of technology.
- **Expands the remit of corporation's** responsibility to their whole value chains.
- **Introduces indicators** that show, for each industrial ecosystem, the progress achieved on the path to well-being, resilience, and overall sustainability.

Industry 5.0

Towards a sustainable, human-centered and resilient European industry

Super-strength Operator

(operator + exoskeleton)

Opportunities...

The increasing digitalisation of the economy and the use of digital technologies in the workplace bring opportunities for workers and employers, including new opportunities for improving OSH:

- **Automation** delegates repetitive, labour-intensive and unsafe tasks to machines.
- **Robotics** and **AI** support and replace workers in hazardous working environments.
- Digital technologies and performance enhancing technologies (e.g. **exoskeletons**) improve access to the labour market for disadvantaged workers such as disabled workers, migrants or workers located in areas with scarce employment opportunities.
- Better monitoring combined with **Big Data** allow for more timely and effective interventions.
- A better **work-life balance**, flexibility and autonomy experienced by workers who can **work from home**.

... and risks

There are also challenges and risks for OSH stemming from the deployment of digital technologies into the workplace:

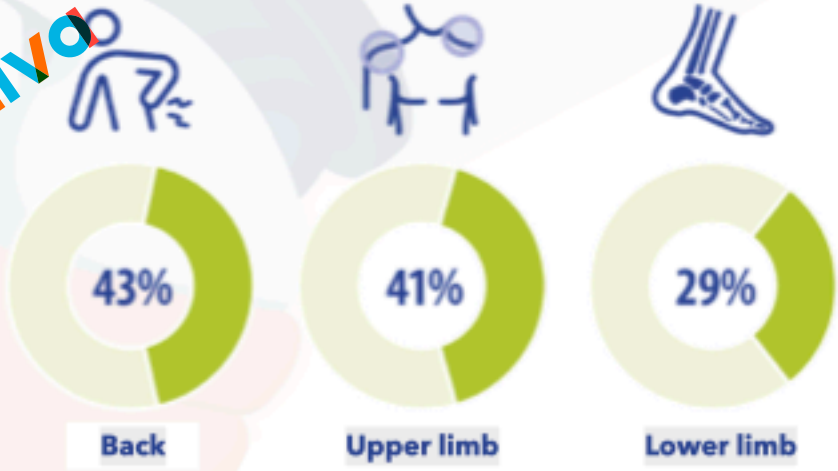
- **Digital monitoring**, **loss of autonomy**, **work intensification** and **pressure** to perform at a certain standard.
- Middle management jobs are replaced by **algorithms** allocating tasks to workers and **monitoring** their **performance**.
- **Loss of job control**, fragmentation of jobs into very simple tasks to be executed in a standard way, narrowed job content and de-skilling of jobs.
- **Isolation of workers**, **increase of virtual interactions** and **loss of peer support**.
- Incorrect or unfair decisions about workers stemming from automated or semiautomated processes using data and/or software containing mistakes.
- Systems of nudges and penalties and the **rating of workers' performance**.
- Unclear responsibility for OSH and the applicability of the existing OSH regulatory framework.
- **Mobility**, **flexibility**, **24/7 availability**, and **blurring of boundaries between work and private life**.

Silver Tetradrachm
Attica, Athens (c. 454-430 B.C.)

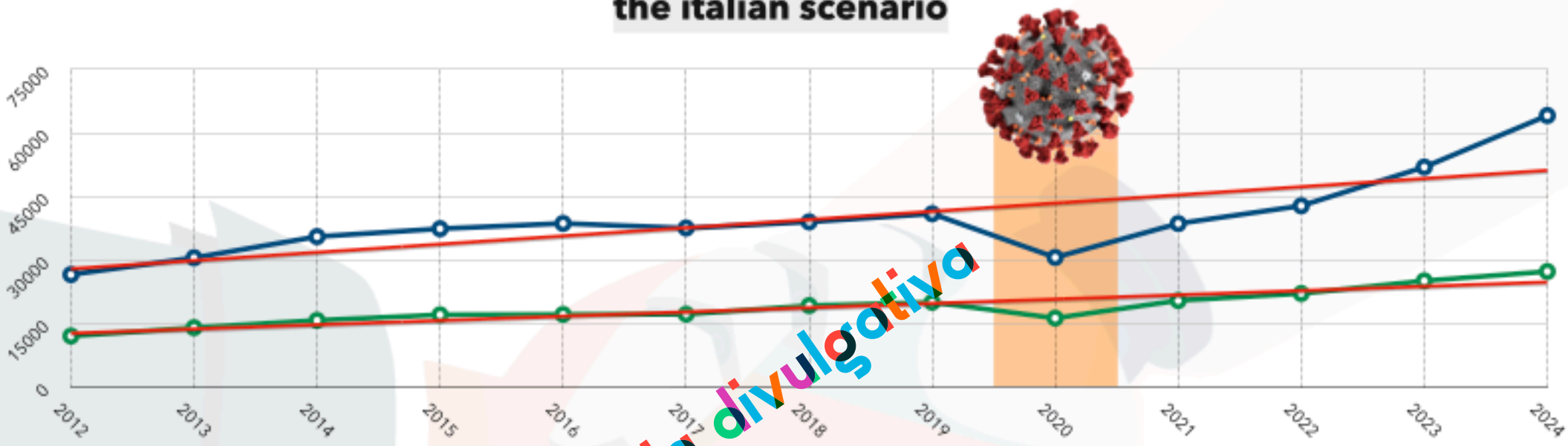
biomechanical overload

European Agency for Safety and Health at Work

Healthy Workplaces



the italian scenario

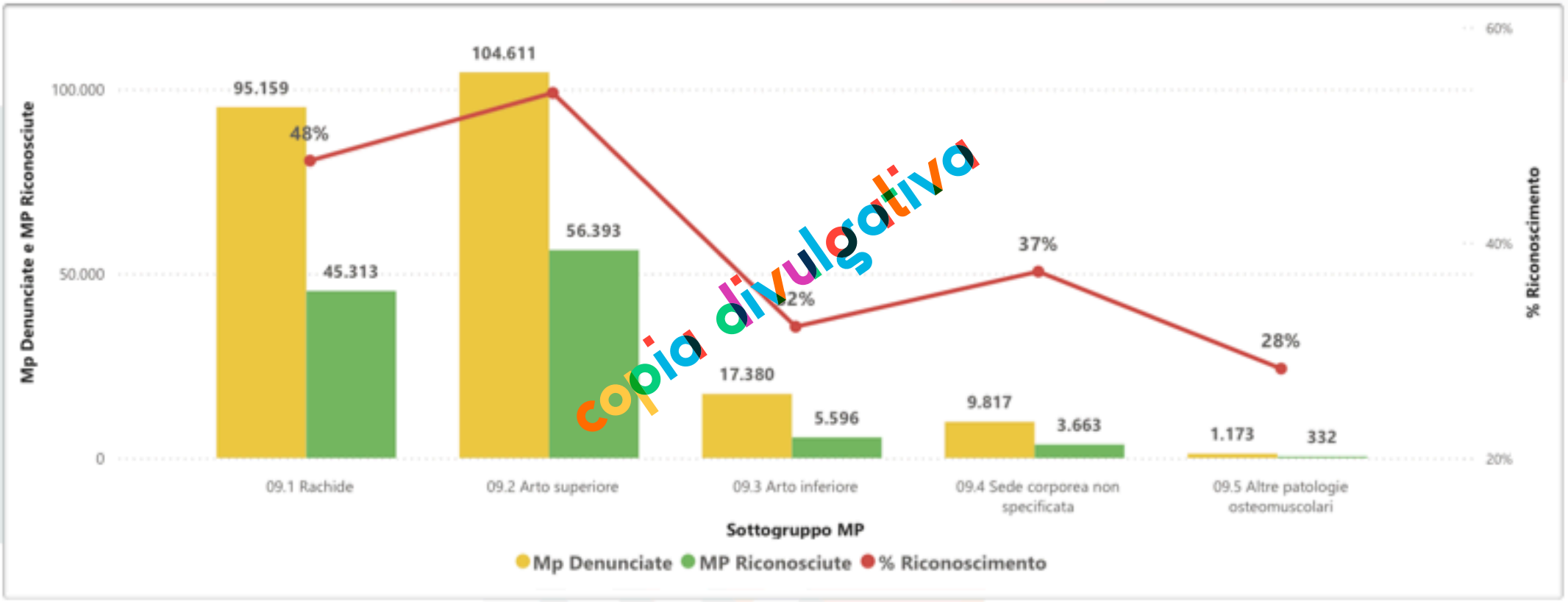


Anno protocollo	2020			2021			2022			2023			2024		
Tipologie	Den	Ric	%	Den	Ric	%	Den	Ric	%	Den	Ric	%	Den	Ric	%
D - WMSDs	**30.631**	**16.310**	**53%**	**38.622**	**20.459**	**53%**	**42.822**	**22.116**	**52%**	**51.951**	**25.107**	**48%**	**64.114**	**27.305**	**43%**
09.1 Rachide	12.654	6.681	53%	16.300	8.559	53%	18.070	9.124	50%	21.787	10.184	47%	26.348	10.765	41%
09.2 Arto superiore	13.912	8.135	58%	17.426	10.098	58%	19.501	11.170	57%	23.681	12.726	54%	30.091	14.264	47%
09.3 Arto inferiore	2.284	802	35%	2.861	1.013	35%	3.194	1.064	33%	4.118	1.292	31%	4.923	1.425	29%
09.4 Sede corporea non specificata	1.568	624	40%	1.853	748	40%	1.804	681	38%	2.112	818	39%	2.480	792	32%
09.5 Altre patologie osteomuscolari	213	68	32%	182	41	23%	253	77	30%	253	87	34%	272	59	22%
Totale	**30.631**	**16.310**	**53%**	**38.622**	**20.459**	**53%**	**42.822**	**22.116**	**52%**	**51.951**	**25.107**	**48%**	**64.114**	**27.305**	**43%**

INAIL - Open Data (aggiornati 31/10/2025)

the italian scenario

2020 - 2024



INAIL - Open Data (aggiornati 31/10/2025)

The International Labour Organization has estimated that more than **3.9% of the world's annual GDP** (Gross Domestic Product) is lost as a result of occupational accidents and diseases, at an annual direct and indirect cost of €2,680 billion and comprising **more than 120 million disability-adjusted life years (DALYs)** lost.

XXI World Congress on Safety and Health at Work in Singapore in September 2017

The analysis estimated that the total costs of work-related MSDs were in the **European region** of €240 billion or up to **2% of GDP**. MSDs are, according to this analysis, responsible for 40-50% of the costs of all work-related health issues. The Global Burden of Disease data show that back pain accounts for the **highest proportion of years lost to disability (YLDs)** of all conditions, with neck pain and other MSDs all in the top 10 ranking. MSDs affect at least **100 million people in Europe**, accounting for half of all European absences from work and for **60% of permanent work incapacity**.

Bevan S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Pract Res Clin Rheumatol. 2015 Jun;29(3):356-73. doi: 10.1016/j.berh.2015.08.002. Epub 2015 Oct 24. PMID: 26612235.


solutions
copia divulgativa

WMSDs (Work related Muscolo Skeletal Disorders) prevention ISO standards

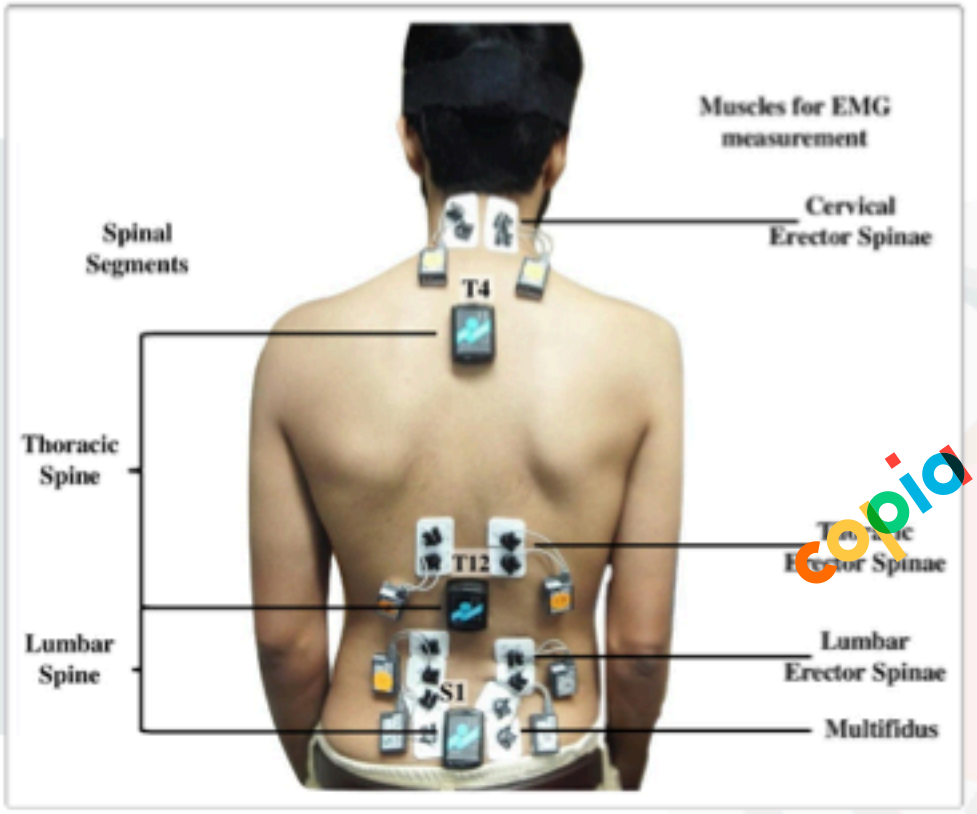
- ISO 11226: Ergonomics - **Evaluation of static working postures**
- ISO 11228-1: Ergonomics - **Manual handling - Lifting and carrying**
- ISO 11228-2: Ergonomics - **Manual handling - Pushing and pulling**
- ISO 11228-3: Ergonomics - **Manual handling - Handling of low loads at high frequency**

ISO TR 12295

- ISO 12100: Safety of machinery - General principles for design - Risk assessment and risk reduction

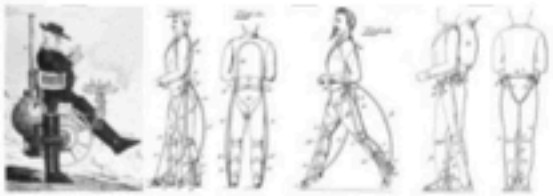
- Ergonomics – **Manual handling of people in the healthcare sector**

ISO TR 12296



Biomechancial Risk Factors

	Awkward postures	High forces	Long durations	High frequency
Neck	✔	✔	✔	✔
Shoulder		✔		✔
Upper limb	✔	✔	✔	✔
Elbow/forearm	✔	✔	✔	✔
Wrist/hand	✔	✔	✔	✔
Low back	✔	✔	✔	✔
Lower limb	✔	✔	✔	✔

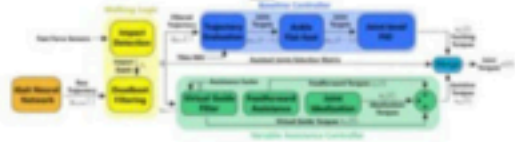


The first idea/concept was shown with the support of steam power for walking, riding or flying

During 1st industrial revolution (1750-1850)

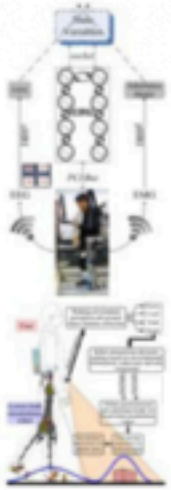
This was a time when exoskeletons for gait rehabilitation were designed and developed

During 3rd industrial revolution (1970-Early 2000)



With technological advancements, the scope of exoskeletons has been explored in various commercial & industrial fields

Current era



1830s — 1960s — 1980s — 2000s — Present

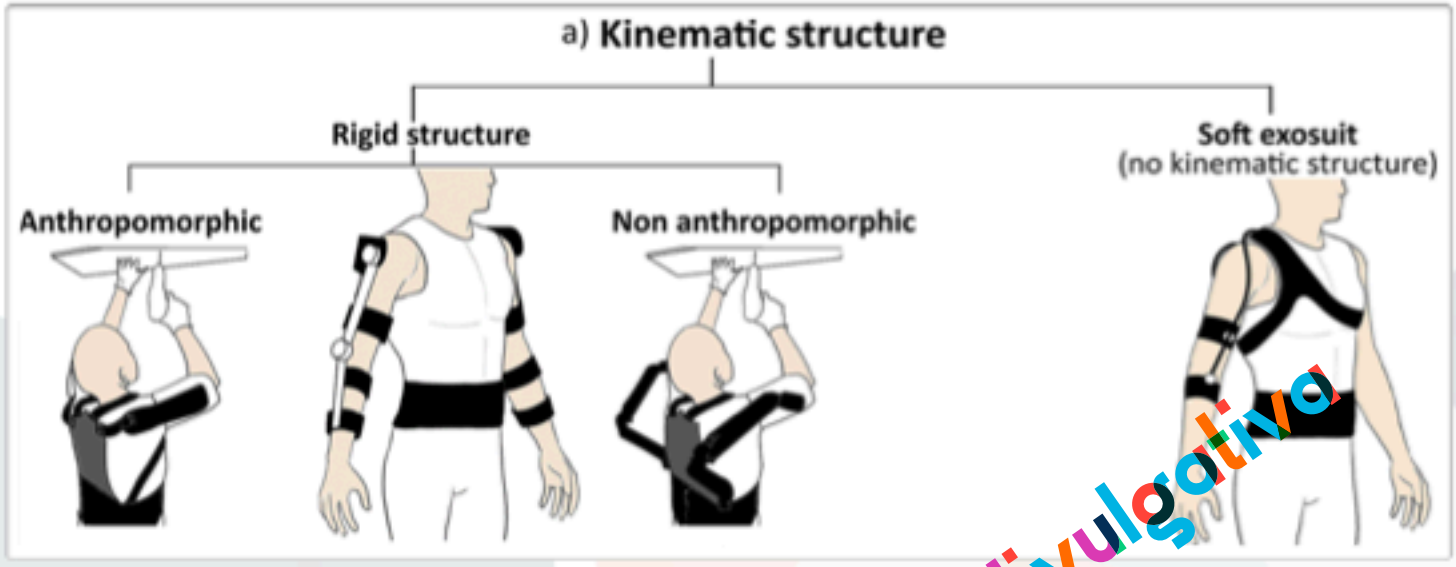
After 2nd industrial revolution (1850-1915)

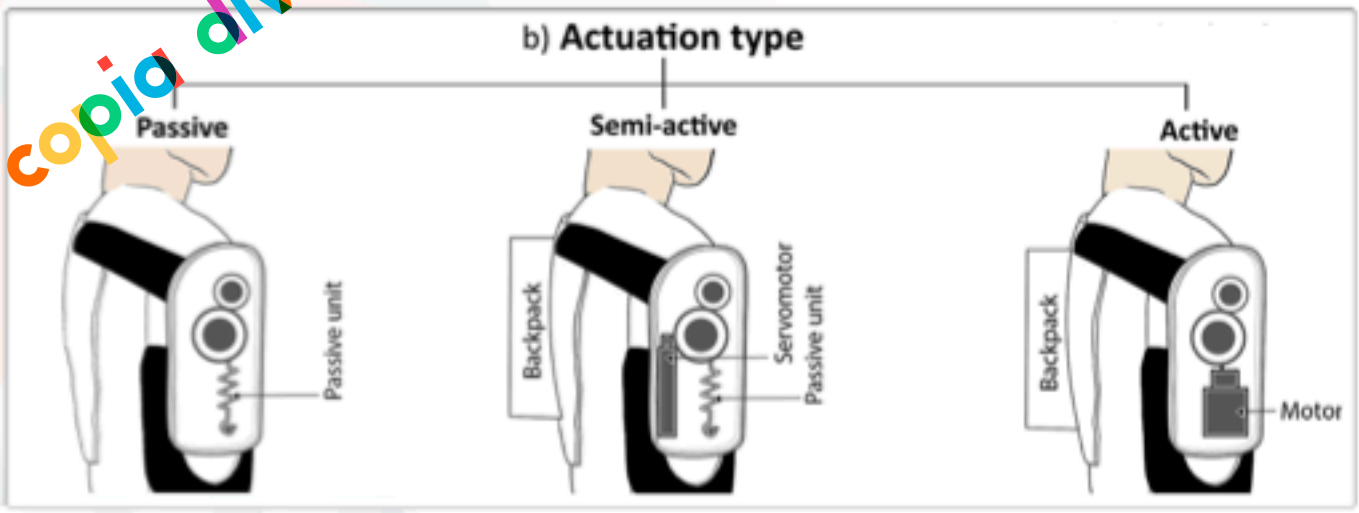
As discussed in the literature first human-powered exoskeleton was designed and developed for which many modifications were brought to meet the user's need

Entering 4th industrial revolution

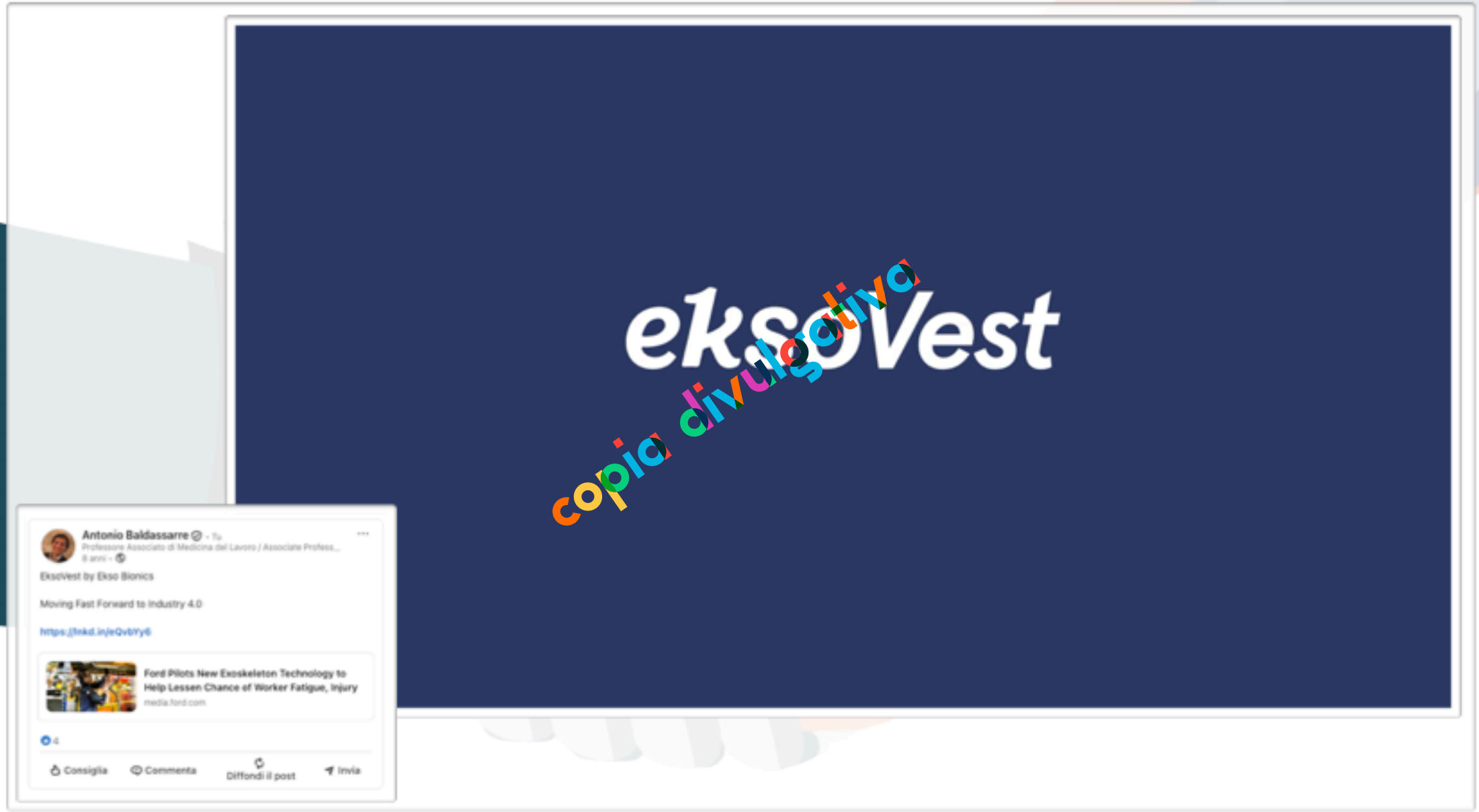
Technical aspects of the exoskeletons were detailed towards load augmentation and gait rehabilitation

Arunkumar, S., Jayakumar, N. A comprehensive review on lower limb exoskeleton: from origin to future expectations. Int J Interact Des Manuf 19, 4625–4648 (2025). https://doi.org/10.1007/s12008-024-02076-7





Crea, S., Beckerle, P., De Looze, M., De Pauw, K., Grazi, L., Kermavnar, T., Veneman, J. (2021). *Occupational exoskeletons: A roadmap toward large-scale adoption. Methodology and challenges of bringing exoskeletons to workplaces.* Wearable Technologies, 2, E11. doi:10.1017/wtc.2021.11


eksoVest
copia divulgativa
Antonio Baldassarre
EksoVest by Ekso Bionics
Moving Fast Forward to Industry 4.0
https://lnkd.in/eQvbYy6
Ford Pilots New Exoskeleton Technology to Help Lessen Chance of Worker Fatigue, Injury
media.ford.com
Consiglia
Commenta
Diffondi il post
Invia

From bench to workplace... and back again!

- complex work activities compared to experimental tests
- workers represent a heterogeneous population compared to the population recruited for the studies
- offers **advantages depending on the activity it supports** (prolonged static positions, e.g. support of the upper limbs with the arms above the level of the shoulders)
- it can represent an ergonomic risk in the case of dynamic tasks (e.g. surgeon, farmer, warehouse worker) as it can increase discomfort, represented by bulk, with increased overload... even emotional!
- a design phase focused on ergonomic aspects (e.g. ease of use, low bulk, easy donning/donning, rapid learning curve) is crucial in terms of the acceptability of this technology
- it could **contribute to mitigating the risk of biomechanical overload** of the spine and upper limbs, further support for national and supranational policies to stop the phenomenon (e.g. decreased demand for medical visits in "enhanced" workers)

UNI/TR 11950:2024

Sicurezza e salute nell'uso degli esoscheletri occupazionali orientati ad agevolare le attività lavorative

18/04/2024

La UNI/TR 11950 approfondisce lo stato dell'arte degli esoscheletri occupazionali e si propone di:

- fornire indicazioni sulla corretta terminologia e definizioni da adottare nel settore degli esoscheletri occupazionali;
- individuare e descrivere le **diverse tipologie di esoscheletri** ad oggi sviluppati ed in uso negli ambienti di lavoro (con particolare riferimento agli attivi e passivi);
- illustrare i **principi generali di progettazione e costruzione** degli esoscheletri;
- rappresentare i **settori lavorativi di possibile applicazione** degli esoscheletri;
- inquadrare le **potenziali opportunità e problematiche** correlate all'uso degli esoscheletri.

La definizione di una terminologia comune e di una classificazione di questi dispositivi, esplicitandone i campi e i limiti di applicazione e le caratteristiche funzionali e di progettazione e costruzione, è essenziale per avviarne un utilizzo corretto e consapevole.

Dispositivi indossabili come gli esoscheletri vengono presentati come una soluzione utile per ridurre o mitigare i rischi da sovraccarico biomeccanico, ma ciò richiede come precondizione una corretta implementazione nei luoghi di lavoro, al fine di evitare potenziali rischi correlati al loro uso.

Le malattie e i disturbi muscoloscheletrici da sovraccarico biomeccanico lavoro-correlati sono infatti associati a fattori di rischio fisici legati ad attività di movimentazione manuale dei carichi e ad attività che richiedono il mantenimento di posture fisse e incongrue per prolungati periodi di tempo.

L'approccio tradizionale alla mitigazione di questi rischi prevede l'adozione di misure di prevenzione atte a eliminare o quantomeno ridurre il potenziale danno, attraverso, ad esempio, un'idonea configurazione del luogo di lavoro, una corretta gestione dell'attività lavorativa e un'appropriata scelta delle attrezzature di lavoro utilizzate dal lavoratore. Nei casi in cui queste misure di prevenzione non possano risultare efficaci per la mitigazione del rischio di sovraccarico biomeccanico, recentemente in alcuni contesti produttivi si sta introducendo appunto l'utilizzo di esoscheletri.

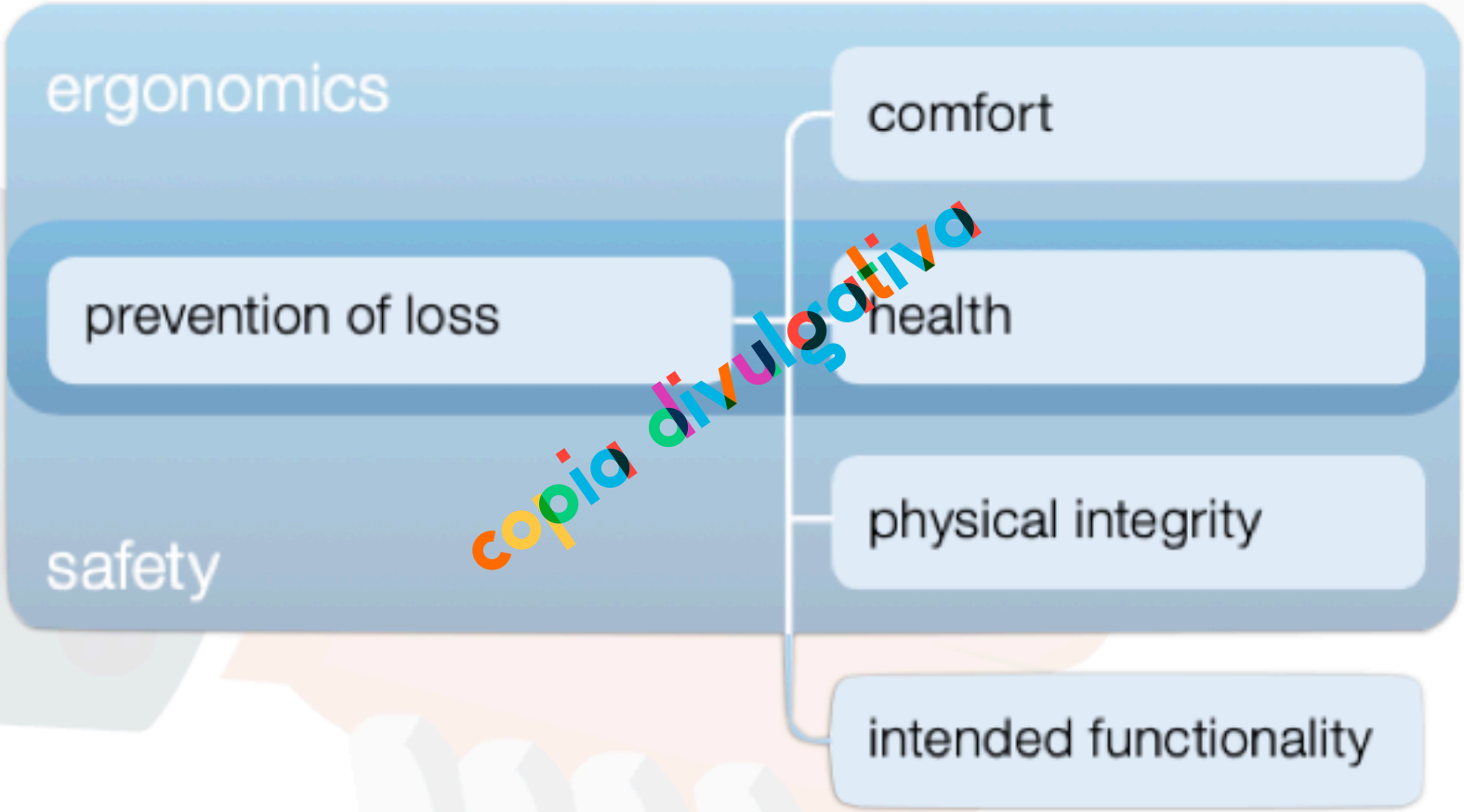
Occorre valutare il contributo di questi dispositivi e, soprattutto, quale può essere il loro contributo alla riduzione del rischio, quali rischi residui permarranno e quali, invece, verranno magari introdotti dal loro impiego nei diversi contesti produttivi.

Ergonomics *(or human factors) is the scientific discipline concerned with the* ***understanding of interactions among humans and other elements of a system****, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.*

International Ergonomics Association (IEA)

- ***ἔργον*** (érgon)
  "work, task"
- ***νομία*** (nómos)
  from *νέμω* (nèmo) "law, custom"

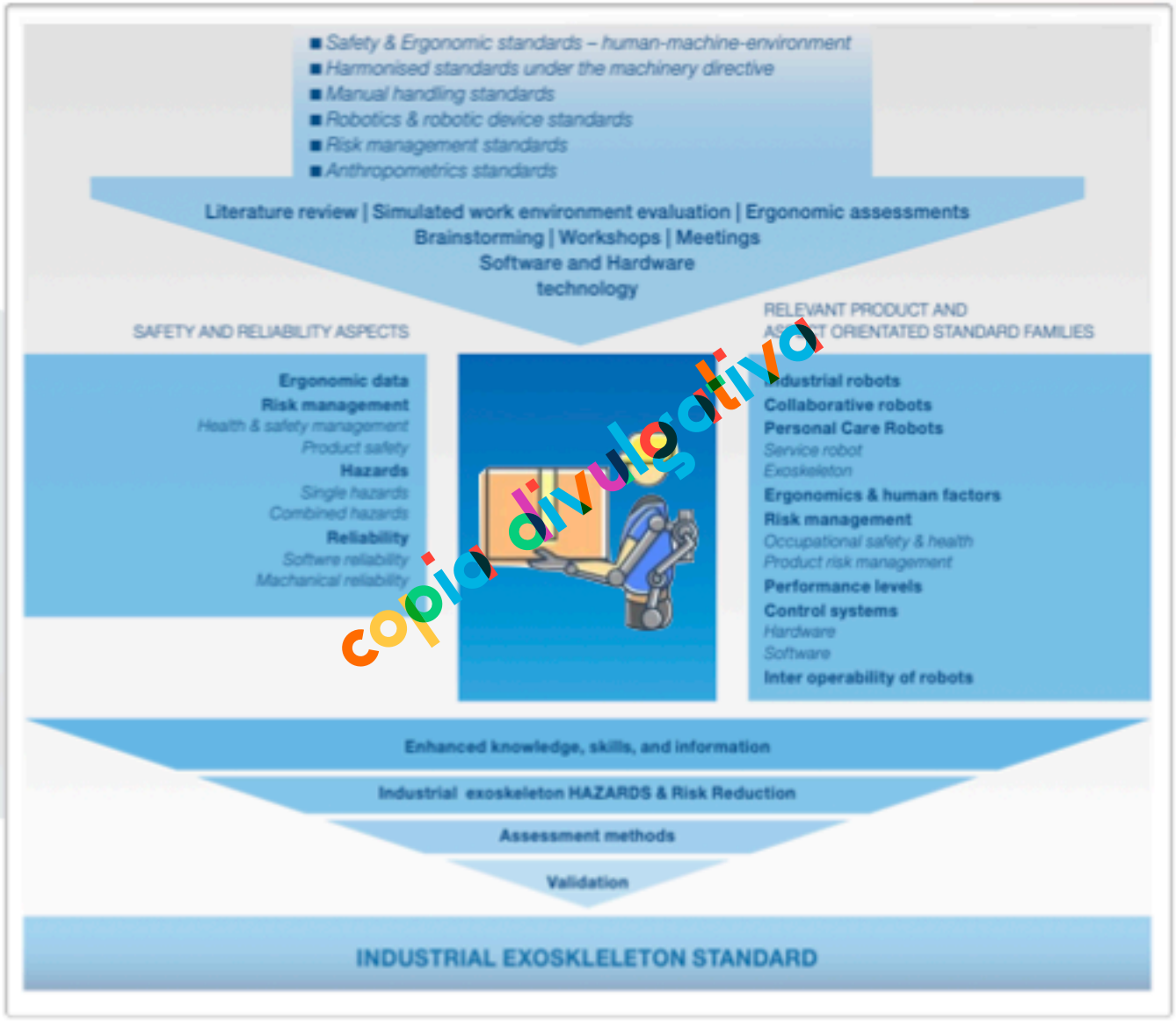
} *how to work according to nature*



Van der Vorm, Johan; O'Sullivan, Leonard; Nugent, Rachel; de Looze, Michiel. White Paper. Considerations for developing safety standards for industrial exoskeletons. Robo-Mate. May 2015

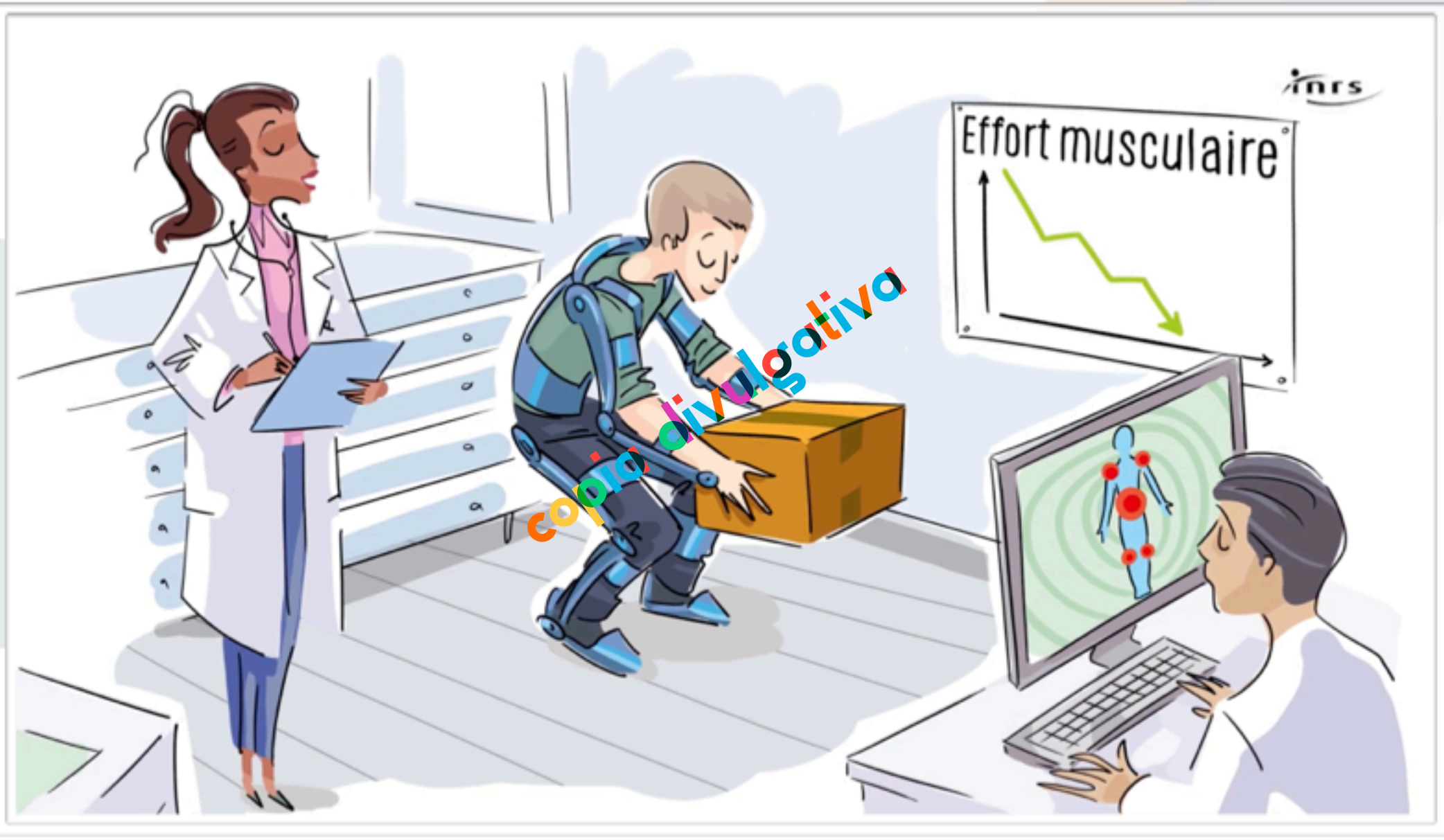
ISO 13482: Robots and robotic devices - Safety requirements for personal care robots	*ISO 10218/1 Robots and robotic devices - Safety requirements for Industrial Robots, Part 1 Robots*	*ISO 10218/2 Robots And Robotic Devices - Safety Requirements for Industrial Robots: Part 2 Robot Systems and Integration*
GENERAL		
Terms & definitions	Terms & definitions	Terms & definitions
Hazard management	Hazard management	Hazard management
Elimination & risk reduction	Elimination & risk reduction	Elimination & risk reduction
List of significant hazards	List of significant hazards	List of significant hazards
Risk reduction strategies	Risk reduction strategies	Risk reduction strategies
Risk assessment guidelines	Risk assessment guidelines	Risk assessment guidelines
SPECIFIC HAZARD MANAGEMENT		
Due to robot shape	Safety-related control system performance	Layout design
Due to stress, posture & use	Operational modes	Risk assessment
Due to robot motion	Control of simultaneous motion	Hazard identification
Due to insufficient durability	Collaborative operation requirements	Hazard elimination & Risk reduction
Due to incorrect decisions & actions	Axis limiting	
Due to contact with moving components	Movement without drive power	
Environmental conditions	Provisions for lifting	
Due to localisation & navigation errors		
SAFETY REQUIREMENTS & PROTECTIVE MEASURES		
Robot stopping functions		Safety-related control system performance
Limits to operational spaces		Limiting robot motion
Safety-related speed control		Layout
Safety-related environmental sensing		Robot system operational mode application
Stability control		Maintenance and repair
Safety-related force control		Integrated manufacturing system interface
Design of user interface		Safeguarding
Operational modes		Collaborative robot operation
Manual control devices		
VERIFICATION & VALIDATION OF SAFETY		
Verification & validation	Verification & validation methods	Verification & validation of protective equipment
User & Service manual	User & Service manual	
Labelling & Marking guidelines	Labelling & Marking guidelines	

Van der Vorm, Johan; O'Sullivan, Leonard; Nugent, Rachel; de Looze, Michiel. White Paper. Considerations for developing safety standards for industrial exoskeletons. Robo-Mate. May 2015



Van der Vorm, Johan; O'Sullivan, Leonard; Nugent, Rachel; de Looze, Michiel. White Paper. Considerations for developing safety standards for industrial exoskeletons. Robo-Mate. May 2015

Adoption	Utility	Usability	Impact	Safety
■ Fluidity of movement	■ Compliance with the cycle time	■ Ease of implementation: putting it on, taking it off, changing settings, etc.	■ Good integration in the work activity	■ Assessment of risks to the operator
■ Control of the exoskeleton	■ Compliance with the quality of the operation	■ Ease of use	■ Control of the new operating strategies	■ Assessment of risks to colleagues
■ Duration of the task	■ Efficiency of the physical support	■ Ease of maintenance, cleaning, repair, etc.	■ Effects on the operator (physical and cognitive constraints, health effects)	■ Assessment of risks to the work environment
■ Social acceptance	■ Duration of active support during the task	■ The operator has no discomfort when performing the task	■ Effects on the work community (collaboration among colleagues, time-distribution of tasks, etc.)	■ Consideration of the risks of deterioration of the exoskeleton
■ Operators' perception	■ Operators' perception	■ Adaptability to the different components of the activity	■ Operators' perception	■ Operators' perception
		■ Operators' perception		

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cópia divulgativa

Exoskeletons at work: 6 critical points

Exoskeletons can relieve strain on operators but... using them is not without risk.

1. The exoskeleton repeatedly rubbing or pressing against certain parts of the body can cause **DISCOMFORT AND/OR SKIN IRRITATION.**
2. Some activities done with an exoskeleton require greater attention which can **INCREASE STRESS.**
3. Exoskeletons, because of their size and structure, can pose a **RISK OF COLLISION** with third parties or elements in the environment.
4. Exoskeletons can change perceived exertion and hinder movement, which may result in **LOSS OF BALANCE AND/OR UNCONTROLLED MOVEMENT.**
5. The use of exoskeletons modifies distribution of effort and can therefore contribute to the emergence of **NEW BIOMECHANICAL CONSTRAINTS**, risk factors for musculoskeletal disorders (MSDs).
6. The weight of exoskeletons and the associated discomfort during certain movements can **INCREASE CARDIOVASCULAR LOAD.**

To find out more:
www.inrs.fr/exosquelettes

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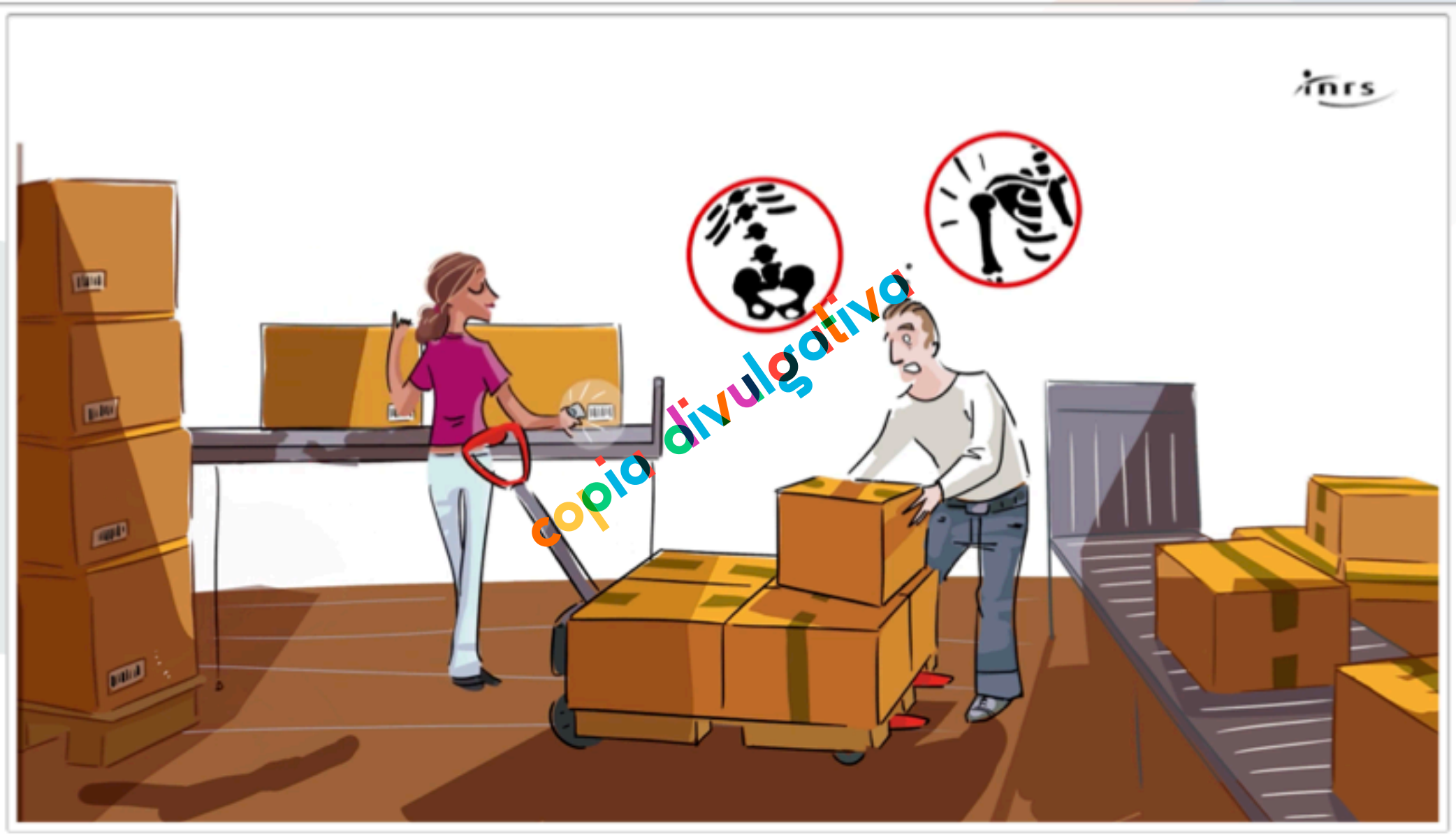
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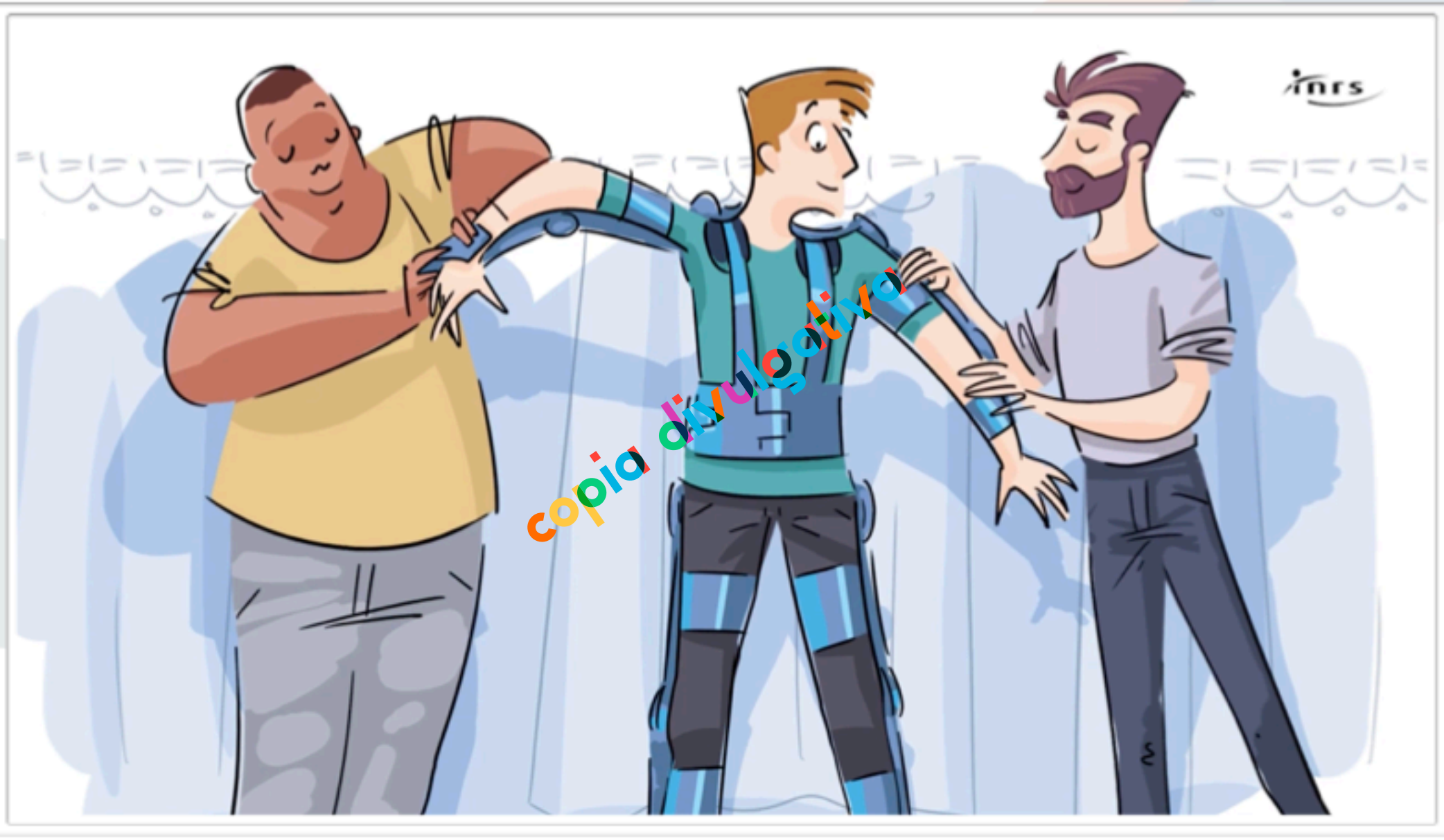
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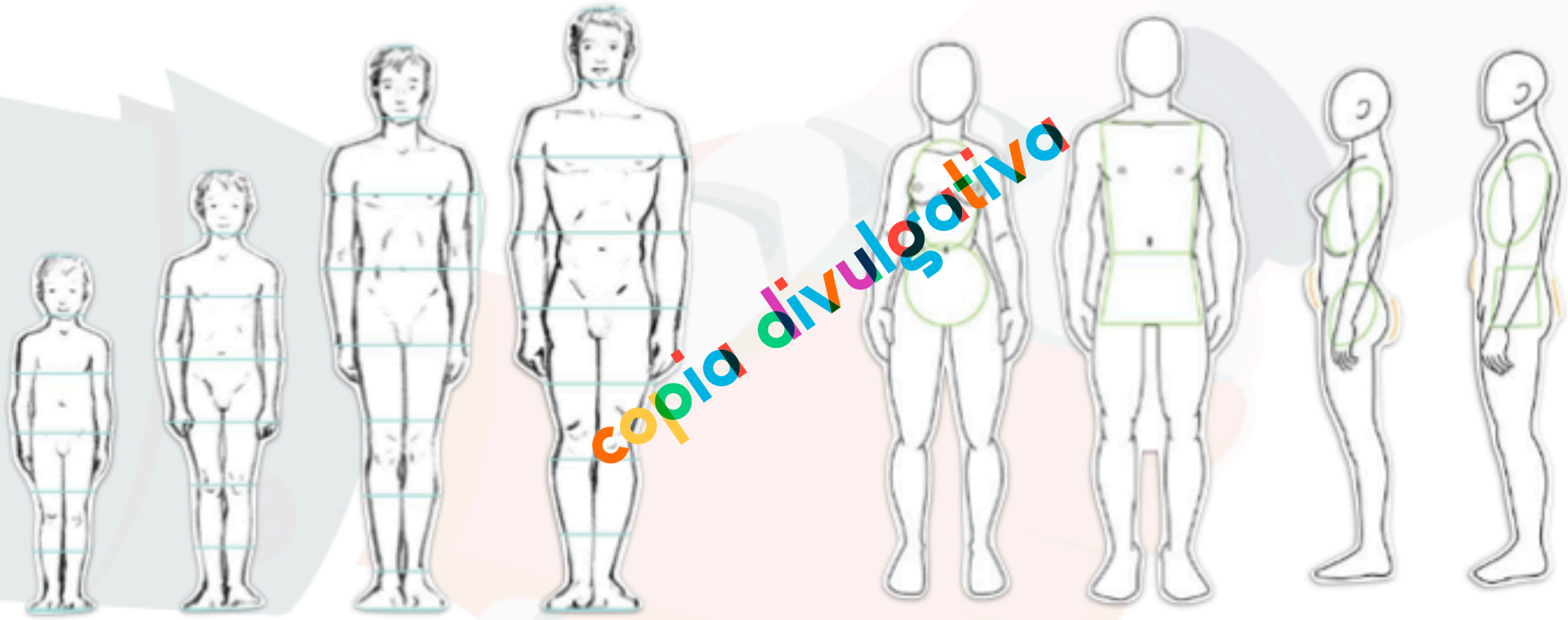
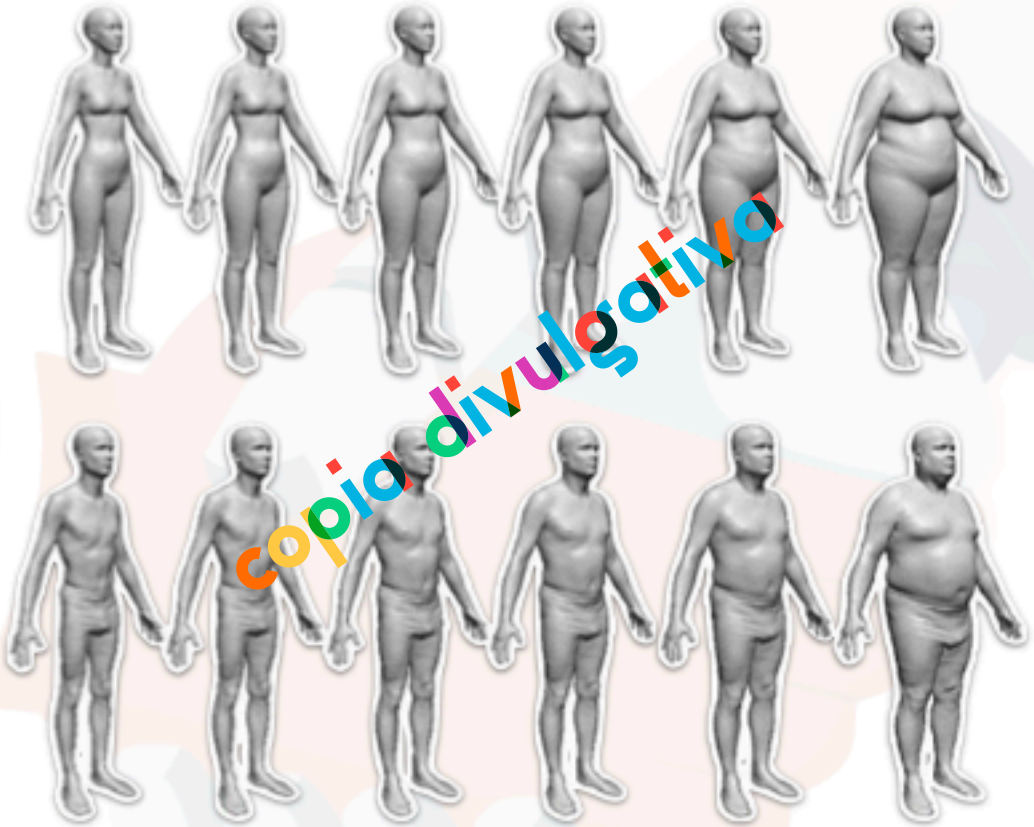
Age and Sex



Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

Body weight
(and fat distribution)



Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

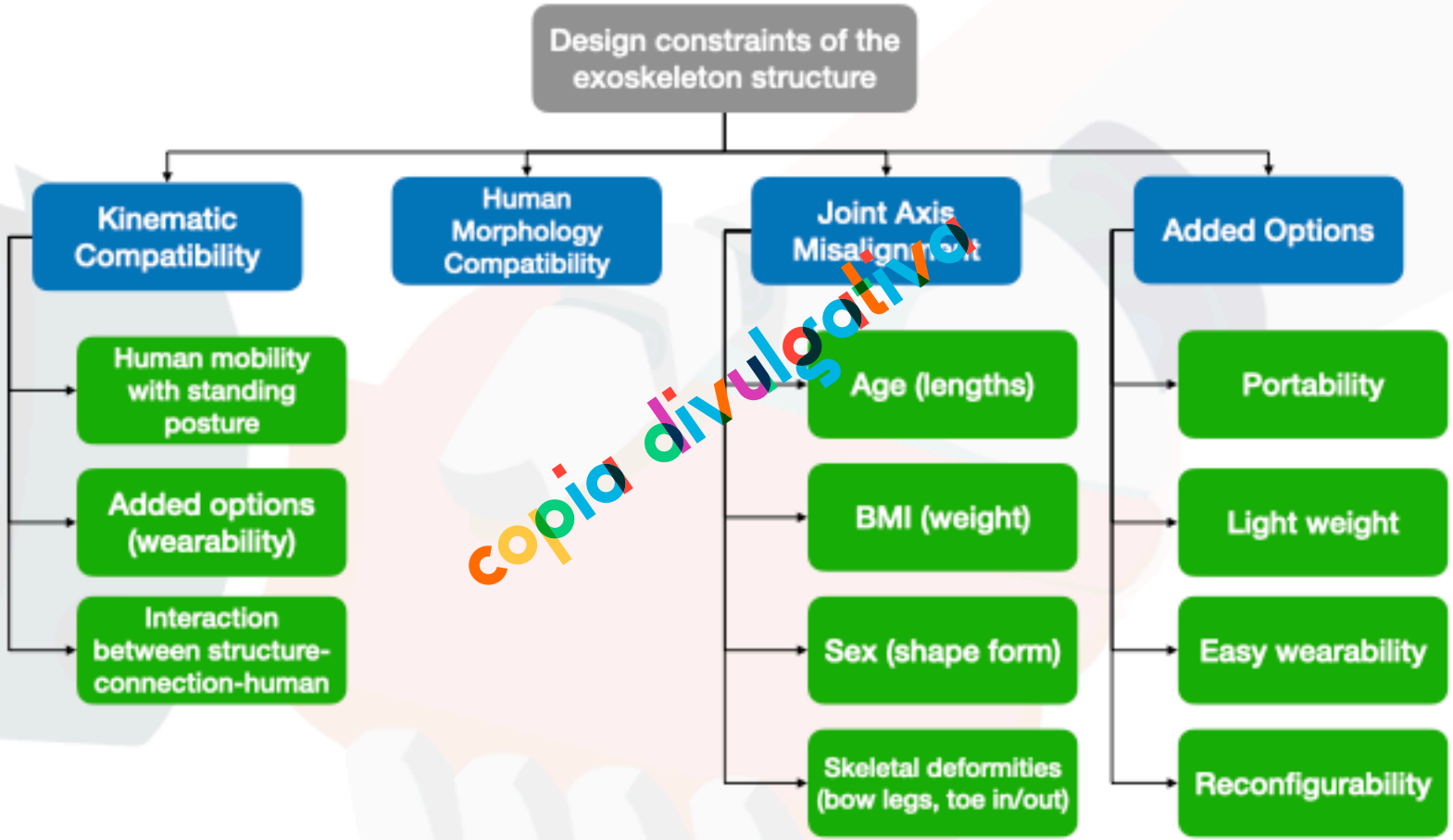
Exoskeleton/Human Joints alignment

Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

Exoskeleton/Human Kinematic Compatibility

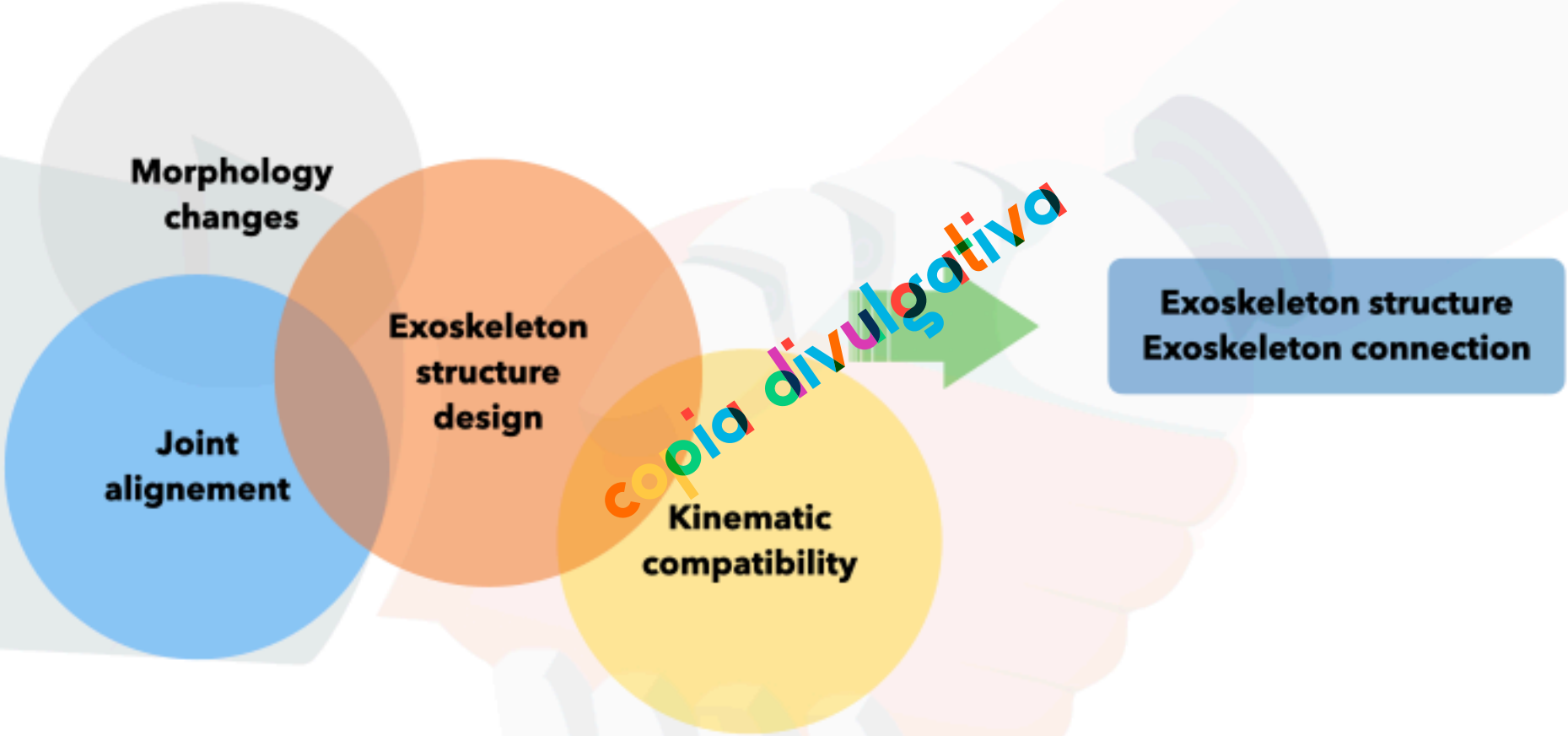
Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

Exoskeleton/Human Kinematic Compatibility



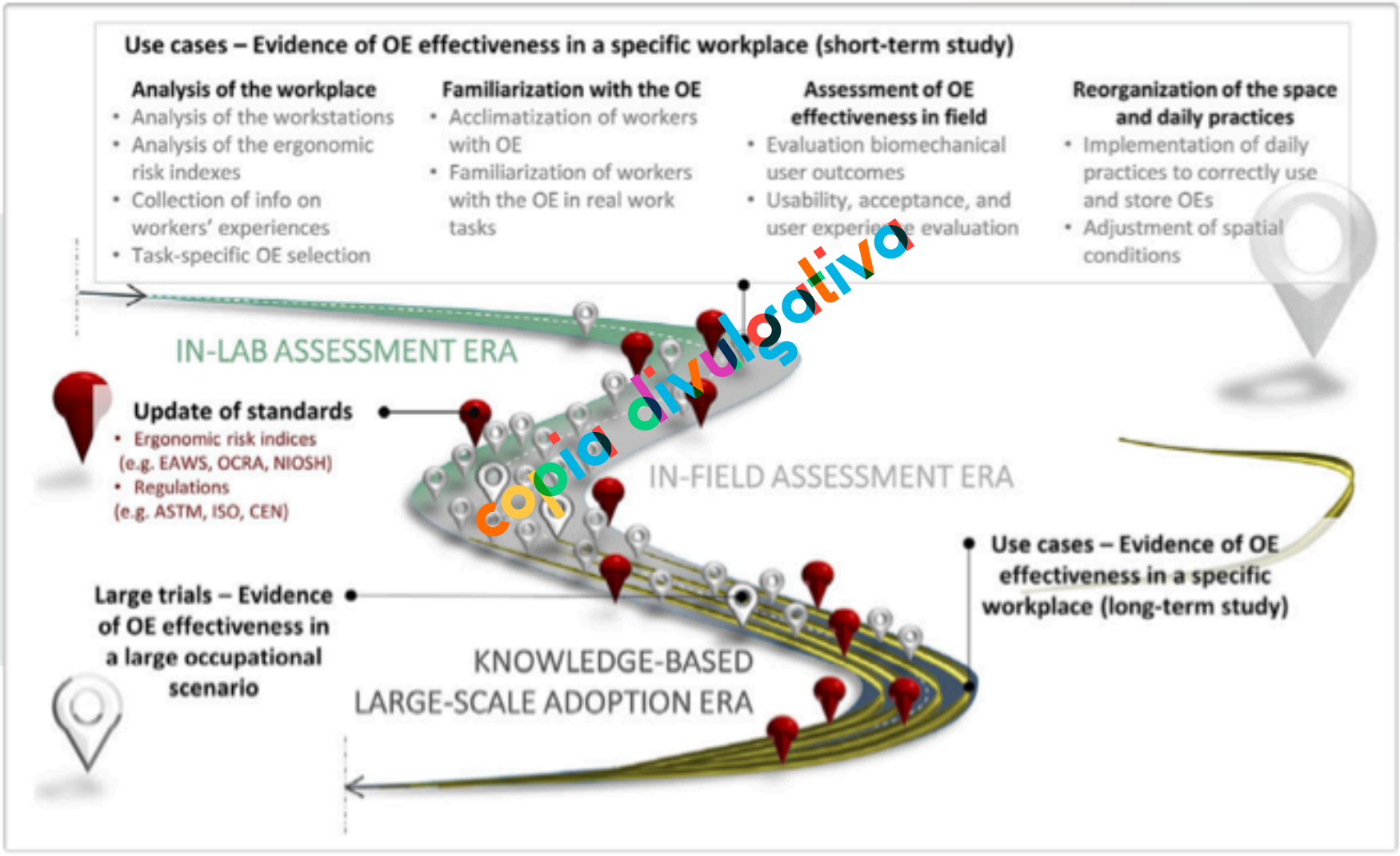
Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

Exoskeleton/Human Kinematic Compatibility



Mohamad Kardofaki. Mechatronics development of a scalable exoskeleton for the lower part of a handicapped person. Automatic. Université Paris Saclay (COmUE), 2019

Roadmap: from bench to the field



Crea S, Beckerle P, De Looze M, et al. Occupational exoskeletons: A roadmap toward large-scale adoption. Methodology and challenges of bringing exoskeletons to workplaces. Wearable Technologies. 2021;2:e11. doi:10.1017/wtc.2021.11

AI / Wearables

Smart helmets

Actively monitor users' heart rate, body temperature, location and work environment.

Wearable cameras

Create real-time photos and videos from a first-person perspective, for use in supply chain management and security monitoring, dust monitoring, process control and field inspection.

Emergency medical information (Emitags)

Intelligent, life-saving devices that can be secured to a hard hat or other flat, clean surface. Contain employees' emergency information, including allergies, health conditions, medications and emergency contact details.

Physical workload and ergonomic sensors

Worn on the hip, back or arm, can alert a user when they perform potentially unsafe movements or tasks (such as improper lifting) and support risk assessment of poor ergonomic work environments.

AI / Wearables

Smart gloves

Gloves containing chromogenic material change colour when in contact with hazardous substances.

Life band

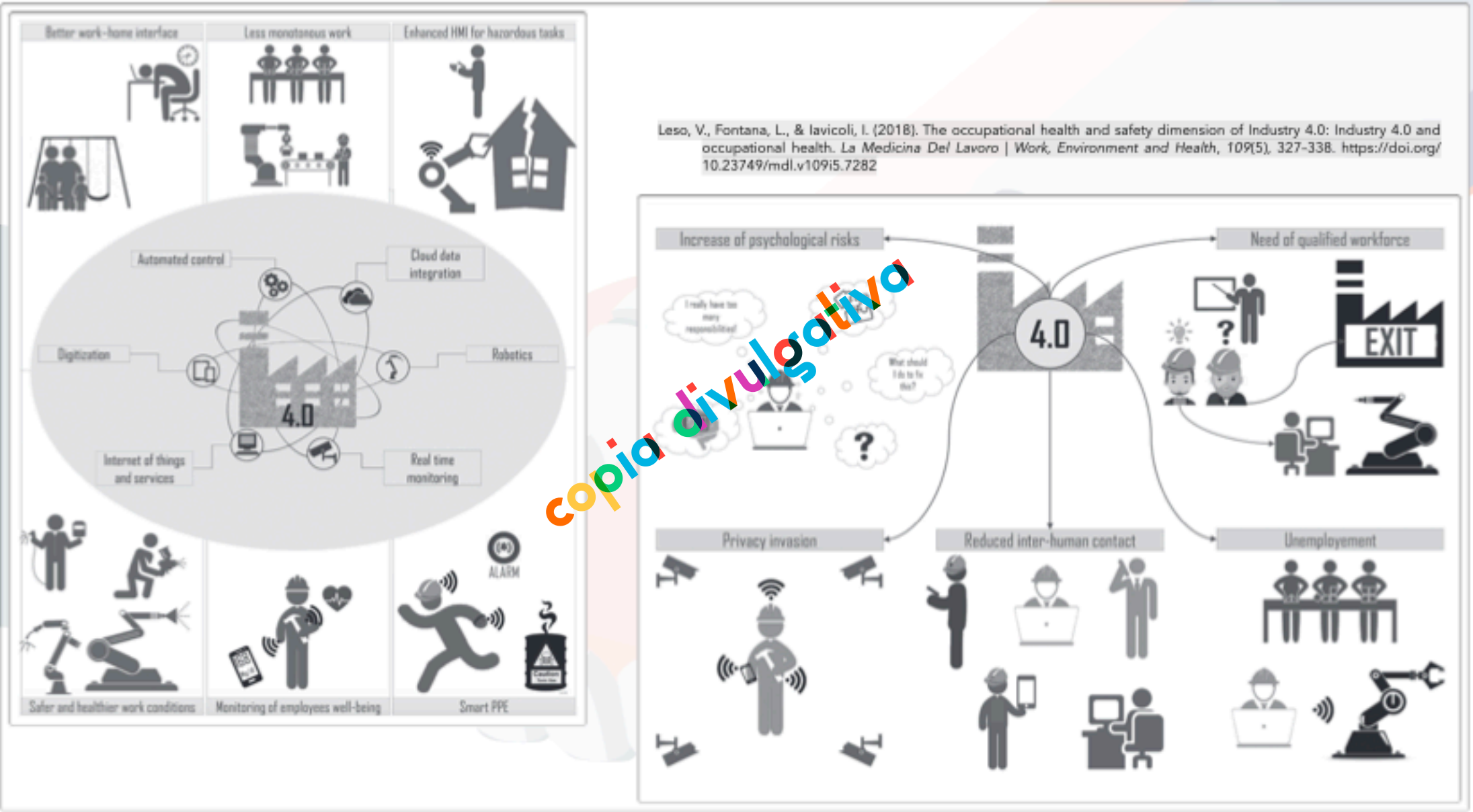
A flexible strap that can be worn alone or placed inside a user's headwear, it monitors and alerts operators to apparent fatigue and decreased alertness.

Smart clothing, e.g. vests

Equipped with sensors for detecting environmental hazards and weather changes as well as potential hazards related to reduced visibility, these garments offer real-time vital signs monitoring, heat stress

Smart glasses

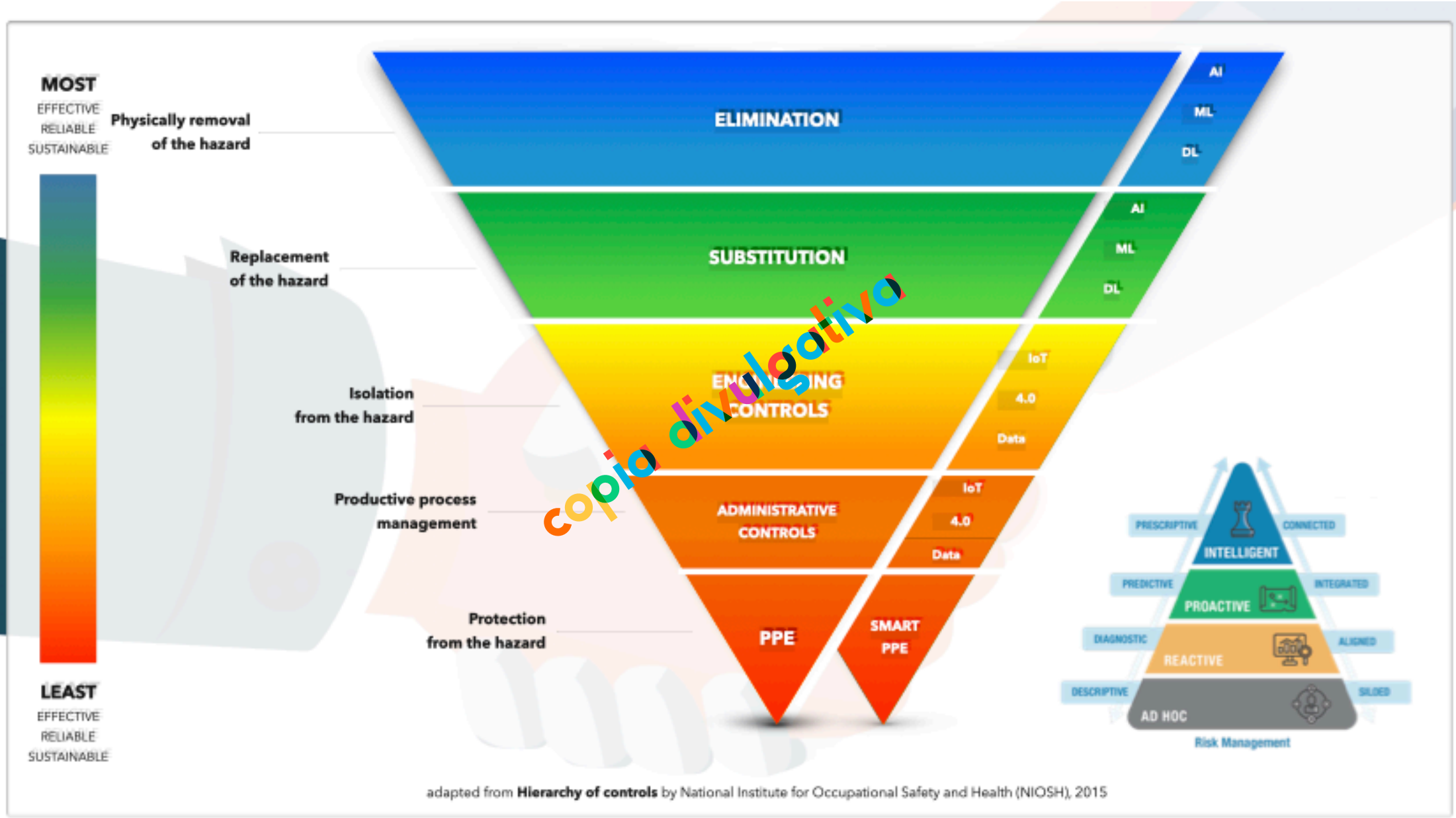
Offer hands-free safety information, augmented reality for tasks and remote assistance, addressing eye strain concerns and potential distractions.



Leso, V., Fontana, L., & Iavicoli, I. (2018). The occupational health and safety dimension of Industry 4.0: Industry 4.0 and occupational health. *La Medicina Del Lavoro | Work, Environment and Health*, *109*(5), 327-338. https://doi.org/10.23749/mdl.v109i5.7282

		Confined spaces	Musculoskeletal disorders	Work sites
More effective	**Elimination** Physically remove the hazard	Replace physical entry with drones or robotic crawlers	Robotic process automation for repetitive work	Robotics to remove workers from hazardous tasks and environments
	Substitution Replace the hazard	Immersive virtual reality simulations for skill development	Exoskeletons to ease heavy manual handling Collaborative robots to share workload	Nano-engineered materials to replace hazardous substance with safer alternatives
	Engineering controls Isolate people from the hazard	Real-time monitoring systems for continuous tracking of environmental conditions inside confined spaces	Computer vision to identify ergonomic risks	Sensors and wearable devices to monitor worker exposures to hazards in real time
	Administrative controls Change the way people work	Digital work permit systems for assessment and authorization before entry	Gamification and simulation of ergonomic training to engage and educate workers on best practices	VR and AR training for hazard recognition and emergency response
Less effective	**PPE** Protect the worker with PPE	Wearable gas detectors for continuous monitoring and immediate alerts	Smart PPE with built-in sensors to detect and warn of incorrect posture or overexertion	Smart PPE with embedded sensors to monitor worker vital signs

Source: Safetytech Accelerator (2024)



adapted from **Hierarchy of controls** by National Institute for Occupational Safety and Health (NIOSH), 2015

Return to Work principles and guidelines

The board, management, policy-makers and return-to-work professional play crucial roles in the setting up and operation of a return-to-work system.

The guidelines should be followed using a "top-down" approach which encourages ownership of their inherent values so that they are simultaneously accepted throughout the organization. The remaining guidelines are based on the following seven principles of return-to-work policy and programmes:

- Holistic process;
- Early intervention;
- Individualized approach;
- Active participation of the individual;
- Collaboration;
- Qualification of experts;
- Monitoring and evaluation.

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Fit for Work Assessment

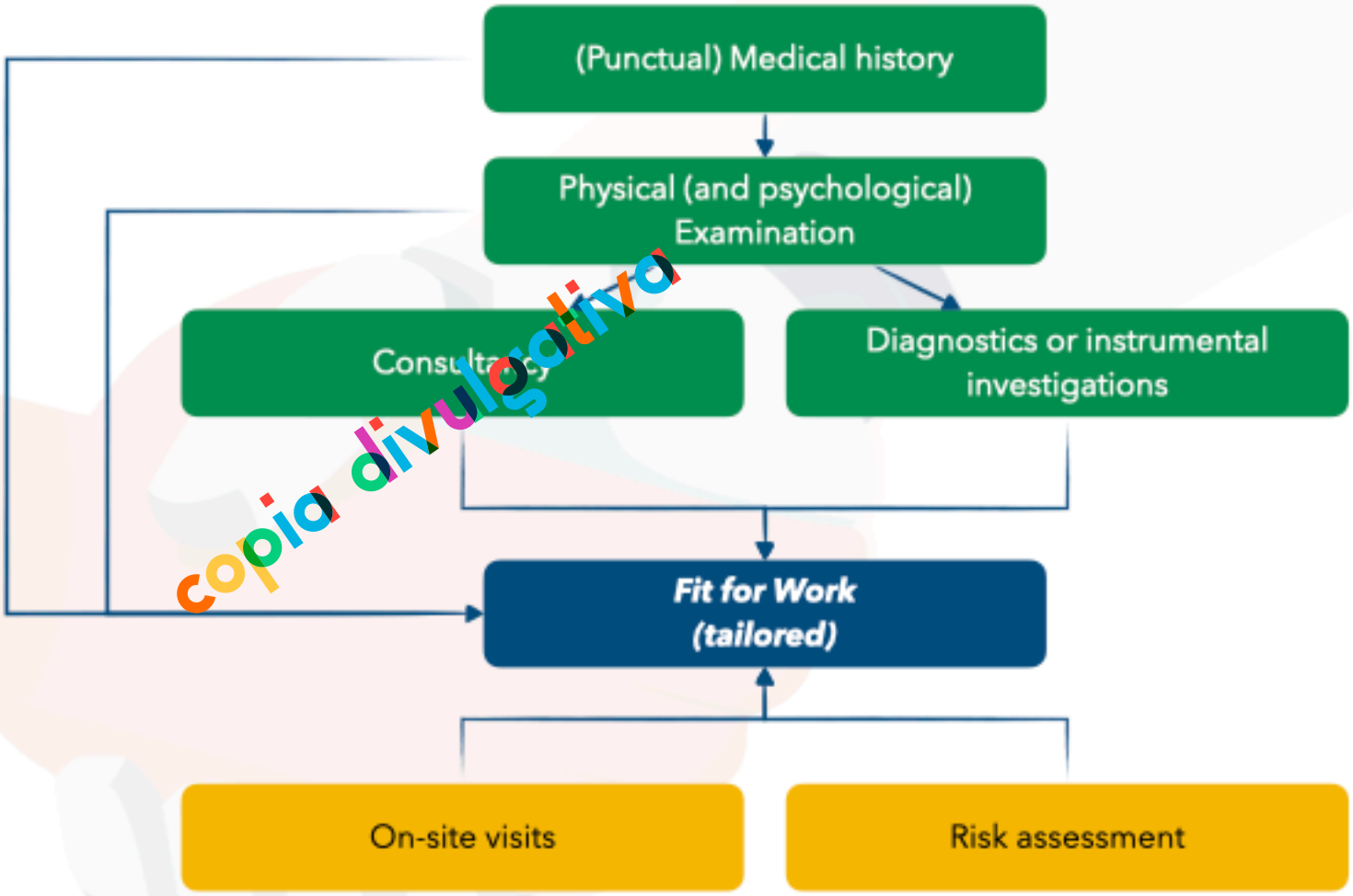
Medical history

Physical (and psychological) Examination

Fit for work

World Health Organization

Fit for Work Assessment



Return to Work - hierarchy

The duration of each person involved in RTW is on case by case basis. Monitoring and coordination is usually over a 6 month period to ensure that the affected individual is able to perform the tasks and maintain the job. Therefore the success of an RTW program is based on the following hierarchy:

- same job same employer
- similar job same employer
- different job same employer

Reintegration with the same employer

- same job different employer
- similar job different employer
- different job different employer

- Cooperation with job centres
- Active Community of RTW stakeholders

- self-employed

issa

Guidelines on Return to Work and Reintegration
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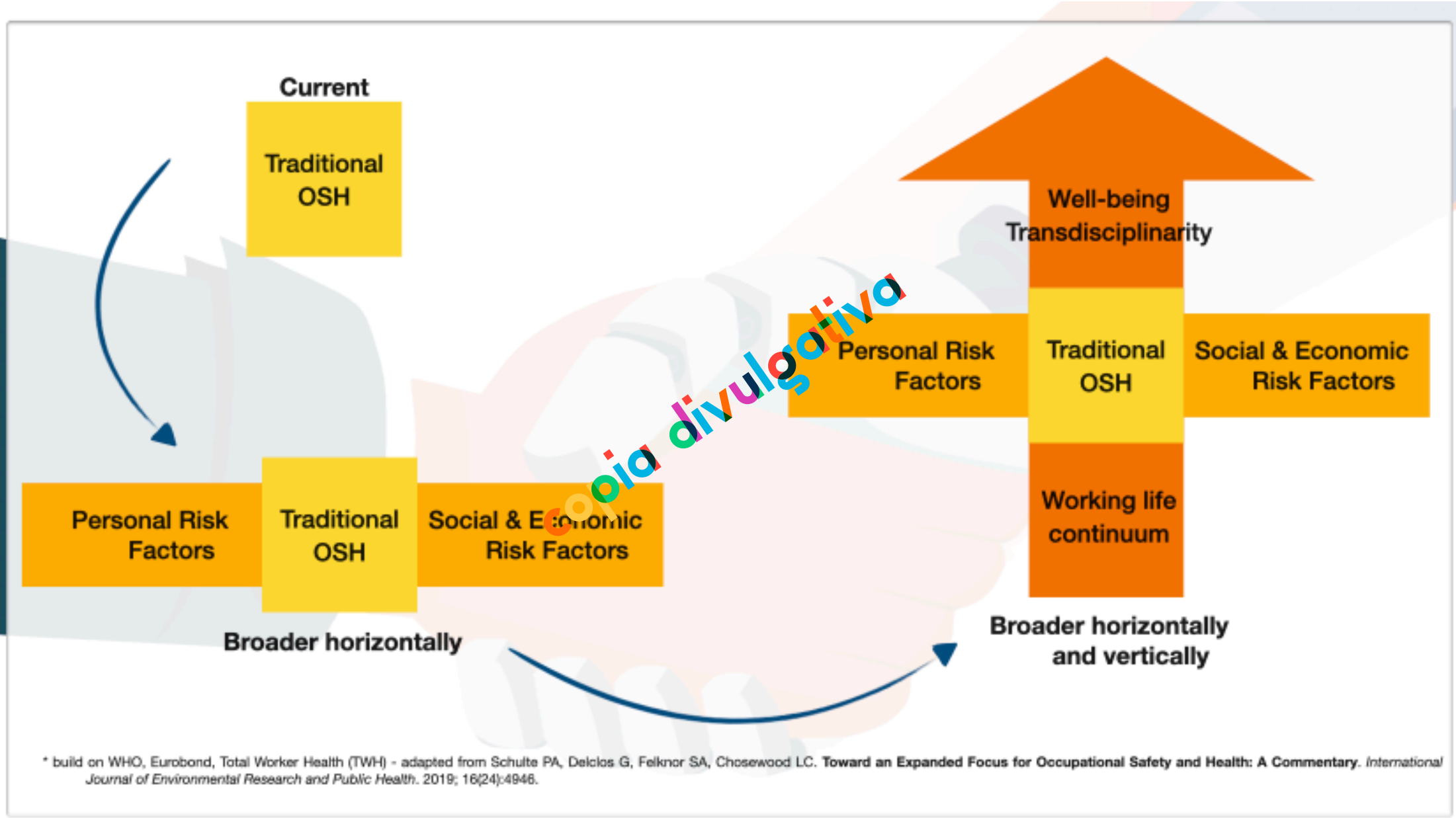
Sherbrooke model
incorporates the biophysical model and shifts from personal disease/biomedical models to person/ environment models within the return to work management



* build on WHO, Eurobond, Total Worker Health (TWH) - adapted from Schulte PA, Delclos G, Felknor SA, Chosewood LC. **Toward an Expanded Focus for Occupational Safety and Health: A Commentary**. *International Journal of Environmental Research and Public Health*. 2019; 16(24):4946.

Etimologia e origine della parola *standard*

La consonante finale della parola standard suggerisce l'origine non italiana del termine, che deriva, senza adattamenti, dall'inglese che ha adottato il termine a sua volta dal francese *estandart* (su tutta la questione etimologica cfr. DELI).

Il significato di "modello, esempio" non è, chiaramente, originario della parola, che ha le prime attestazioni in inglese sin dal 1154 come "stendardo, insegna" e solo successivamente "**esemplare di misura**" (**1429**), "**criterio di eccellenza**" (**1563**) e "**livello definito**" (**1711**). Per quanto riguarda l'italiano, standard col significato di "modello" compare alla fine dell'Ottocento (1892) nel Dizionario del turf italiano di G. Ballarini e viene poi registrato nel Dizionario moderno del Panzini nel 1905: «*è voce inglese usata in commercio, per indicare che la qualità di una merce o di un prodotto dell'industria è quella tipica, normale [quindi eletta]*». Nel Dizionario di Panzini è ricordato anche l'uso ippico registrato da Ballarini e, dal 1942, si registra anche l'uso come aggettivo invariabile posposto al nome (nell'appendice sui Forestierismi). La prima attestazione del termine sarebbe però rintracciabile nel 1764 in un dizionario di G. Bergantini rimasto tuttavia inedito (cfr. Morgana 1985).

In linguistica col termine standard si indicherebbe una varietà di lingua assunta dai parlanti come modello anche d'insegnamento «*non connotata socialmente o regionalmente, risultante dalle tendenze alla convergenza operanti in una comunità linguistica*» (GRADIT, s.v. standard). La definizione non è unanimemente accolta, perché bisognerebbe prima di tutto accettare che esista una varietà di lingua che non abbia nessuna condizione di variabilità (di luogo, tempo, ambito d'uso ecc.) e che si caratterizzi di fatto come avente tutti tratti "non marcati". Una condizione che ad esempio in italiano sembra difficile da rintracciare.

Sempre nell'ambito linguistico si parla anche di neo-standard (e sub-standard) per indicare una varietà di italiano con diversi tratti in comune con l'italiano parlato (ad esempio gli per a lei, a loro; l'indicativo per il congiuntivo nelle subordinate e nelle ipotetiche; il tipo c'ho) e che alcuni considerano destinata ad affermarsi come forma standard appunto: un'altra denominazione di questa varietà è quella di italiano dell'uso medio (Sabatini 1985).

Non senza critiche è stato anche l'ingresso in italiano sia dell'aggettivo nel sintagma italiano standard sia del sostantivo (lo standard). Soprattutto Arrigo Castellani ha proposto di adattare la parola alla struttura morfologica dell'italiano (quindi *stàndaro*), oppure di ricorrere alla locuzione **norma** (italiana) e di conseguenza italiano **normale**, adottando normale come termine della linguistica sinonimo di standard.

Per approfondimenti:

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- F. Sabatini, L'"italiano dell'uso medio": una realtà tra le varietà linguistiche italiane, in G. Holtus-E. Radtke (a cura di), Gesprochenes Italienisch in Geschicte und Gegenwart, Tübingen, Günter Narr, 1985, pp. 154-84;
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ISO International Organization for Standardization

ISO 45001:2018

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Esoscheletri occupazionali - considerazioni su salute e sicurezza

Gli esoscheletri sono dispositivi indossabili assistivi utilizzati sempre più nei luoghi di lavoro per la prevenzione dei disturbi muscoloscheletrici attraverso la riduzione dell'impegno fisico dei lavoratori durante l'esecuzione di attività di movimentazione manuale dei carichi.

A fronte di una comprovata efficacia nel breve periodo, la letteratura scientifica non fornisce ancora indicazioni certe nel medio-lungo periodo anche in relazione ad eventi avversi che potrebbero verificarsi durante l'uso di questi sistemi. Tra questi ultimi sarebbe cruciale descrivere in che modo questi dispositivi impattano sul "comfort'' del lavoratore con particolare riferimento a quello termico, e su altri aspetti rilevanti quali, ad esempio, l'impegno metabolico. Inoltre, è particolarmente importante una chiara definizione del quadro normativo entro cui considerare gli esoscheletri, della modalità con cui è possibile fare una corretta valutazione del rischio da sovraccarico biomeccanico in attività che prevedono il loro utilizzo ed approfondire il tema della sicurezza ad essi associato.

16/02/2026

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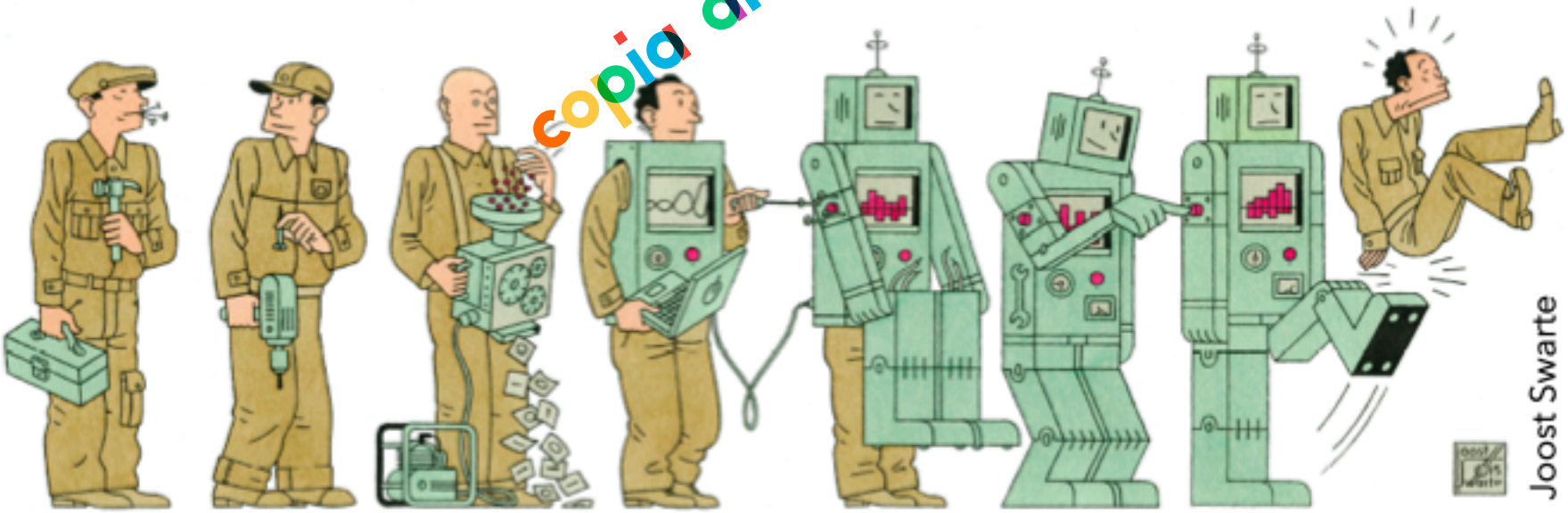

Joost Swarte