EUROSHNET

Realizing the promise of exoskeletons

Research efforts to increase the efficacy and acceptance through Artificial Intelligence-enabled wearable robots.

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Tecnalia Research and Innovation

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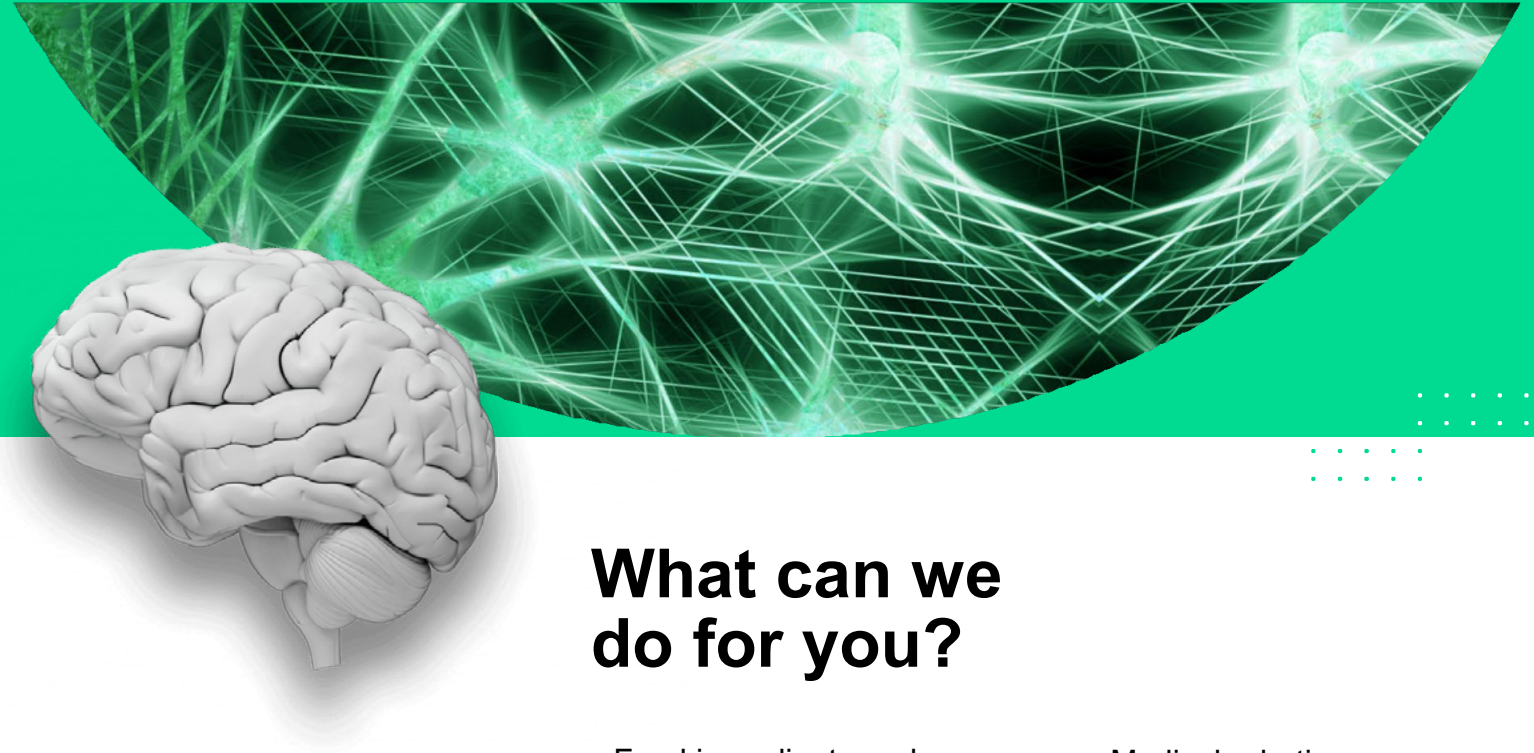
With a multi-sectoral and multi-technological perspective, we listen and work with companies to respond to the major global challenges.

In this way, we are able to generate profit for companies and create value for society.

Personalized Health @ Tecnalia



We foster the development of customised products and services in prevention, diagnosis, prognosis, treatment and rehabilitation phases, through an integrated approach that includes genetics, nutrition and physical and social environments, as the main variables that affect people's health.

What can we do for you?

- Food ingredients and functional compounds
- Healthy foods
- In vitro diagnosis
- Regenerative medicine
- Neuroengineering
- Biomedical product
- Medical robotics
- Digital health and medical imaging
- Pharmaceutical development
- Health and safety *wearable* devices
- Healthy urban solutions

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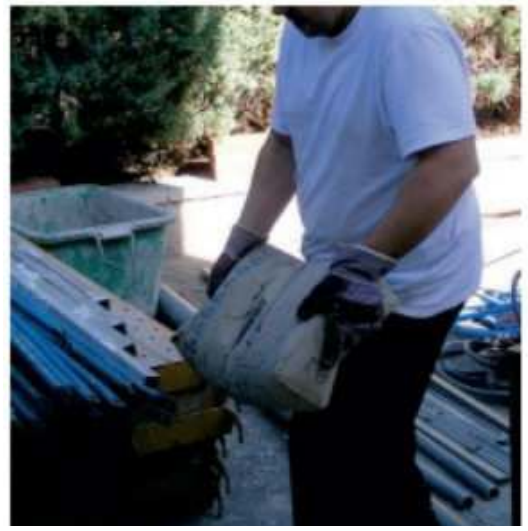
Why exoskeletons?

Injury and ill-health resulting from manual handling activities incur significant costs:

- 20% of all non-fatal workplace injuries are attributable to manual handling injuries
- One-third of musculoskeletal disorder injuries are also caused through manual handling activities.
- **About a fourth of European workers suffer from back pain**, which tops the list of all reported work-related disorders.



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Exoskeletons:

The Dream

Stronger!

Exoskeletons:

The Dream

More Agile!

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Exoskeletons:

The Dream

Who knows ?!?!

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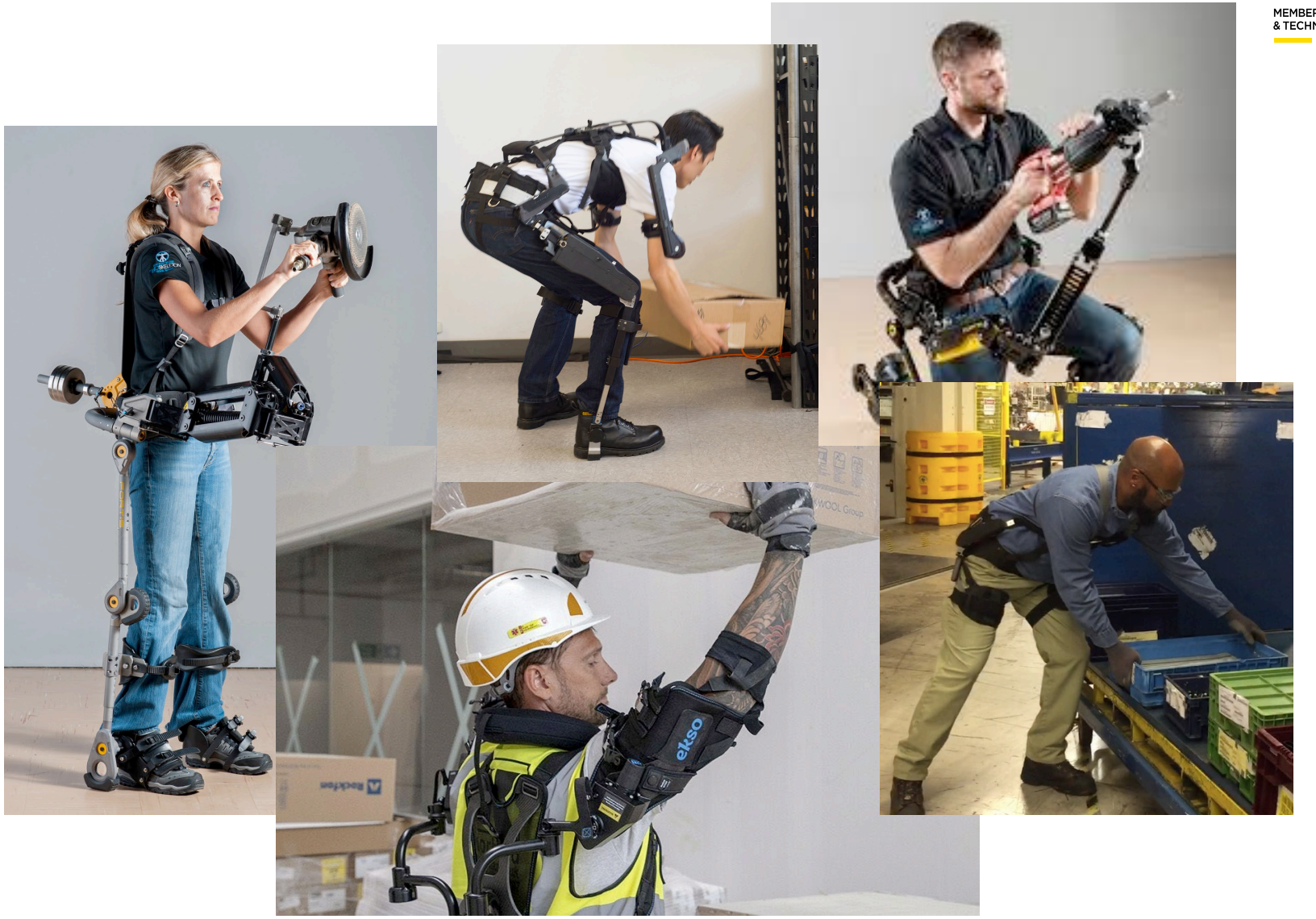
Exoskeletons: The Reality

Passive Devices to Transfer Loads



The Goal

Courtesy of Ana Elvira Planas Lara, NISSAN

"En cuanto decido moverme, el exoesqueleto responde, me levanta los brazos y los sostiene mientras realizo la operación, sin ningún esfuerzo… "

"As soon as I decide to move, the exoskeleton responds, raising my arms and supporting them while I perform the operation, without any effort"

"Este exoesqueleto es mi segunda piel … "

"This exoskeleton is my second skin …"

"Ojalá lo hubiera tenido antes …"

"I wish I had it sooner …"

The Goal

Courtesy of Ana Elvira Planas Lara, NISSAN

"Uff… me roza en el brazo … "

"Uff … It rubs against my arm …"

"Me impide alcanzar las piezas… "

"It prevents me from reaching the pieces …"

"Cuanto más lo uso, más me canso…

¡¡ por favor quitádmelo ya !! "

"The more I wear it, the more tired I become …
Please, take it off me!"

Toward better acceptance of exoskeletons

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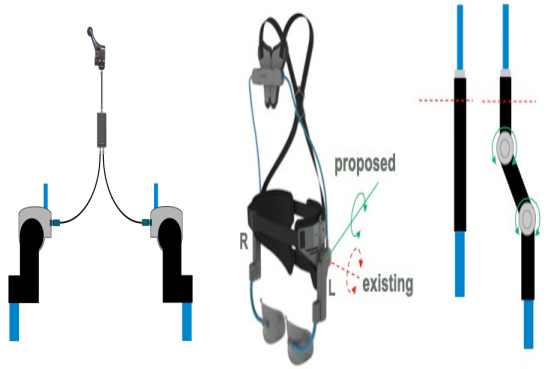
- Passive, but Intelligent
- AI-enabled User Interactions
- “Like a second skin”

Simple Mechanical Solutions

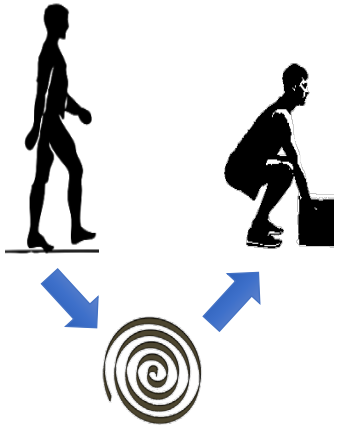
Intelligent Mechatronic Design

Intelligent Transparency



walking

lifting



Simplified User Interfaces

Kinematic Compatibility

Intention Detection/Selection

Energy Storage and Release

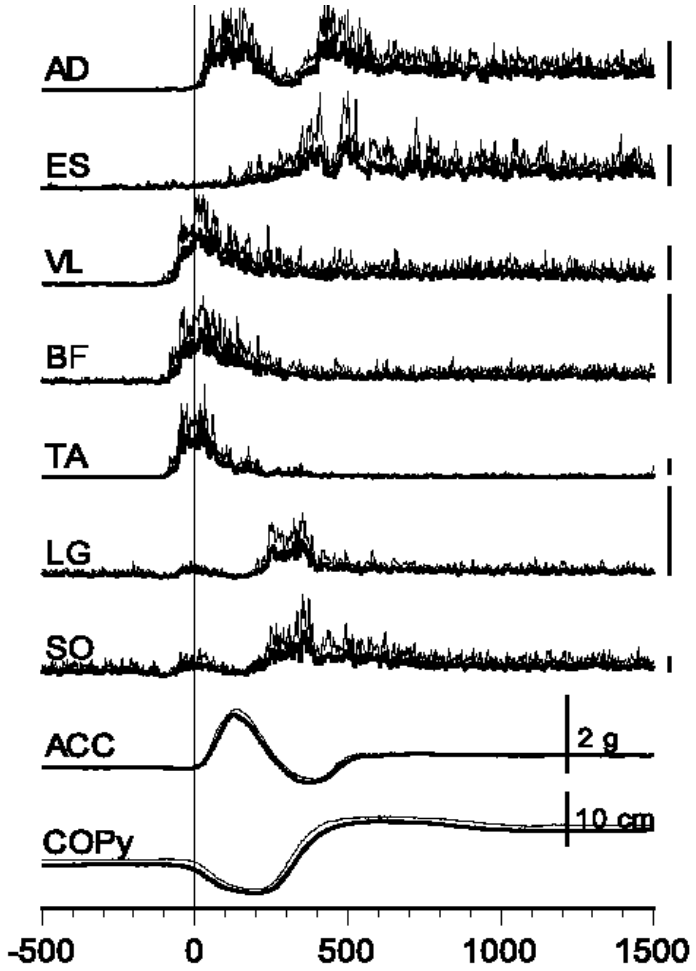
Usability

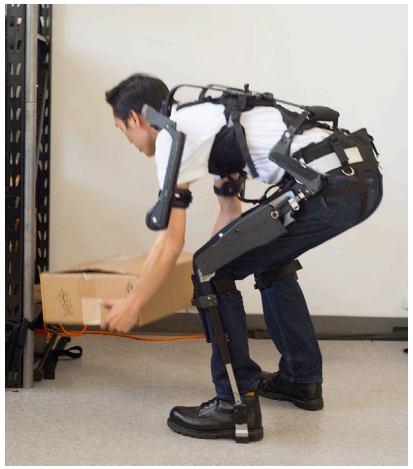
Acceptability

Efficacy

Intention Detection

- Anticipate the needs of the user (AI)
- Activate mechanisms “as needed”
- “Get out of the way” when not needed.





- Activity in leg and trunk muscles begins prior to targeted lifting of the arm.
- Amplitude of EMG activity depends on length of reaching movement.

➢ *Intention Detection* may be achieved prior to movement onset by observing anticipatory responses in postural muscles as well as in prime movers.

Energy Storage and Release

- Store energy during “regular” activities
- Release energy when needed
- AI to anticípate when to store and when to release

Non-linear linkages open the possibility to modulate the apparent resistance to an otherwise passive element.

- Elliptical chain rings for bicycles represent a common example for optimizing exchange of power.
- Self-winding watches allow storage of energy with minimal impediment to movement.

➢ *Can clever mechanical designs optimize assistance for targeted motions while increasing transparency for auxiliary motions?*

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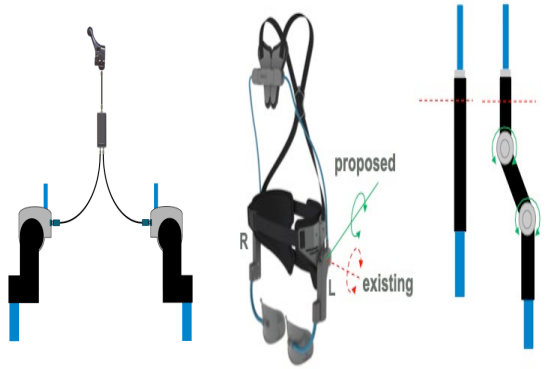

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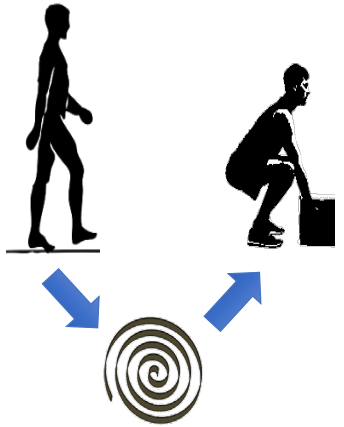

Simplified User Interfaces

Kinematic Compatibility

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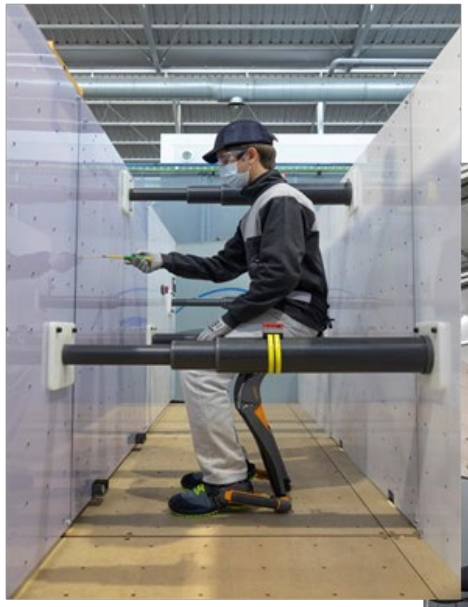
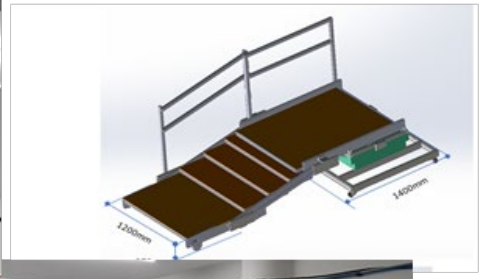
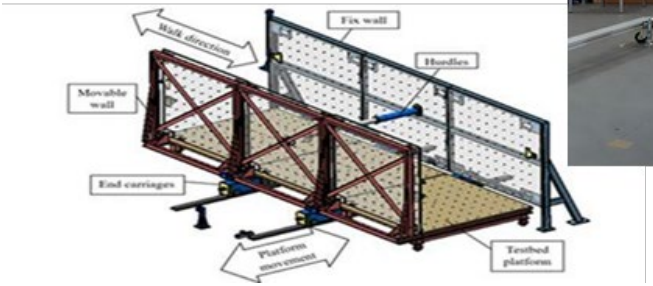
Lowering barriers to exoskeleton uptate

InteX

Expert Services to predict Return on Investment







Lowering barriers to exoskeleton uptake

How to go from measurements to results?

Researchers

- Time to Complete Tasks
- Muscle Activity
- Exerted Forces
- Limb Kinematics
- Balance Indicators
- Precision
- Accuracy

AI

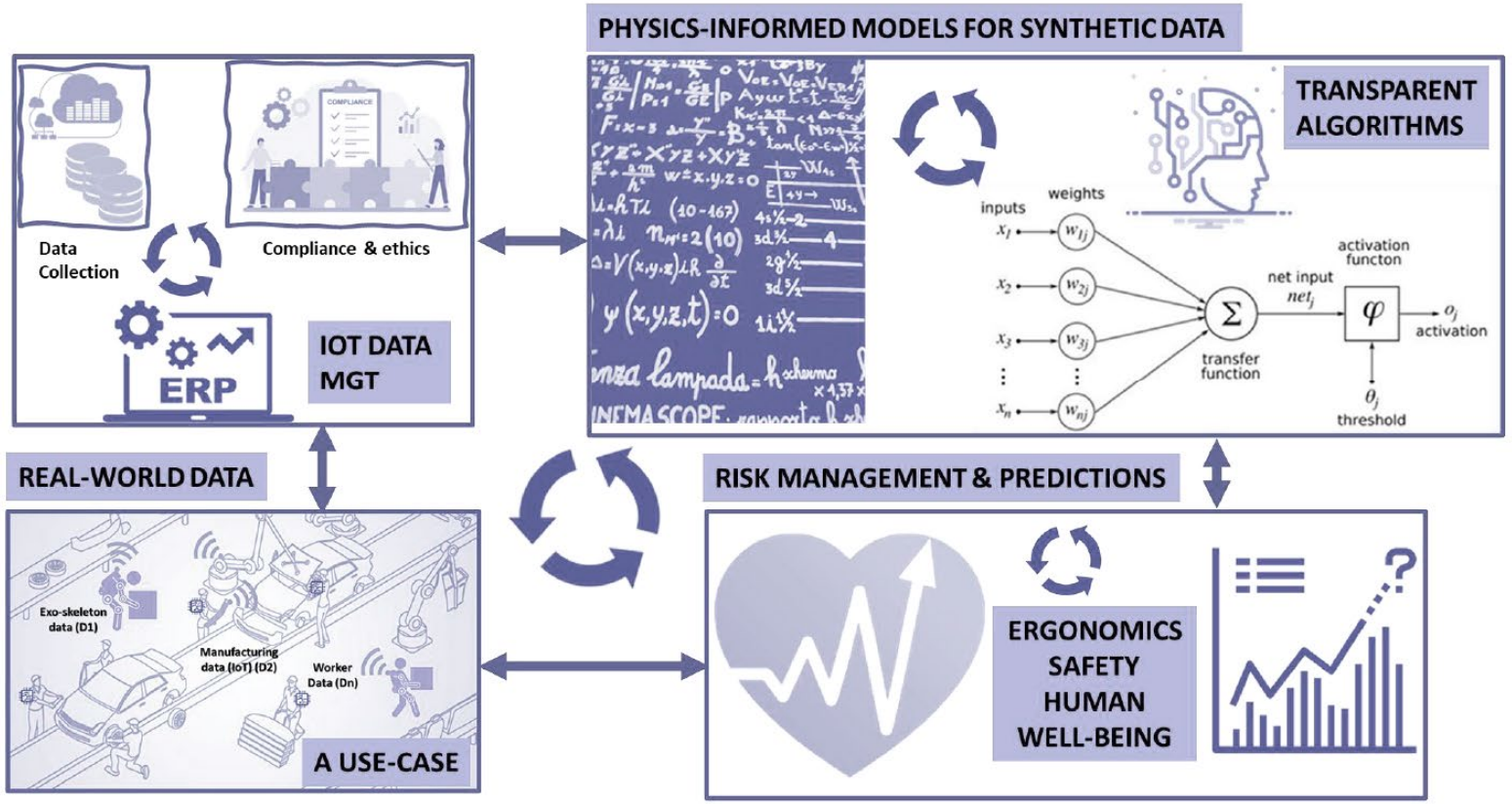
Decision Makers

- Are my workers safer?
  - lower risk of injury
  - greater longevity
- Are my workers “happier”?
  - increased comfort
  - less fatigue
- Are my workers more efficient?
  - shorter execution times
  - fewer workers for the same task

Lowering barriers to exoskeleton uptake

How to go from measurements to predictions?

Physics-Informed AI for outcome predictions



Courtesy of: Courtesy of CTAG

InteX Performance Predictors

	Standardized analytical predictions from sensor data	**AI optimized predictions from sensor data**	DATA mining
INPUT DATA and PROCESING INVOLVED	Direct Interpretation of Sensor Readings	Physiological data linked to sensor data	Longitudinal Data
OUTCOME EXAMPLE	Total Muscular Effort	Total Metabolic Effort (holistic)	Risk of Injury Return on Investment

Realizing the Promise of Exoskeletons

- Potential for exoskeletons as an effective tool for worker health
- Barriers to Uptake of Exos in the Workplace
  - Lack of Acceptance by Users
  - Unproven Efficacy
  - Uncertainty of Return on Investment
- AI approaches to overcome the barriers
  - Better Acceptance through Intelligent Transparency
  - Decreased Uncertainty through AI-enabled Performance Predictors