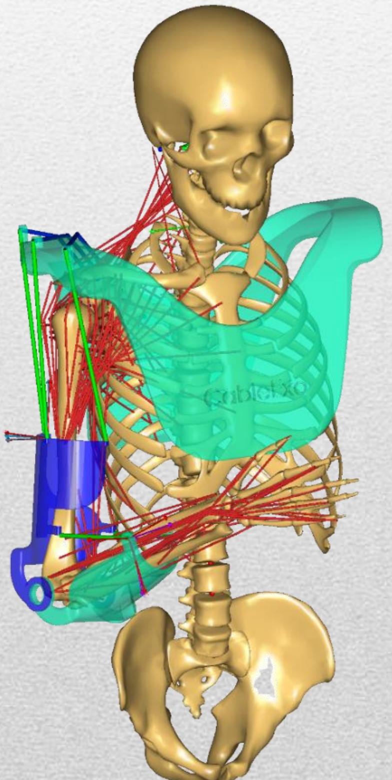
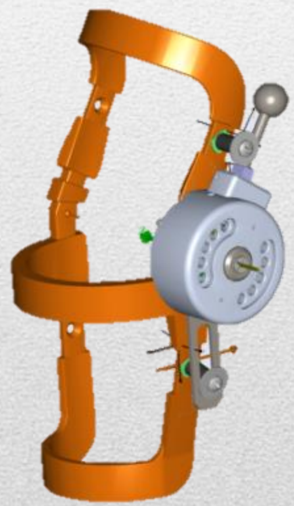
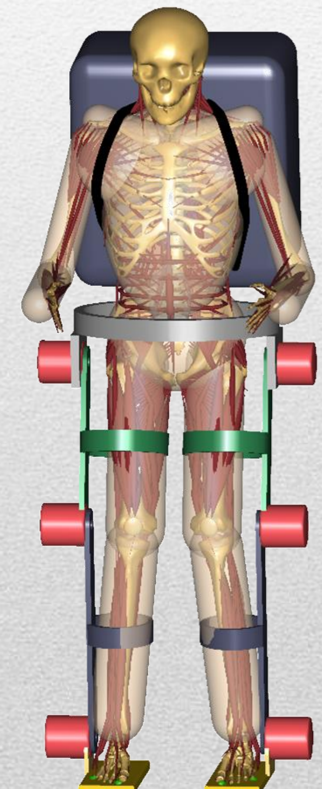
WearRA Webinar Series - Modeling and Simulation for Wearable Robots





20 July 2016
AnyBody Technology

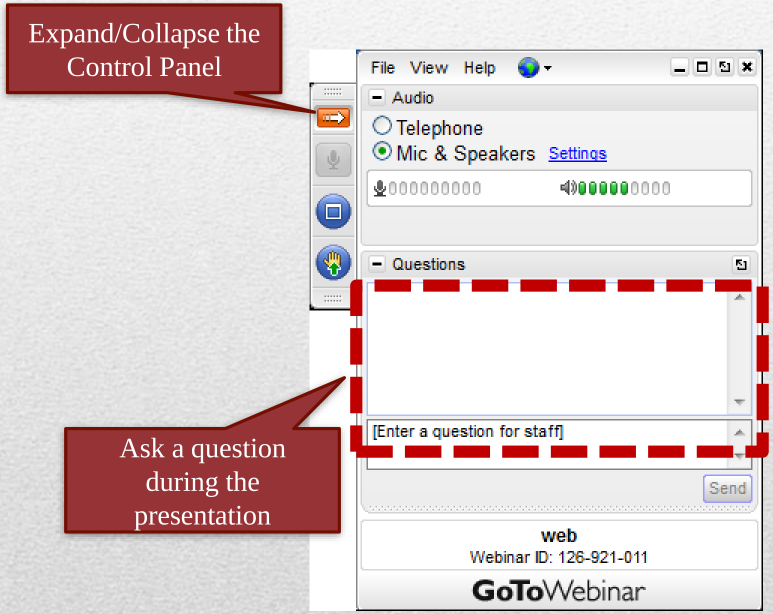


Control Panel

The Control Panel appears on the right side of your screen.

Submit questions and comments via the Questions panel.

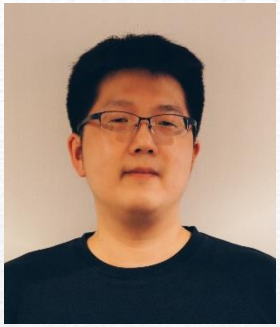
> *Questions will be addressed at the end of the presentation. If your question is not addressed we will do so by email.*



Outline:

- Introduction
  - AnyBody Group
  - AnyBody Modeling System
- Presentation
  - Exoskeletons and AnyBody
  - AnyBody Examples for Exoskeletons
  - AnyBody contribution to the field of exoskeleton
  - Conclusions
- Final words
- Questions and answers

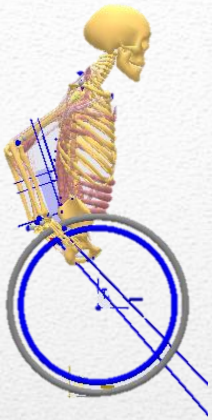
Mohammad S. Shourijeh
PhD, R&D Engineer,
AnyBody Tech.
mss@anybodytech.com



Moonki Jung, PhD
Sr. Application Engineer,
AnyBody Tech.
mj@anybodytech.com

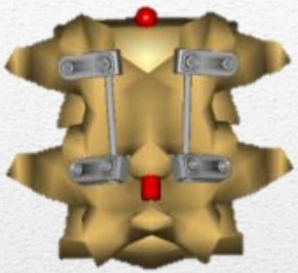
ANYBODY TECHNOLOGY

AnyBody Group



AnyBody Technology
(Aalborg, DK; Boston, US)

- *Licenses, Training, Support*
- *Consulting*

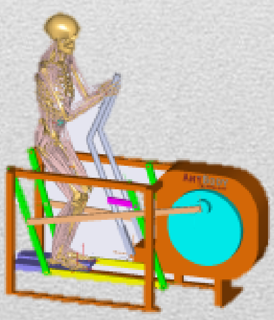


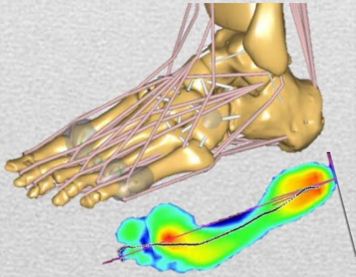
AnyBody Research Group

- *DK: Aalborg University - Prof. Rasmussen*
    - *Biomechanics, Ergonomics, Sport, Automotive*

- *US: Colorado School of Mines – Prof. Patrella*
    - *Biomechanics, Orthopedics, Sport*

- *GER: OTH Regensburg – Prof. Dendorfer*
    - *Biomechanics, Orthopedics, Gait*

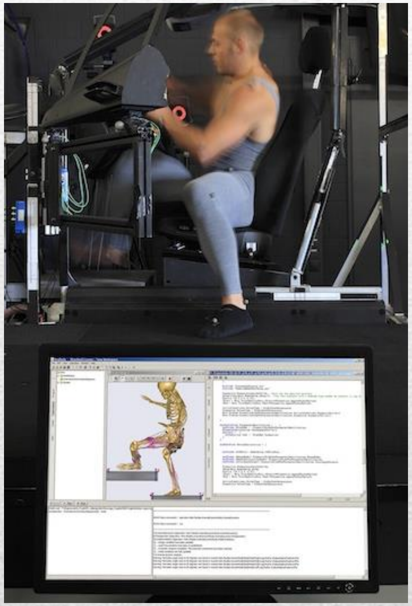




ANYBODY TECHNOLOGY

AnyBody Modeling System

- Simulations of Musculoskeletal systems
  - Multibody kinematic and dynamic analyses
- AnyBody Managed Model Repository
  - Applications
  - Open Body Models
- Special simulation features
  - Man-machine interaction simulation
  - Reaction force prediction
  - Imaging → Patient-specific anatomy



Rasmussen et. al. (2011), ORS Annual Meeting

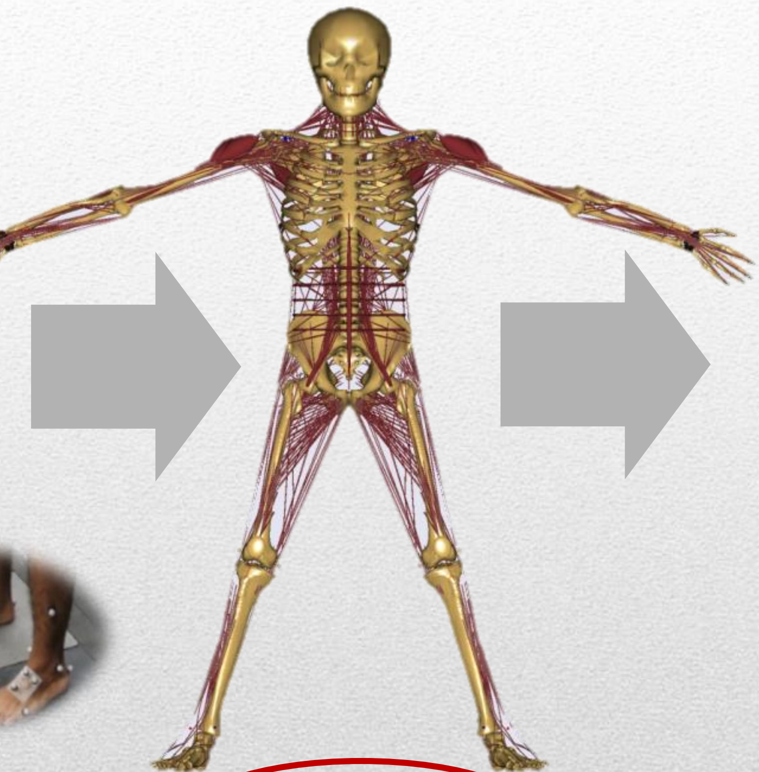
Musculoskeletal Simulation

Input

Task/Motion +
External
forces/moments

Courtesy: Qualysis

Courtesy: Kistler

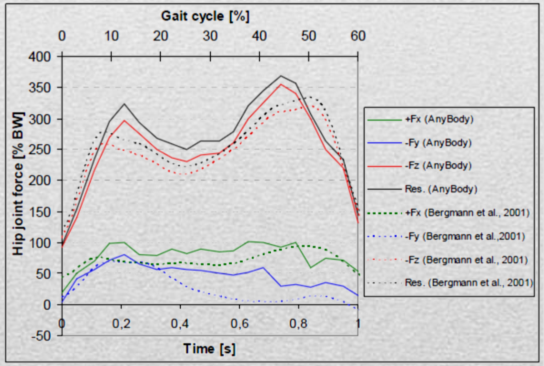


Body Model

Bones Joints Muscles Ligaments

Output

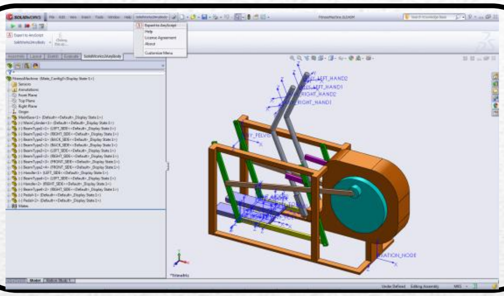
Muscle:
force, activity, power
Joint:
load, moment, ...



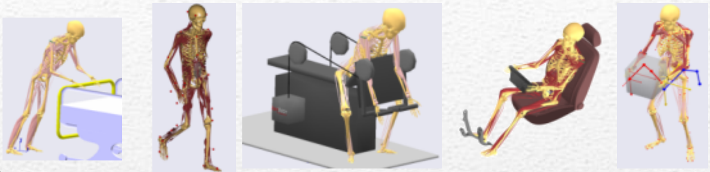
Courtesy: Thielen et al., 2009

ANYBODY TECHNOLOGY

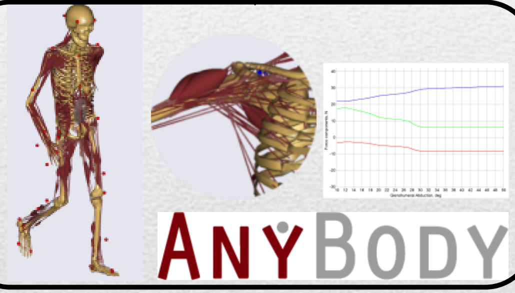
Simulation Work flow



CAD environment model (SolidWorks2AnyBody)

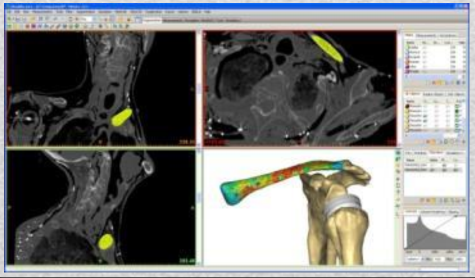


Applications: Activities of daily living

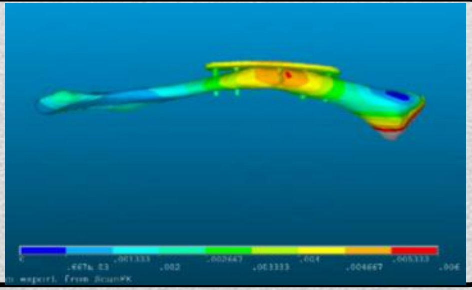


Software interaction:
- Scripting e.g. Python, MATLAB.
- Optimization/control

Subject information



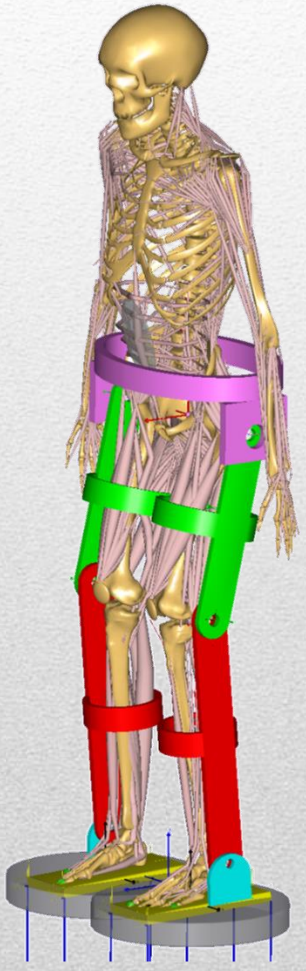
FE-model



Exoskeletons and AnyBody

Human-Exoskeleton example

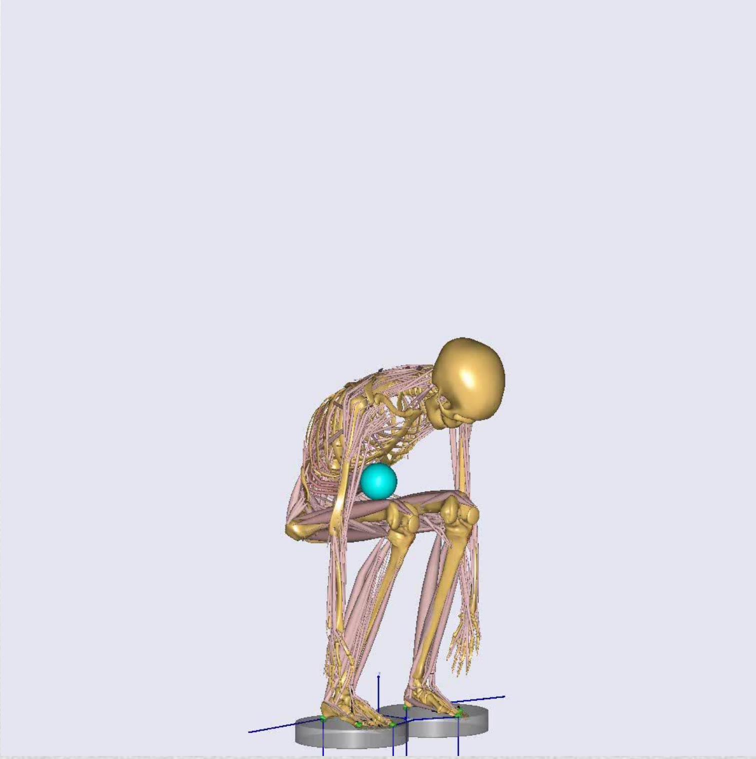
- “I have a conceptual design of an exoskeleton, how will it affect a human subject?”
  - How to attach an exoskeleton to the human?
  - What are the affected human variables?



Human-Exoskeleton model

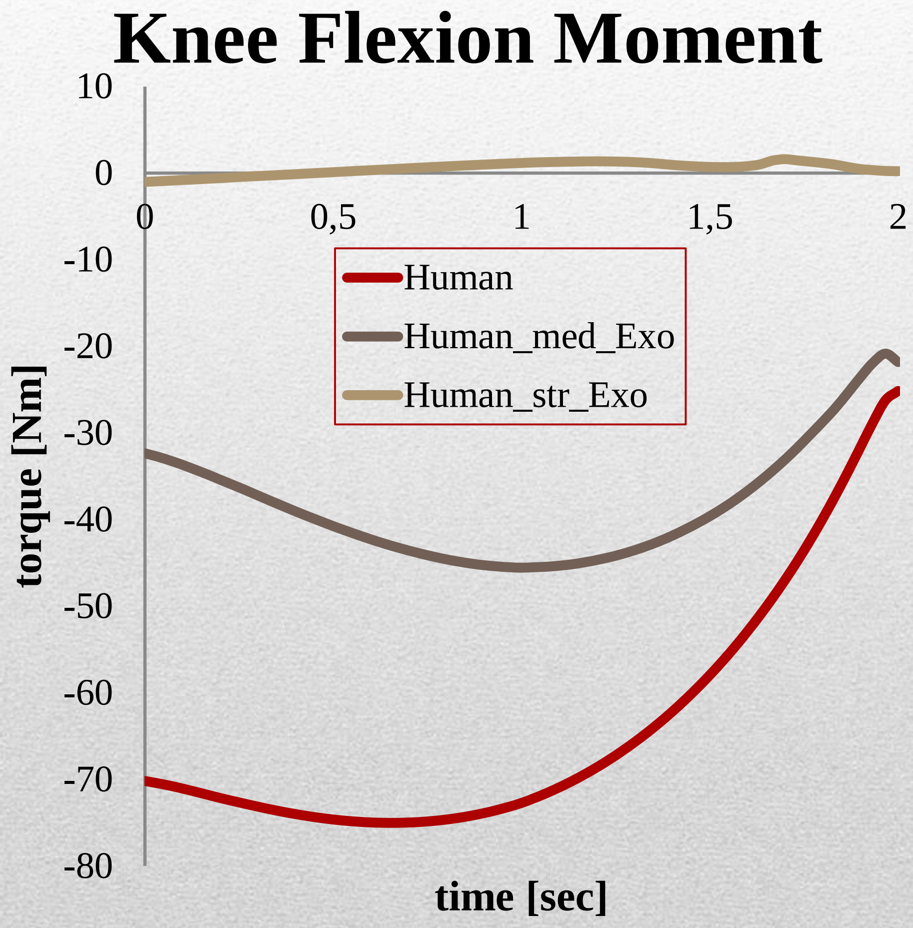
- What actuator in exoskeleton?
  - 6 actuators (hip, knee and ankle)
  - 2 different actuators types
    - STR: Strong torque actuator
    - MED: Medium torque actuator
- Interactions between human and exoskeleton
  - Conceptual straps at pelvis, both thighs, both shanks
  - 6 DOFs forces and moments

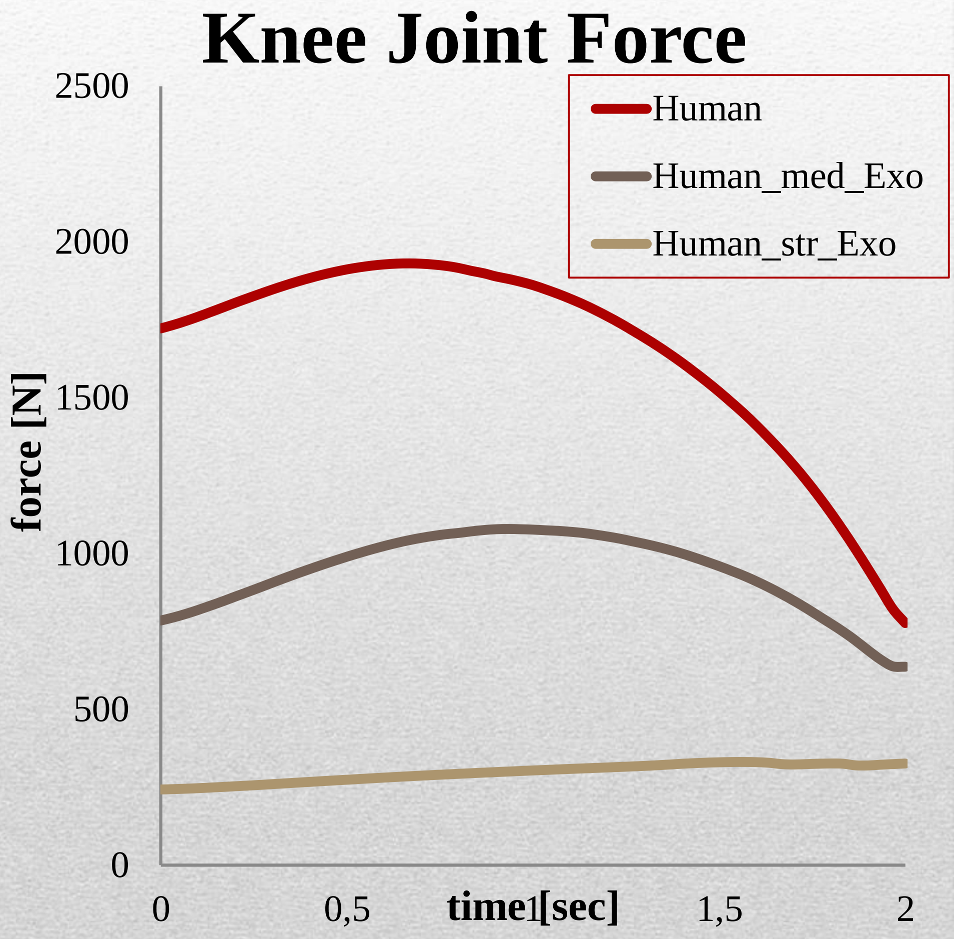
Human-Exoskeleton model



- Definition of motion
    - Parameterized joint angle definition available
- External forces
    - Prediction of ground reaction forces

Results in Human

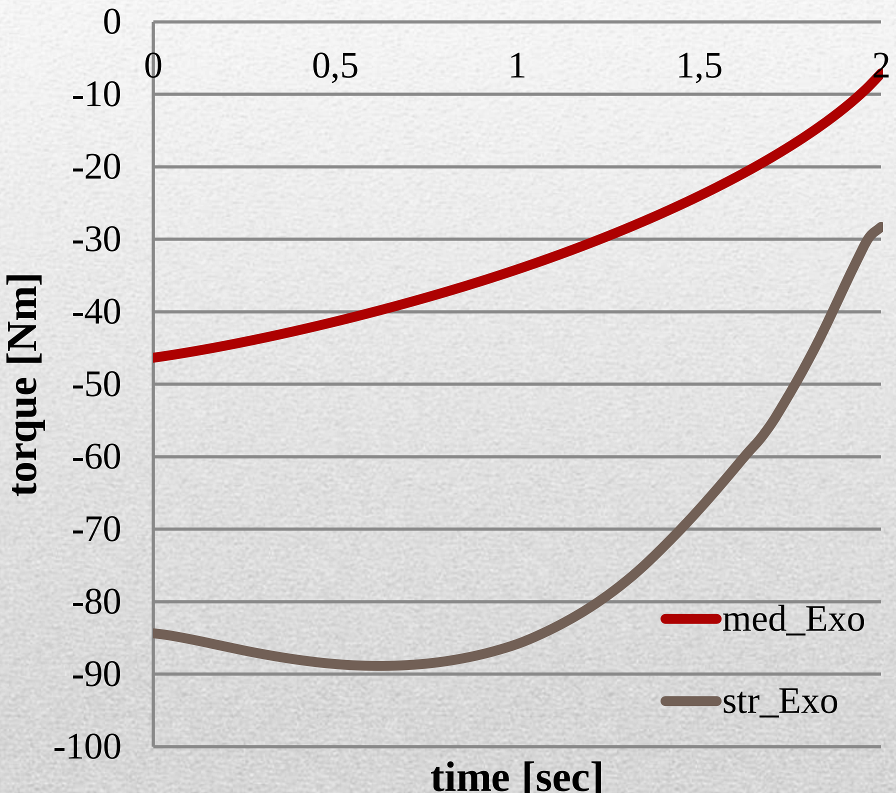




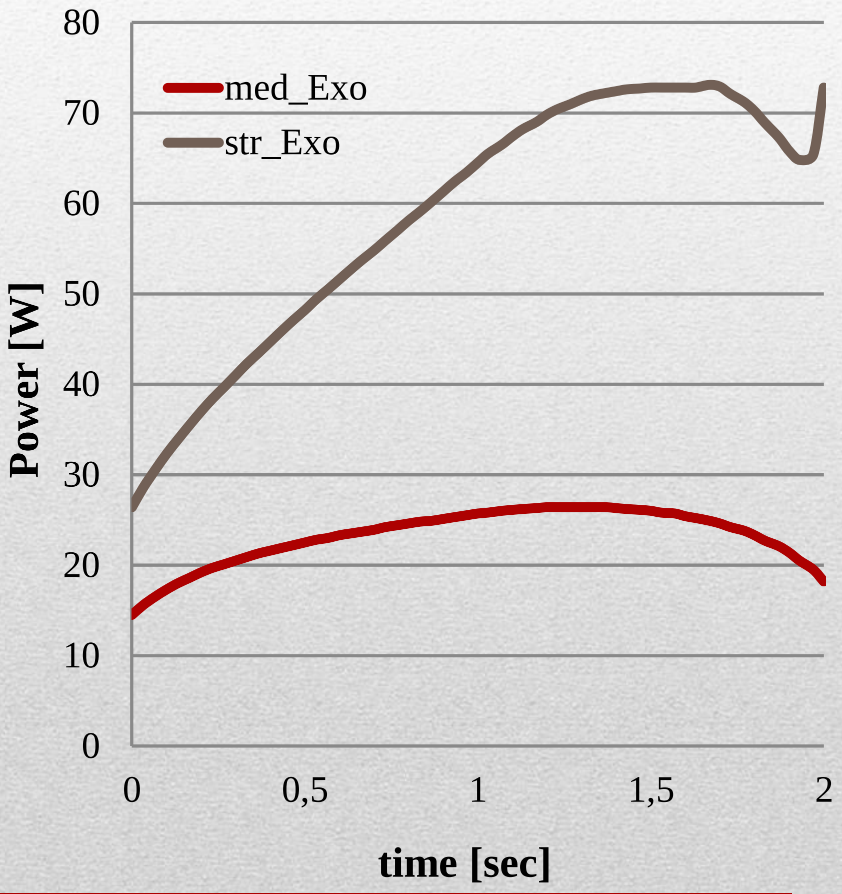
ANYBODY TECHNOLOGY

Results in Exoskeleton

Knee Actuator Moment



Knee Actuator Power

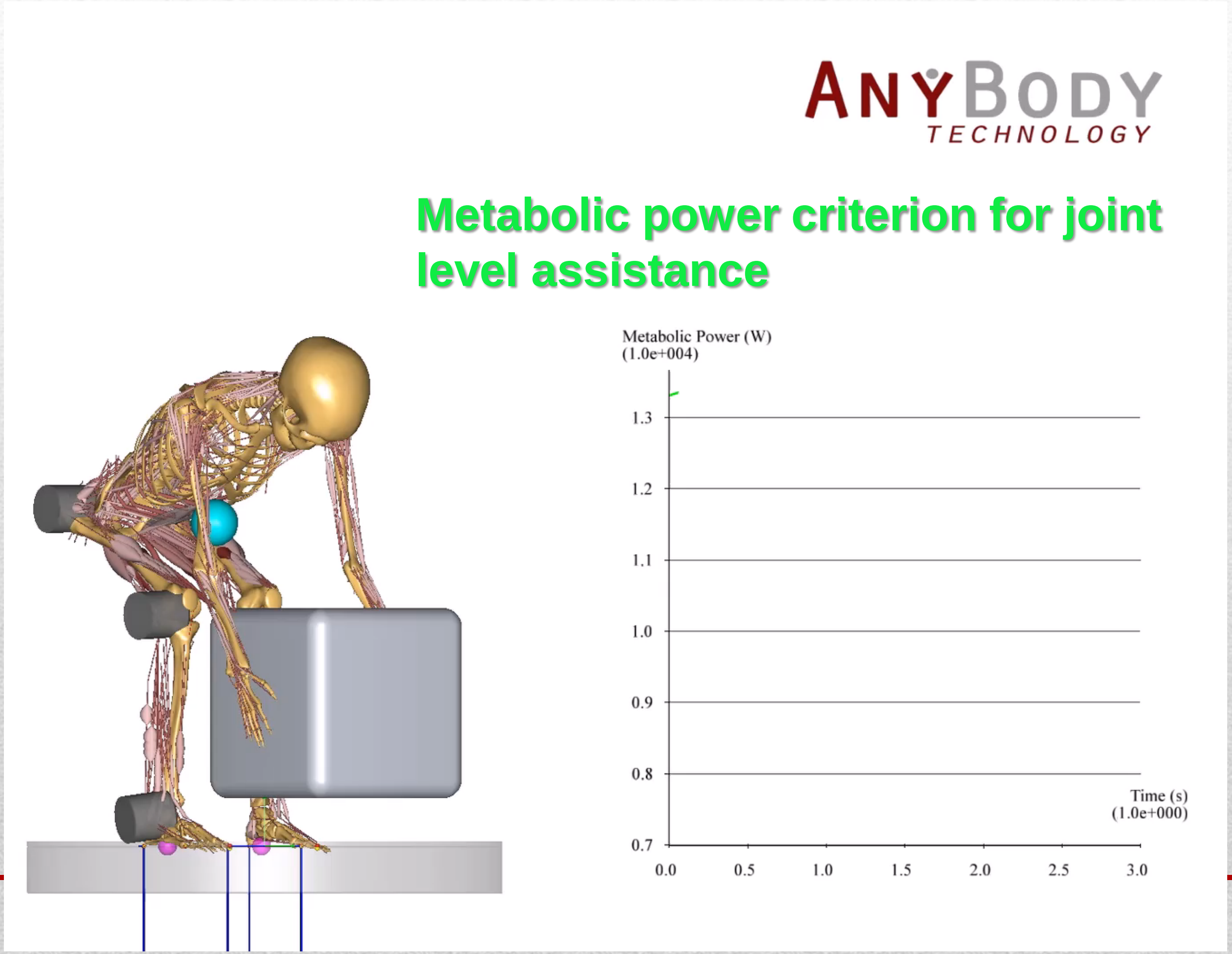


ANYBODY TECHNOLOGY

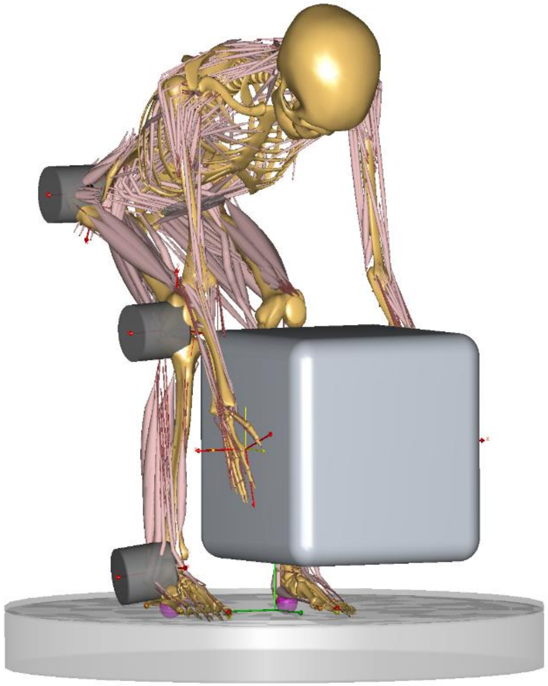
AnyBody Exoskeleton Demo Cases

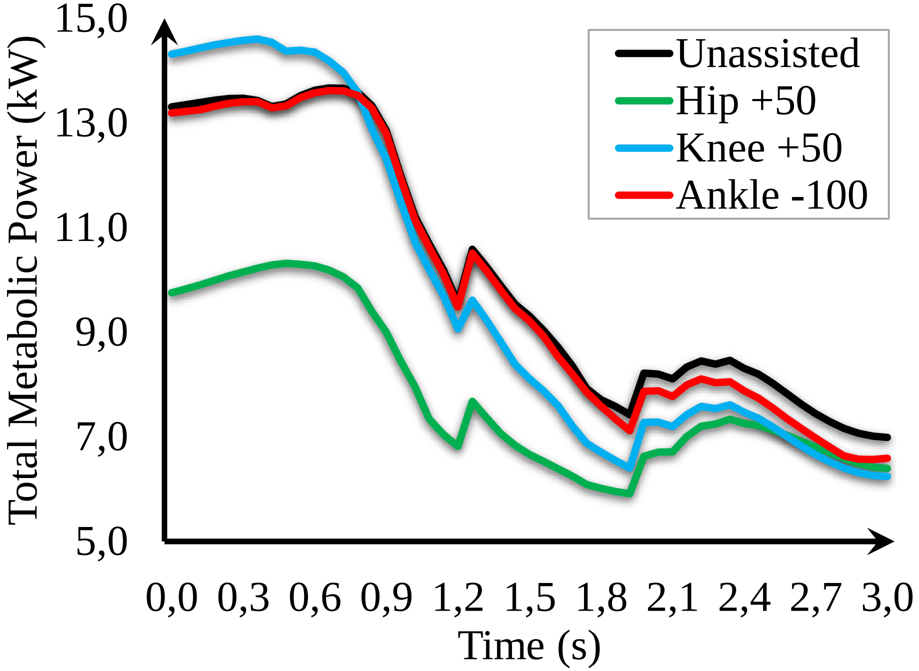
- Metabolic energy cost evaluation
- Exoskeleton anlaysis using motion capture data
- Human-exoskeleton interaction
- Soft exoskeleton

Metabolic power plays an important role in the design and evaluation of exoskeletons



Metabolic Energy Consumption in a Box-Lifting Task*



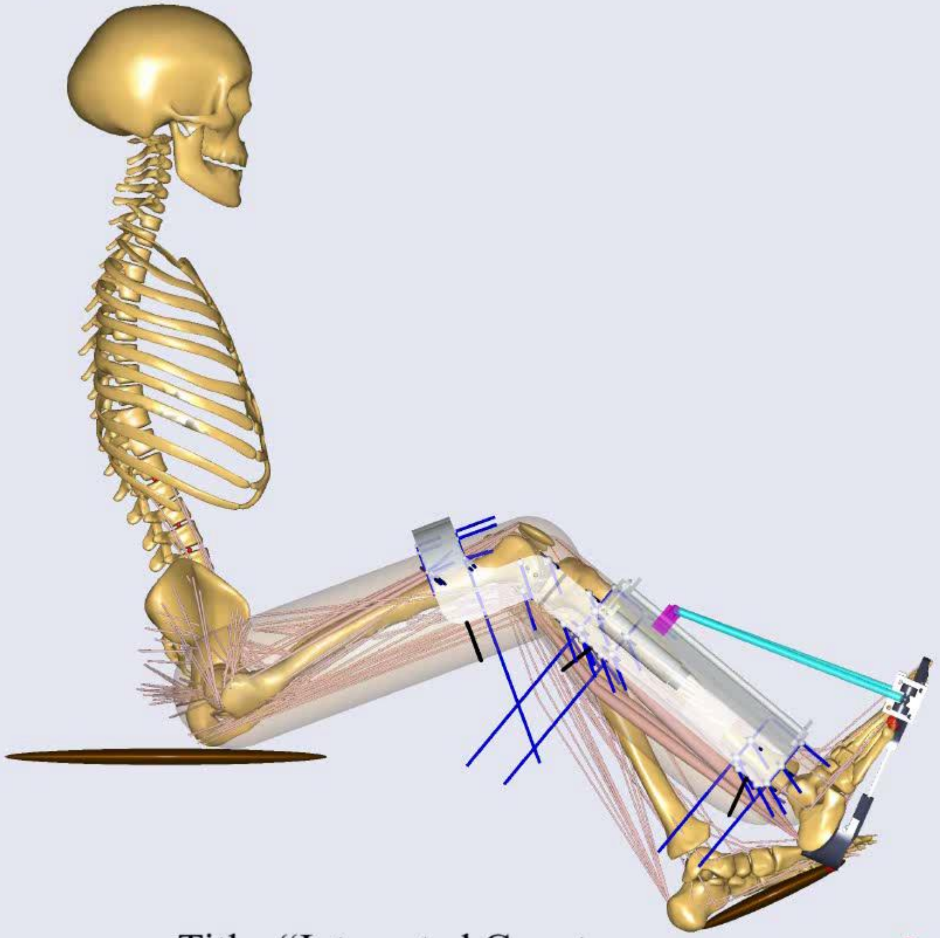


* M.S. Shourijeh, M. Jung, M. Damsgaard, Metabolic Energy Consumption in a Box-Lifting Task: A Parametric Study on the Assistive Torque, WeRob 2016

ANYBODY TECHNOLOGY

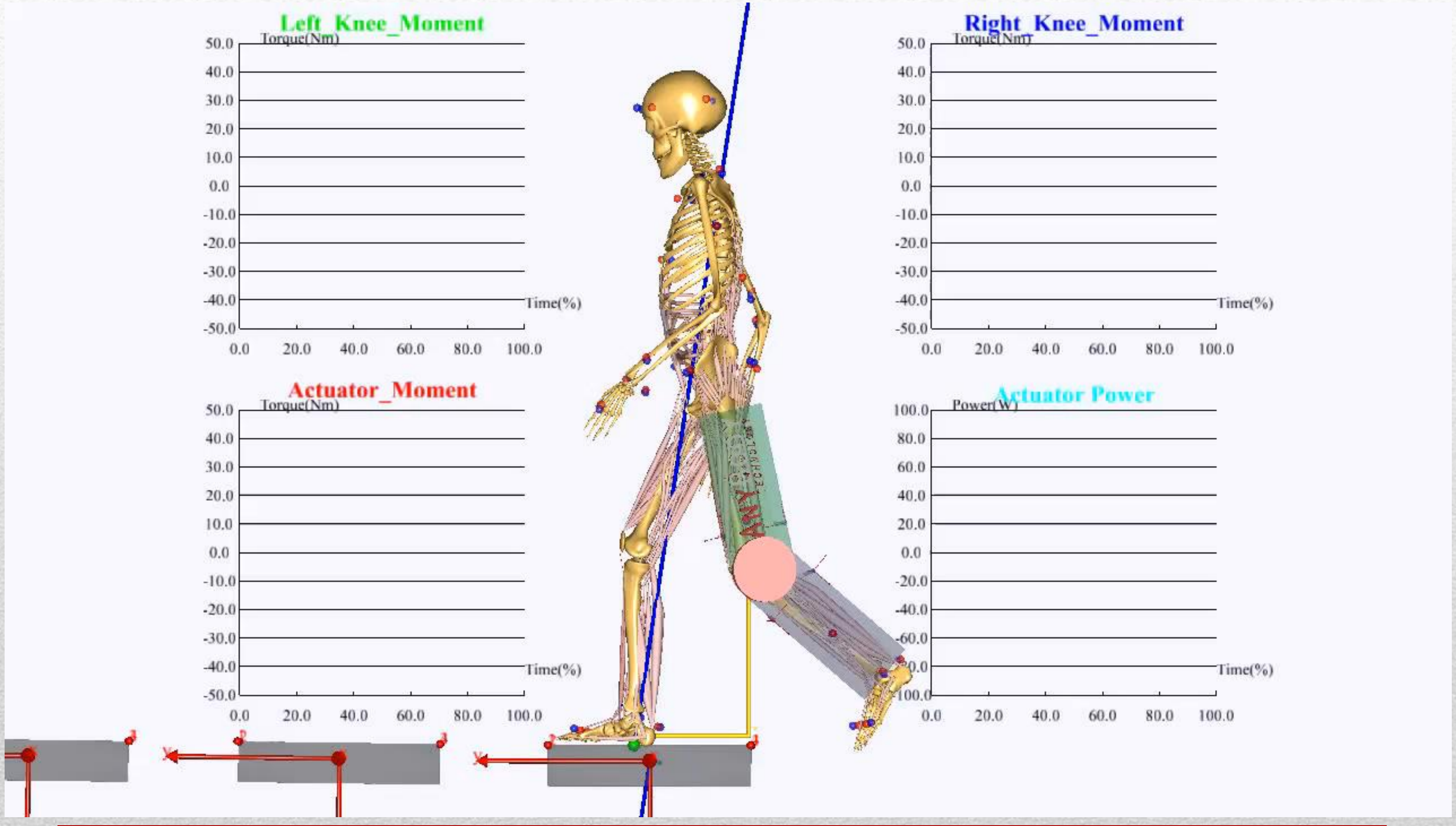
Countermeasure exercise in space

Technology Research Program
(contract No. 4000112181/14/NL/RA)



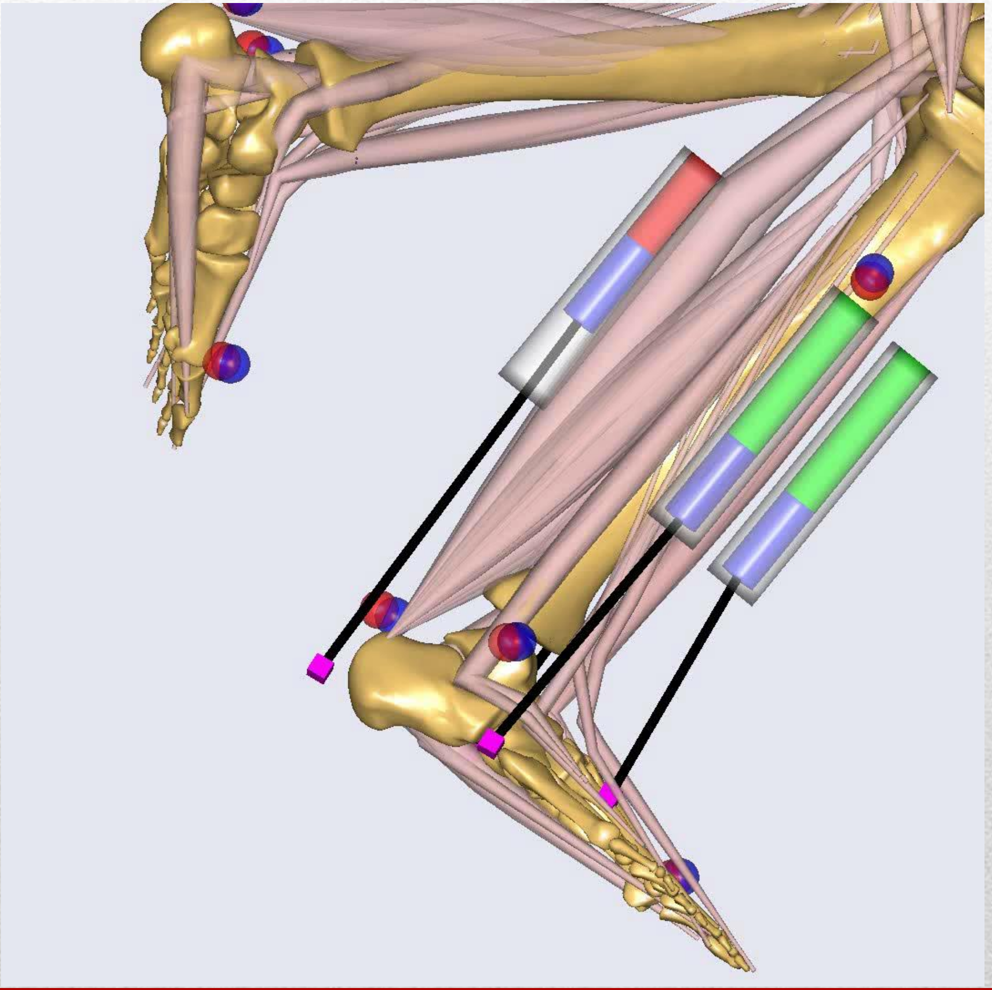
Title: "Integrated Countermeasures
with Biofeedback and Actuators"

Evaluating the effect of assistive devices on human body using motion capture data



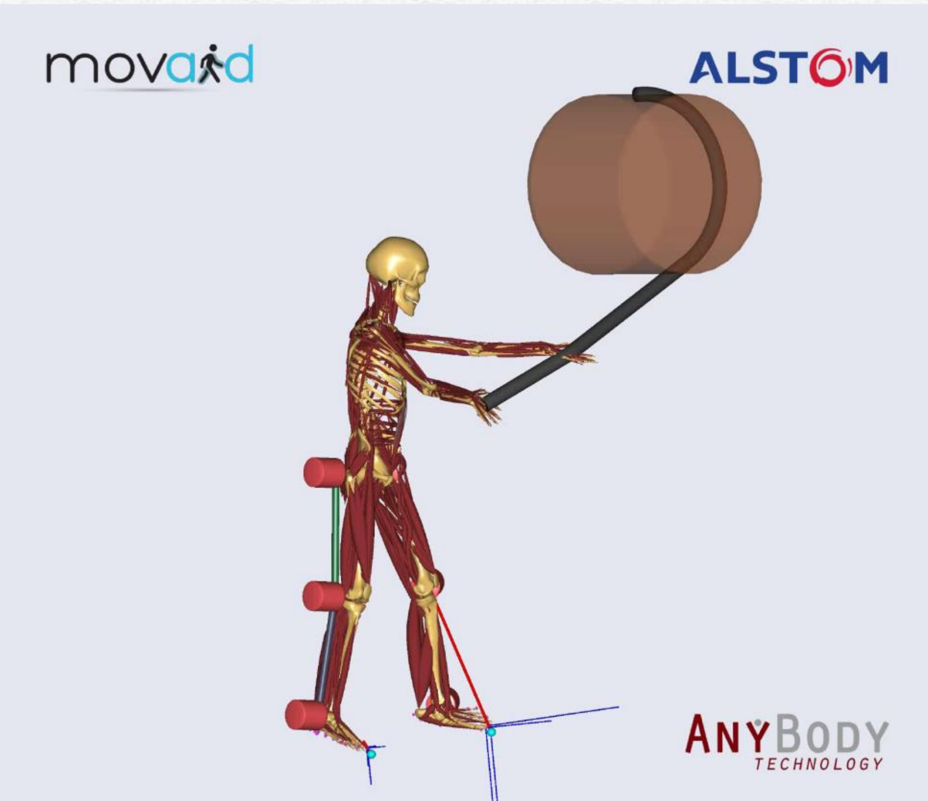
ANYBODY TECHNOLOGY

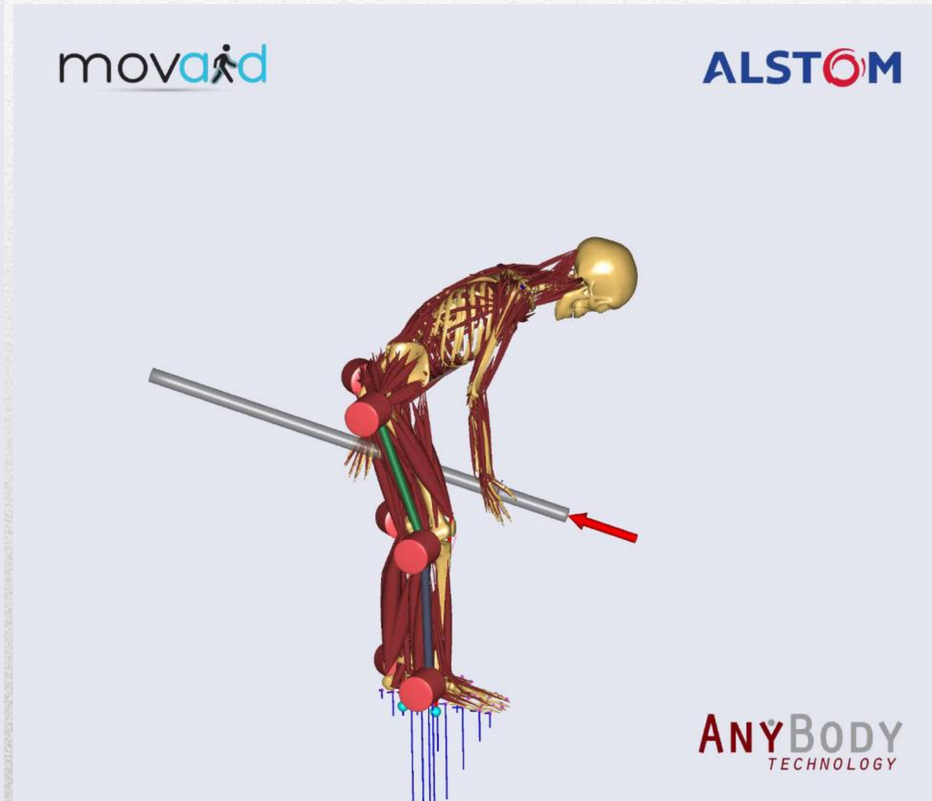
Active (red) and passive (green) linear actuators in an AnyBody hop simulation



ANYBODY TECHNOLOGY

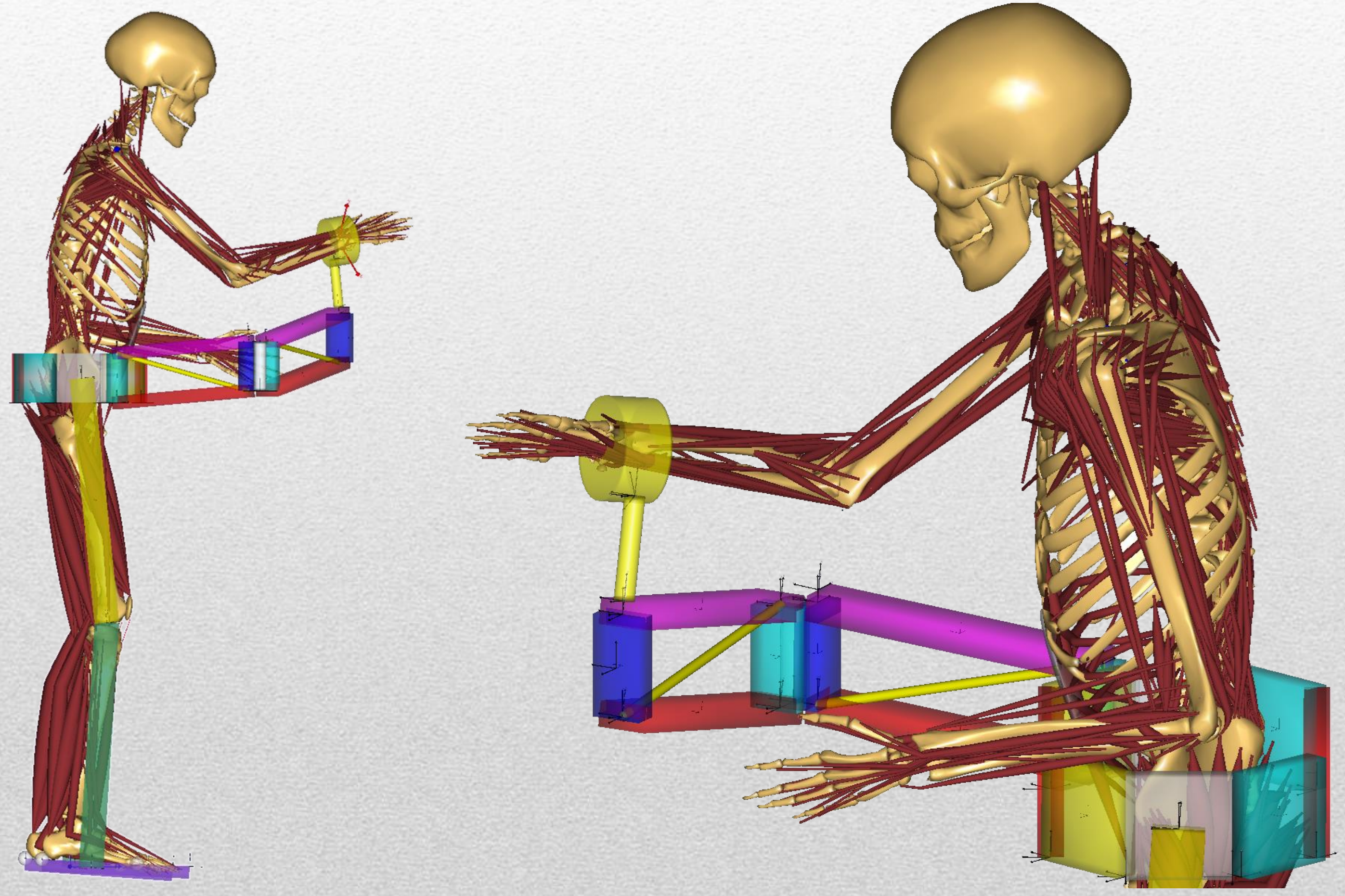
Simulation of an industry exoskeleton during wire winding & sandblasting (www.movaid.eu)



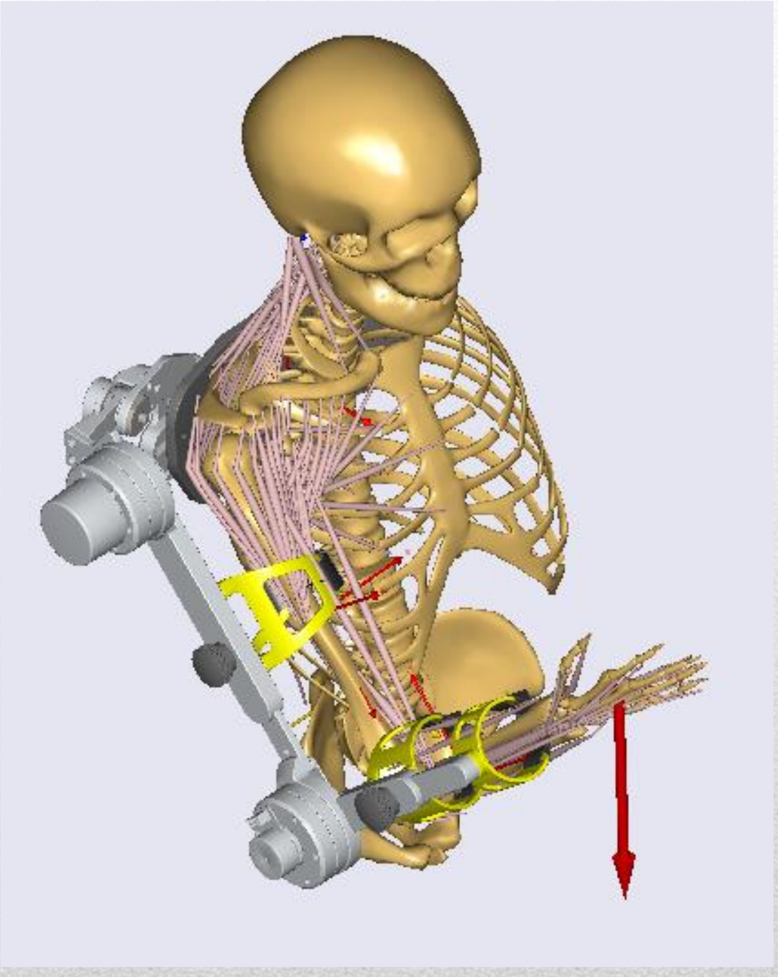


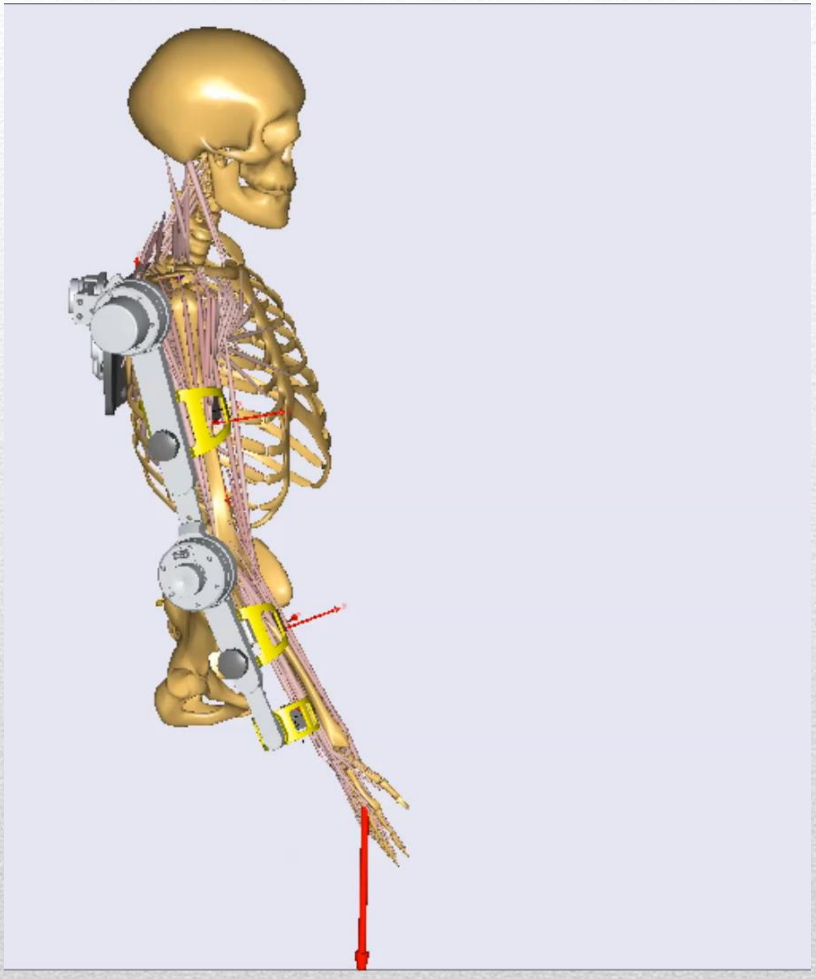
ANYBODY TECHNOLOGY

Conceptual design of passive exoskeleton with gravity compensation (www.movaid.eu)



AXO-SUIT project (www.axo-suit.eu)



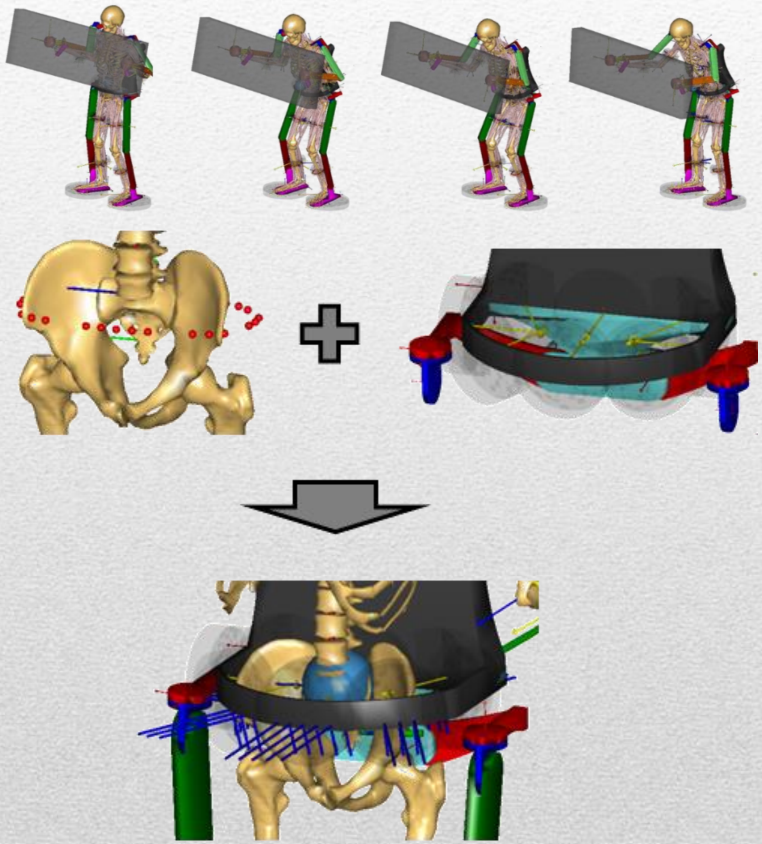


ANYBODY TECHNOLOGY

AnyBody contribution to the exoskeleton projects

AnyBody simulations will:

- Find optimal parameters/variables of exoskeleton
  - Torque
  - Power
  - Kinematics
  - Stiffness
- Comfort/Endurance Analysis
  - Joint loads
  - Muscle activations
  - Metabolics
  - Human/Exo interaction force/pressure

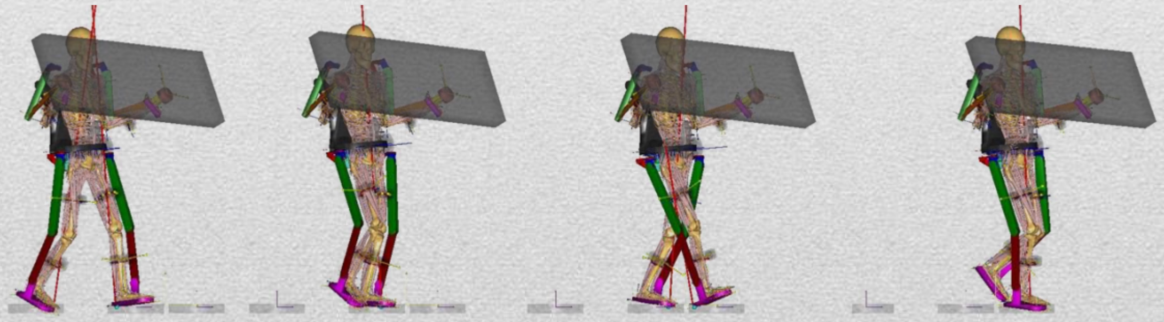


Cho et al. (2012)

ANYBODY TECHNOLOGY

Conclusions

- AnyBody can model simulate the exoskeletons during three phases as:
  - Pre-prototyping (optimize key parameters)
  - Post-prototyping evaluation (effect on the human body)
  - Operation (individualized optimization of the adjustments)

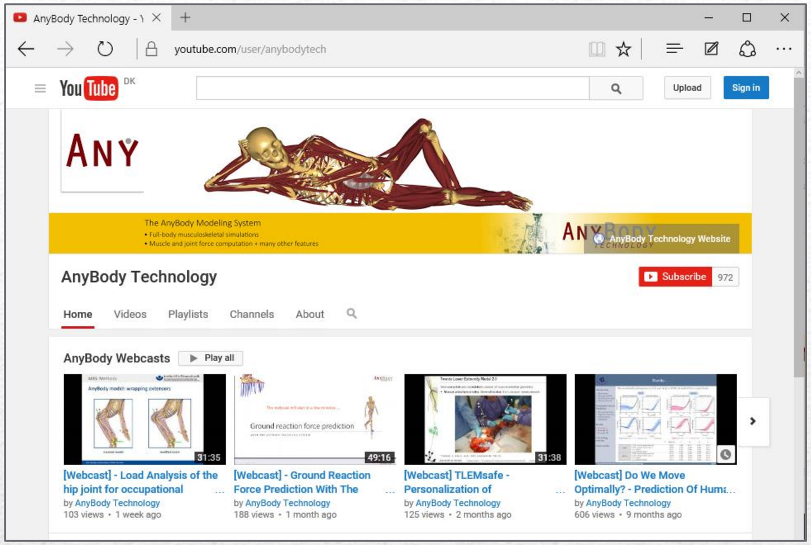


Cho et al. (2012)

ANYBODY TECHNOLOGY

Webcasts

- New round of webcasts will start after summer 2016
- Check our YouTube channel (‘AnyBody Technology’) for previous webcasts



- **Events**
  - IROS 2016 (South Korea)
  - WeRob 2016 (Spain)

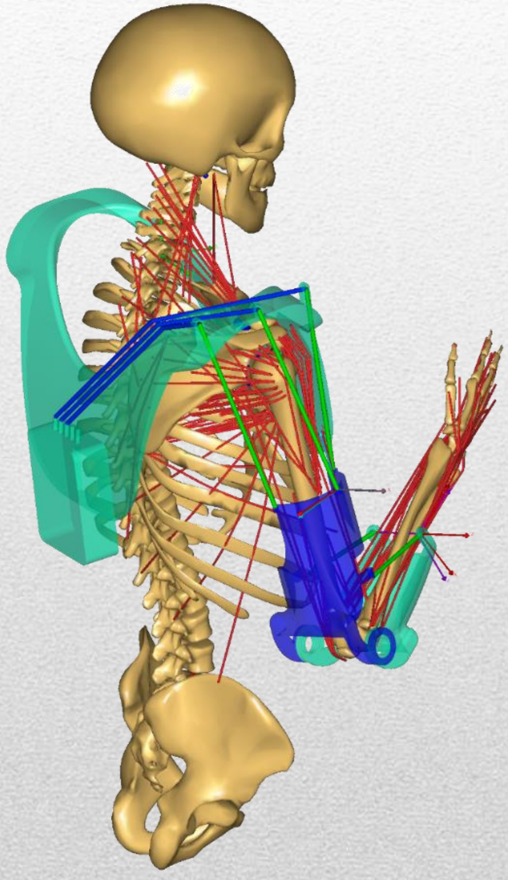
www.anybodytech.com

- More useful links, publication list, ...

inquiry@anybodytech.com

- Contact for any kind of questions

Time for questions



Zhou et al. (2012)