# Hvordan forudses virkningen af et exoskelet?

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# Exoskeletter til arbejdsmarkedet

# Passive exo'er – stort set

- Aflastning af knæ og lårmuskler
- Aflastning af hofter og ryg
- Aflastning af skuldre og arme

Nogle leverandører har modulære systemer, der kan sættes sammen til at dække hele kroppen.

Det fleste brugere synes dog at satse på fokuseret aflastning af en enkelt kropsdel.

Største anvendelsesområde indtil videre er arme og skuldre.

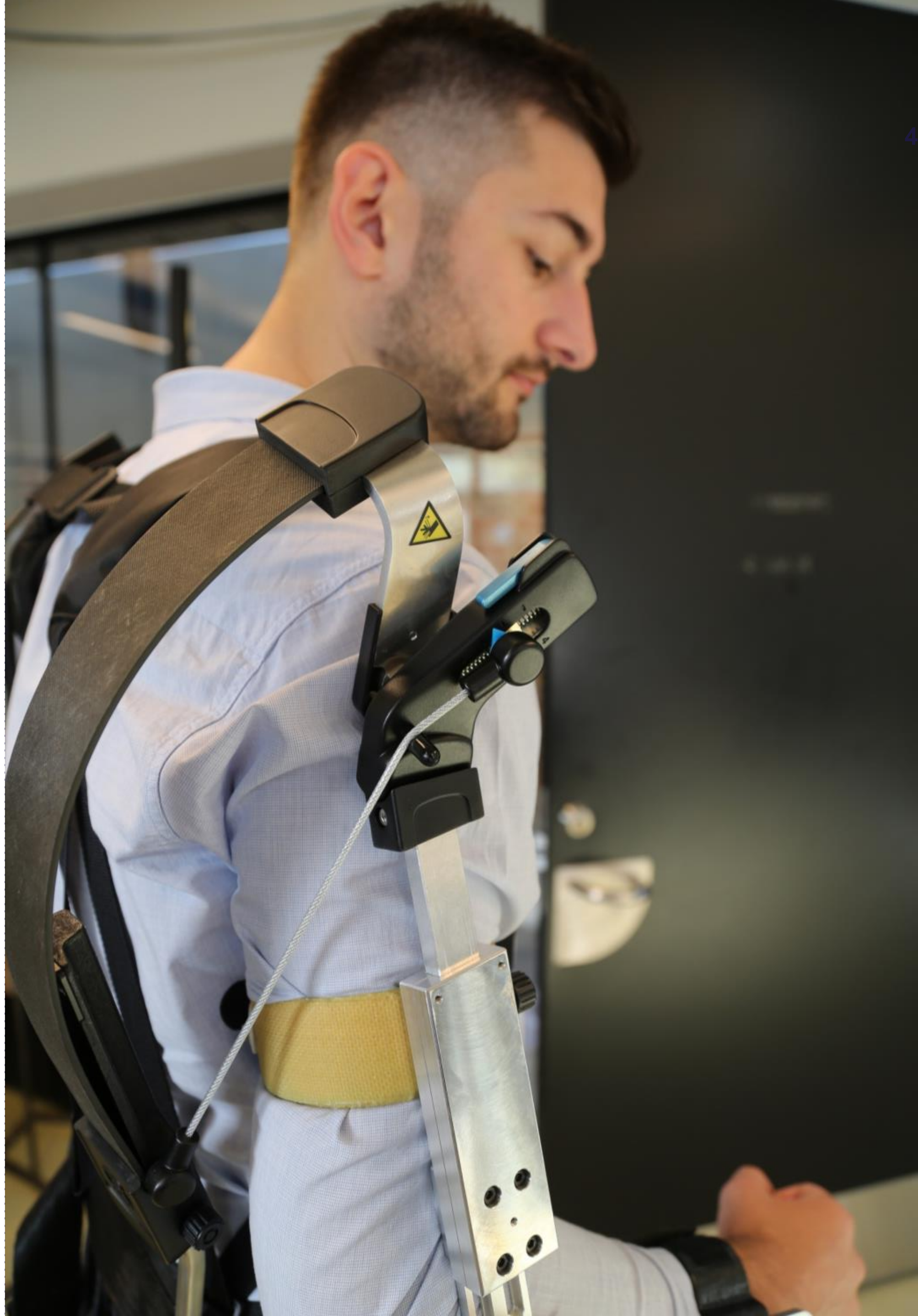
Prisleje per modul: 10.000 – 50.000 kr.


AUXVIVO ryg-exo fra www.exoskeletter.dk
Med venlig tilladelse fra Arne Urskov.

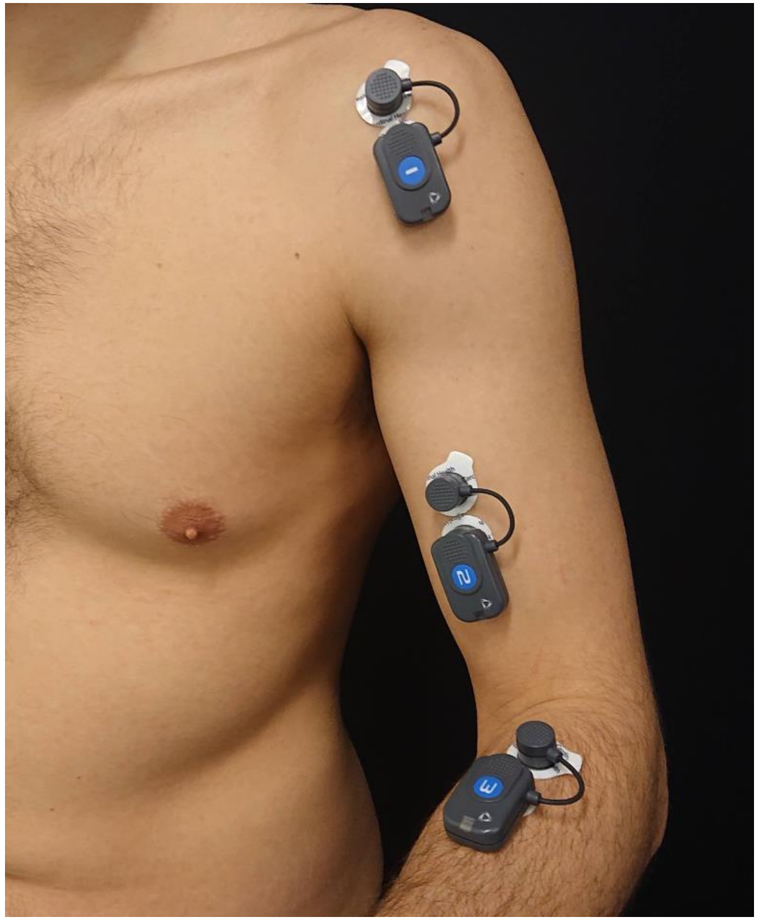
# Nødvendige afklaringer

- Har jeg en arbejdsopgave, som kan aflastes af et passivt exoskelet?
- Hvor meget aflastning har jeg brug for?
- Hvad kan gå galt?
- Hvordan dokumenterer jeg virkningen?

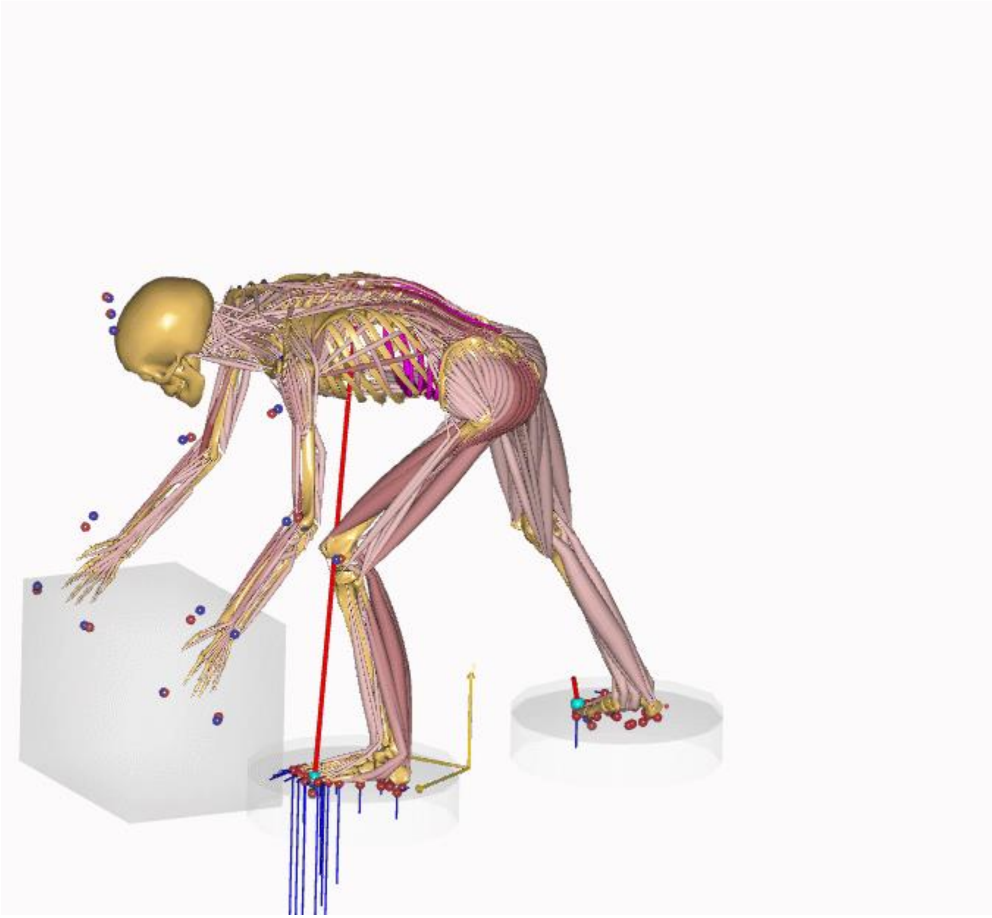
AALBORG UNIVERSITET



# Virkningen af et exoskelet

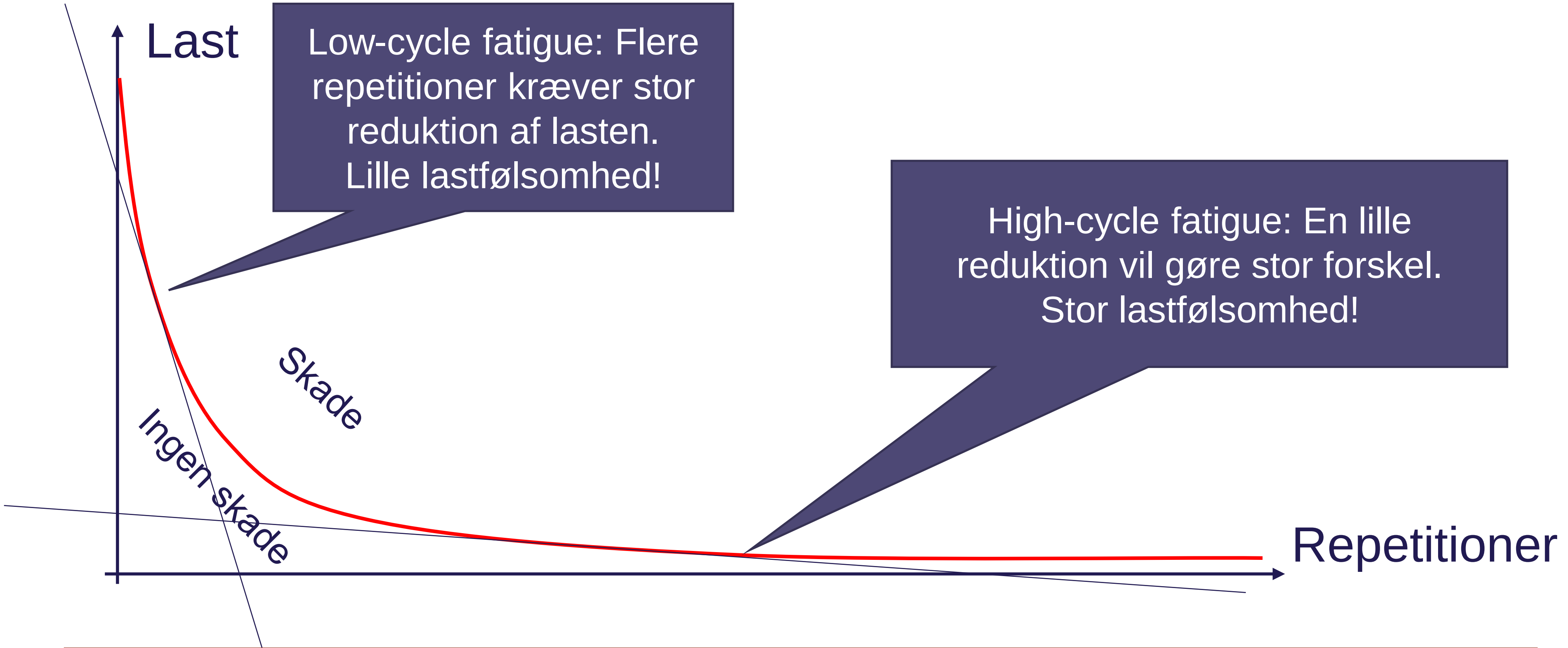



Eksperimentelle metoder



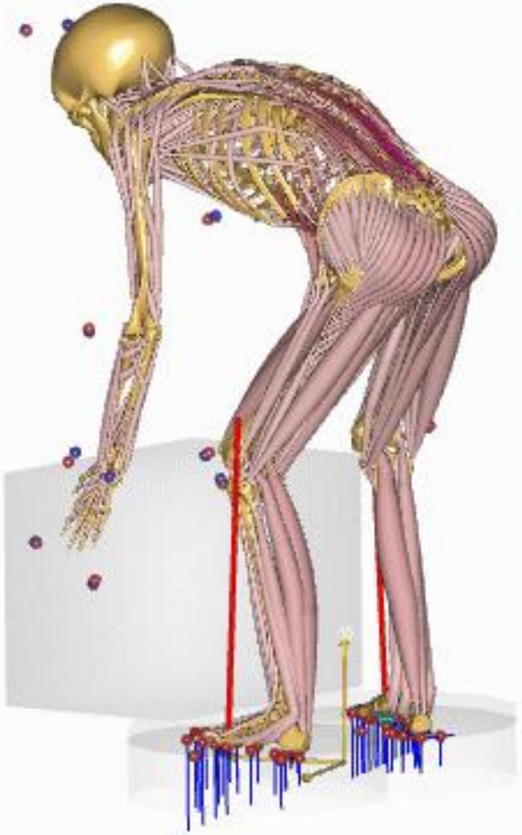
Musculoskeletal Simulering

# Repetitioner og skader



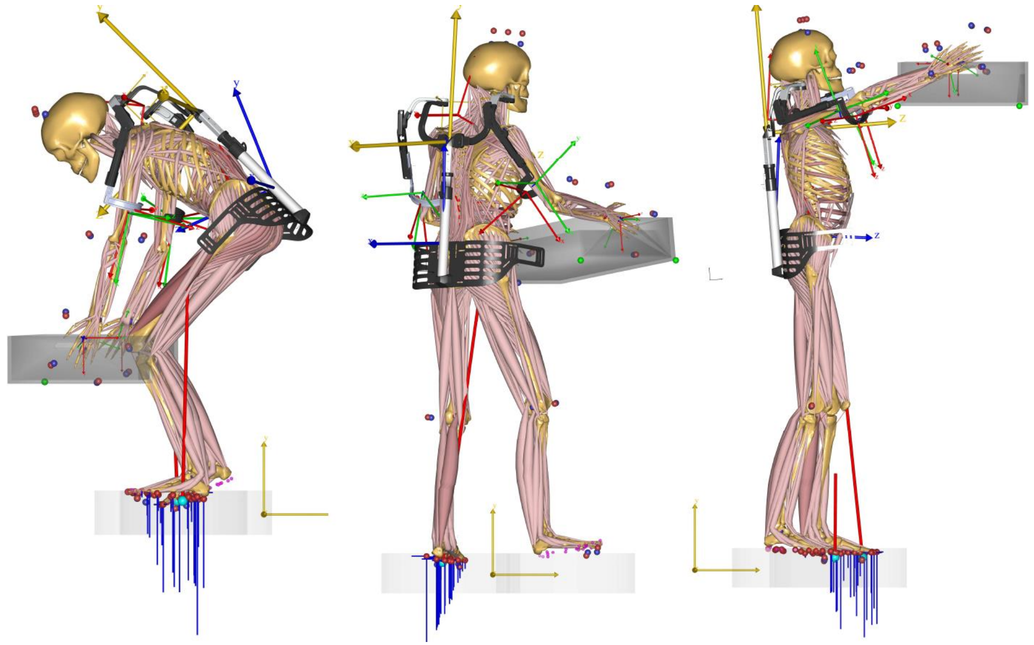

Det virker begge veje: I high cycle fatigue kan man enten skabe en masse problemer eller forbedre situationen kraftigt med en lille ændring af arbejdsforholdene.

# Musculoskeletal simulering



- Den konkrete medarbejders bevægelsesmønster kan måles på arbejdspladsen med ½ - 1 times indsats med ny teknologi.
- Bevægelsen kan overføres til en computer, og de indre belastninger i kroppen kan beregnes med computermodeller.
- Man kan sammenligne med kendte ”sikre” belastningsniveauer.
- Man kan sætte exoskelettet på modellen og undersøge aflastningen.

# Exo + menneskemodel



The AnyBody Modeling System + SuitX shoulder exo

Seiferheld et al.

**BIOMECHANICAL INVESTIGATION OF A PASSIVE UPPER EXTREMITY EXOSKELETON FOR MANUAL MATERIAL HANDLING – A COMPUTATIONAL PARAMETER STUDY**

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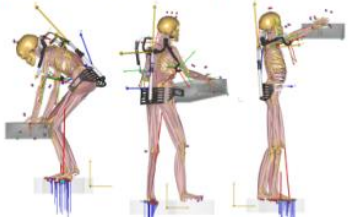
**INTRODUCTION**
Manual material handling (MMH) is a well-known risk factor for developing work-related musculoskeletal disorders (WMSD). Grocery work involves extensive MMH and is ranked within the top 25 occupations with the highest prevalence of WMSD with shoulder and lower back disorders accounting for approximatly 40% [1]. As a solution to protect workers, passive upper-extremity exoskeletons are increasingly being used to decrease the risk of developing WMSD. However, the current litterature is mostly limited to laboratory measurements. Therefore, we wanted to design a method to evaluate the biomechanical risk factors associated with using an exoskeleton based on inertial motion capture data of MMH performed in two supermarkets.

**METHODS**
An inertial motion capture system, Xsens Awinda (Xsens Technologies BV, Enschede, The Netherlands) sampling at 60 Hz, was used to capture full-body kinematics of 15 grocery workers who lifted a bread-case (7.9 kg) onto shopping shelfs (145.5 cm). The kinematic data were used to drive a detailed human-exoskeleton model based on inverse dynamics, modelling the interaction between the human and external objects (i.e. exoskeleton, lifted object, and ground) (Figure 1). The detailed human-exoskeletal model was built in the AnyBody Modelling System v.7.2 (AnyBody Technology A/S, Aalborg, Denmark) and was based on the BVH_XSENS model template from the AnyBody Managed Model Repository v.2.3, which includes a method for predicting ground reaction forces and moments [2].



shoulder muscle force, and 3D spine and shoulder joint reaction forces. All peak forces were normalized to percentage of body weight (%BW) and impulse to %BW per second (BW·s).

**RESULTS AND DISCUSSION**
Simulations of various settings revealed that working with the exoskeleton could have both positive and negative effects on musculoskeletal loading. Generally, simulations with maximum torque combined with a peak angle setting between 75-105° led to the highest reductions of L4-L5 compression and anterior-posterior shear forces, glenohumeral contact forces and shoulder flexor muscle forces (Figure 2). Contrarily, in some cases, inappropriate settings with maximum torque combined with peak angle settings of 60° led to additional musculoskeletal loading compared to not wearing the exoskeleton.

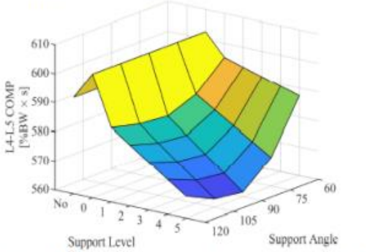



**Fig. 2** L4-L5 compression impulse presented as a function of variations in the support level and support angle of the exoskeleton.

**CONCLUSIONS**
The passive exoskeleton appeared to be an efficient tool to potentially reduce work-related exposure during MMH. However, some support settings increased joint reaction forces, suggesting that not adjusting the exoskeleton properly could be detrimental to the protective effect of the device. Additionally, we demonstrated how musculoskeletal

# Hvad kan man gøre, helt konkret?

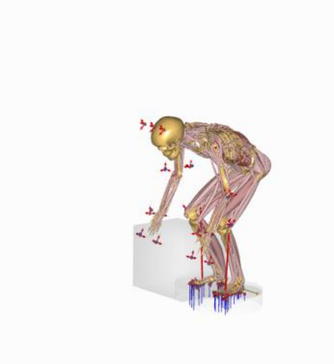
Industri-
virksomhed

↔

Autoriseret rådgiver
(Arbejdsmiljøcentret
Human House)

↕

AnyBody Technology A/S



# Fremtiden



| | | |
|---|---|---|
| Større udbredelse → | Billigere exo'er → | Kineserne kommer (sikkert) |
| Erfaringer → | Best practice → | Regulering |
| Forskning og udvikling → | Aktive exo'er → | Nye anvendelser |

# Hvad nu?

- Snak med Kristoffer Iversen om måling og simulering af din arbejdssituation.
- Snak med Arbejdsmiljøcentret Human House.
- Prøv vores medbragte exo'er.
- Snak med Shaoping Bai eller mig om forskning, kontakt mig på jr@mp.aau.dk eller besøg www.exoskeletons.aau.dk.