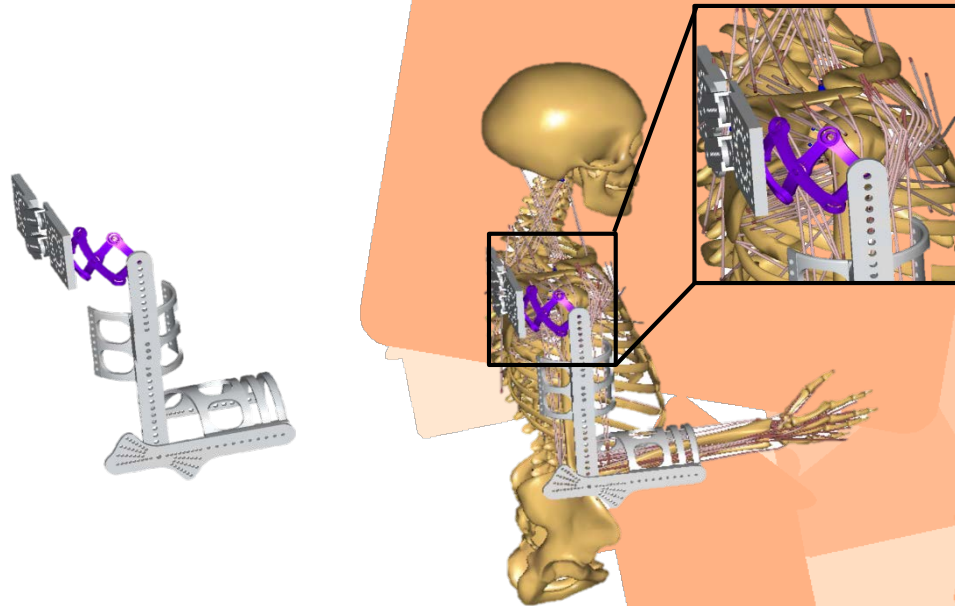


Designing assistive exoskeletons by means of musculoskeletal simulation

By

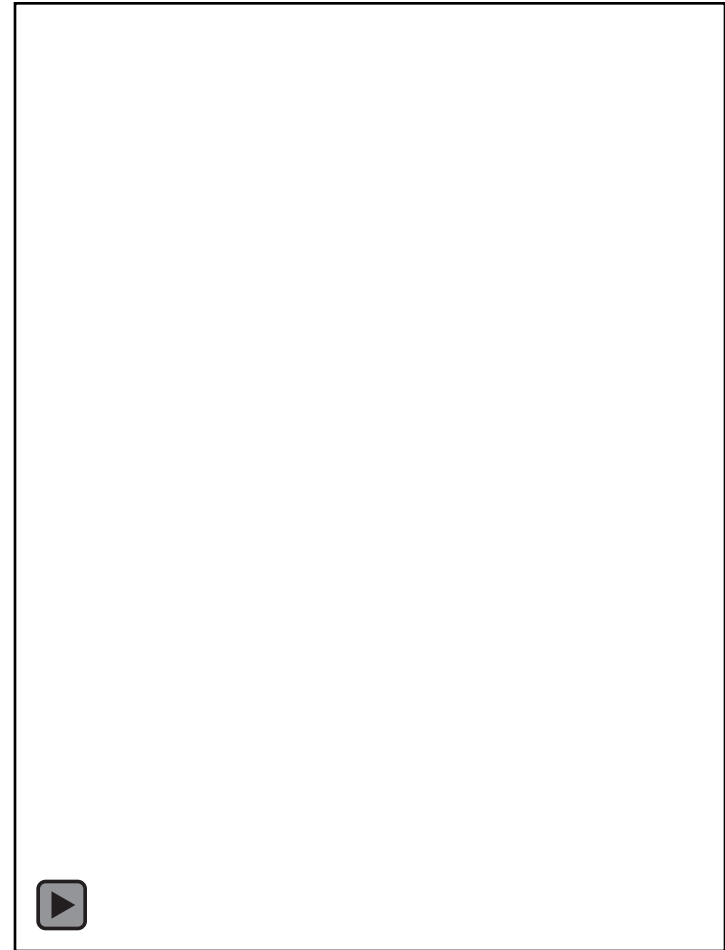
Miguel Nobre Castro, Michael Skipper Andersen, Shaoping Bai & John Rasmussen
Aalborg University

patient@home



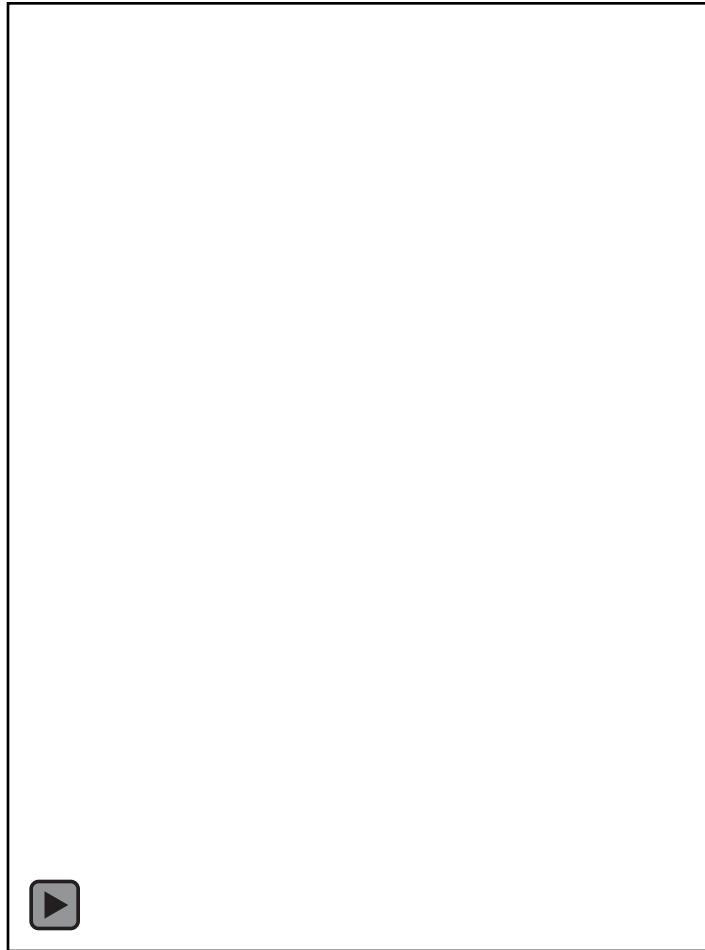
Background

- Upper limb paralysis makes people dependent on assistance.
- Paralysis is often partial with some retained strength.
- Compensating gravity can restore ability for feeding and personal care.



Traditional orthotics...

Orthosis made by our
partner
Bandagistcentret.



...can restore elbow function

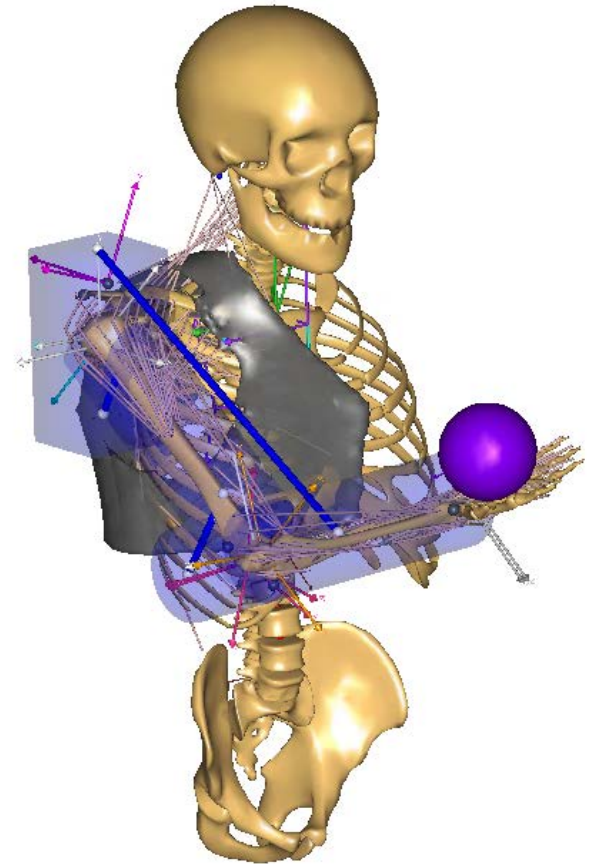


- Works by establishing a stable flexed elbow posture.
- Can switch between elbow postures using small jerks of the body.
- Cannot restore shoulder function.



Aims

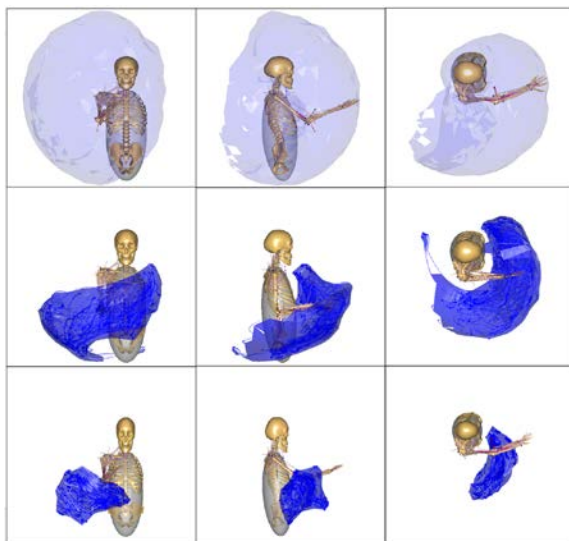
- Develop a conceptual soft-coupled arm assistive device.
- Make it simple: No motors, no batteries, no control system.
- Optimize the parameters to the specific needs of the user.



Methods

USER-SPECIFIC
MODEL CALIBRATION

Healthy



REACHABLE 3-
D WORKSPACE

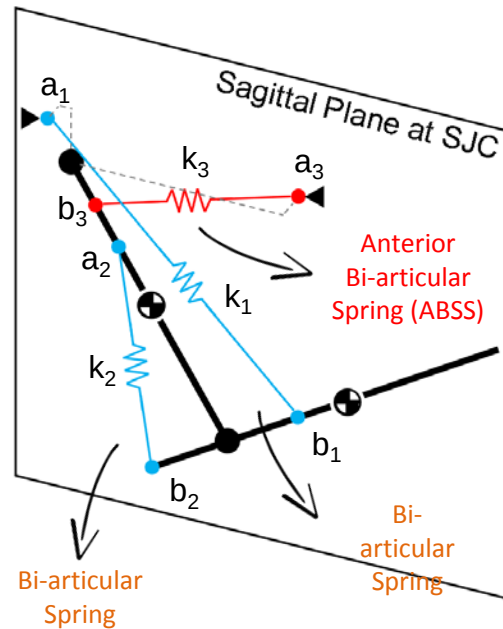


F_{MAX} GENERATION
CAPABILITY

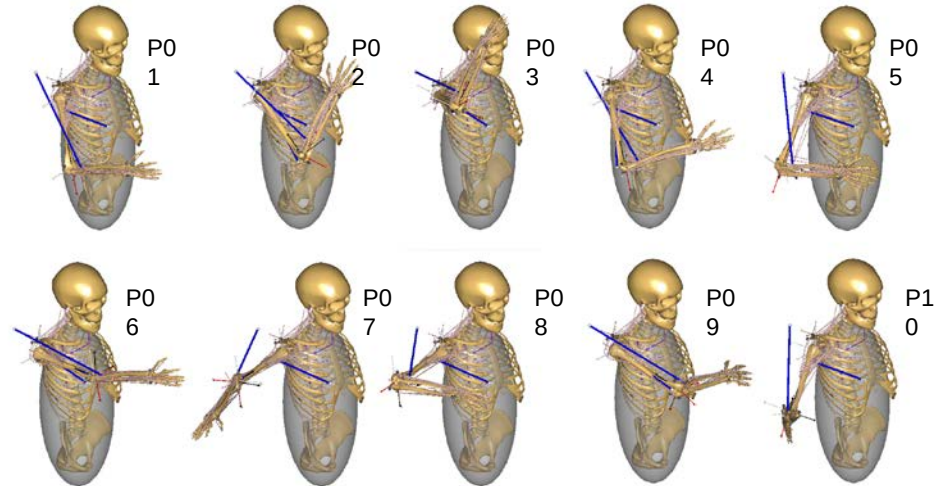


Methods

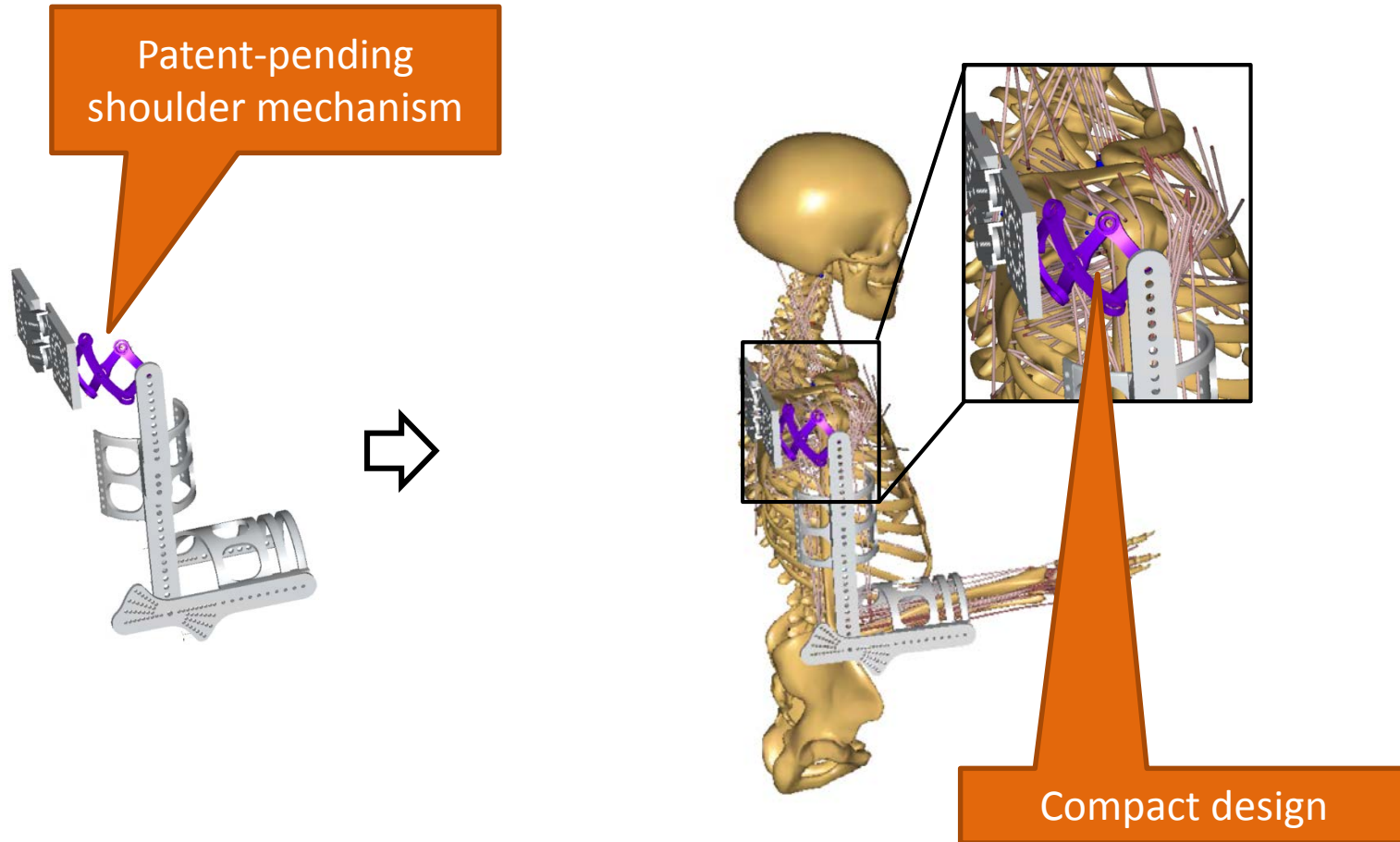
USER-SPECIFIC ORTHOSIS DESIGN

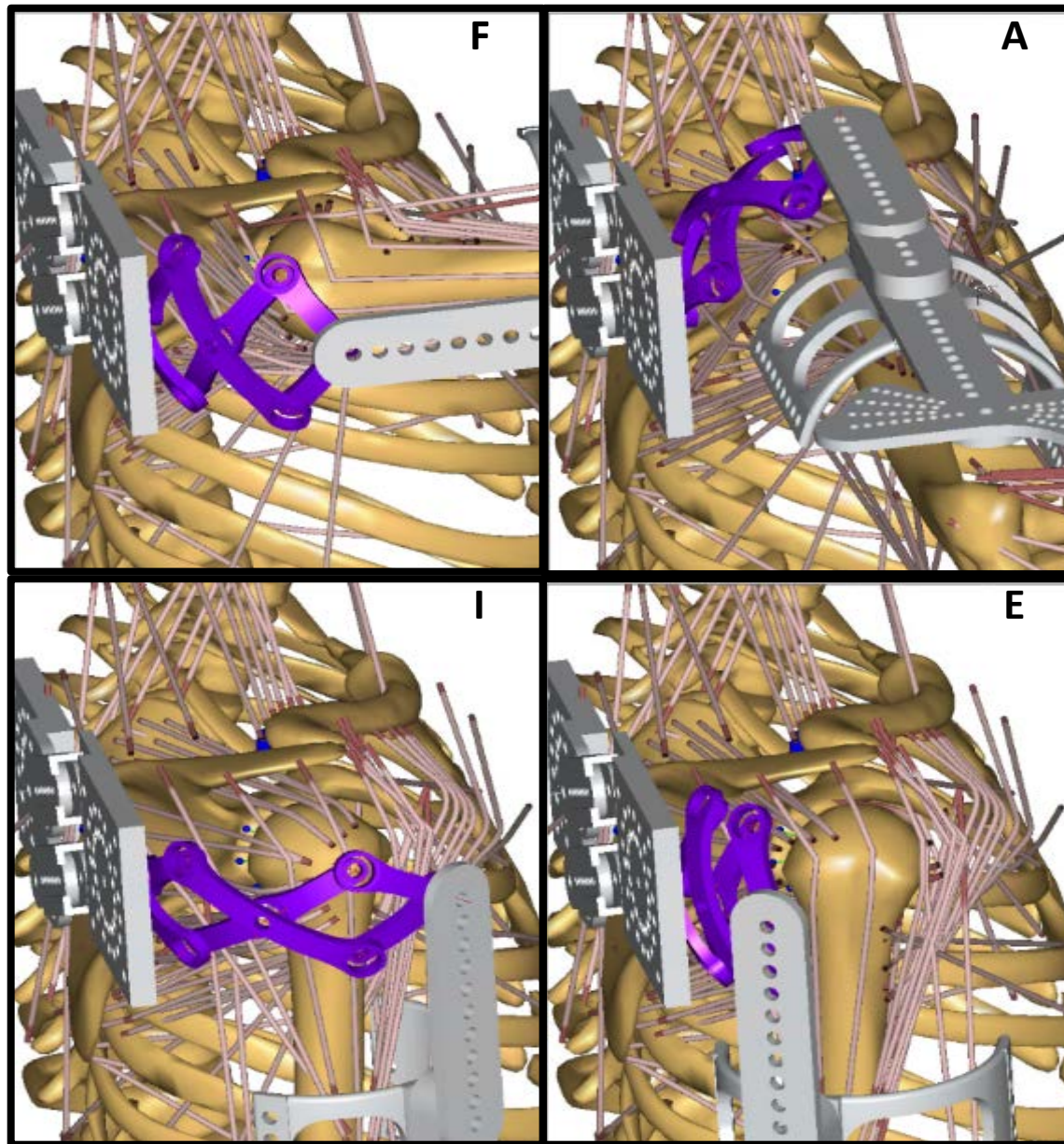


OPTIMIZATION OF THE SPRINGS' PROPERTIES BY MINIMIZING MMACT FOR THE FOLLOWING POSTURES USED IN THE ACTIVITIES OF DAILY LIVING



Innovation

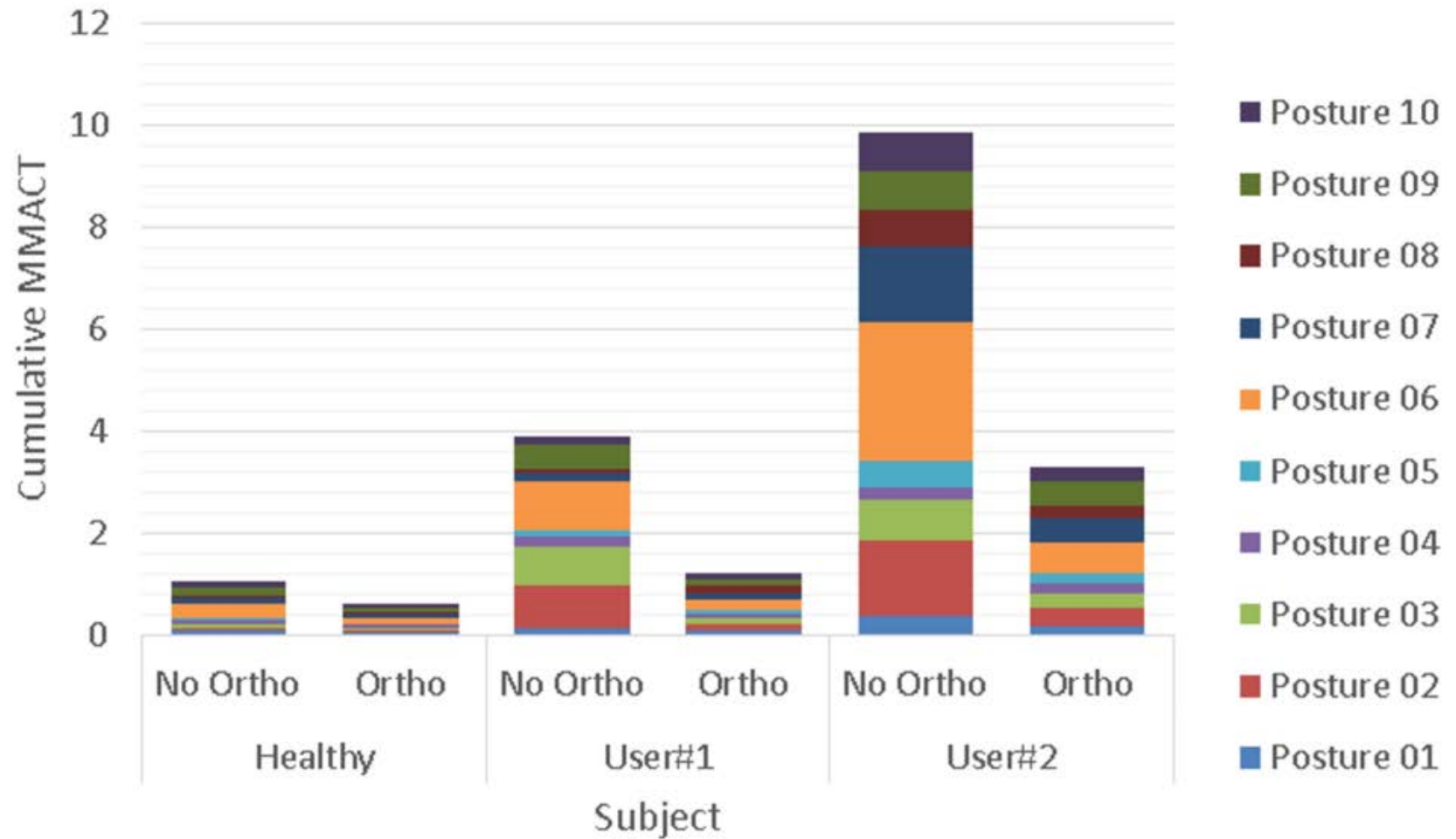




Recent prototype

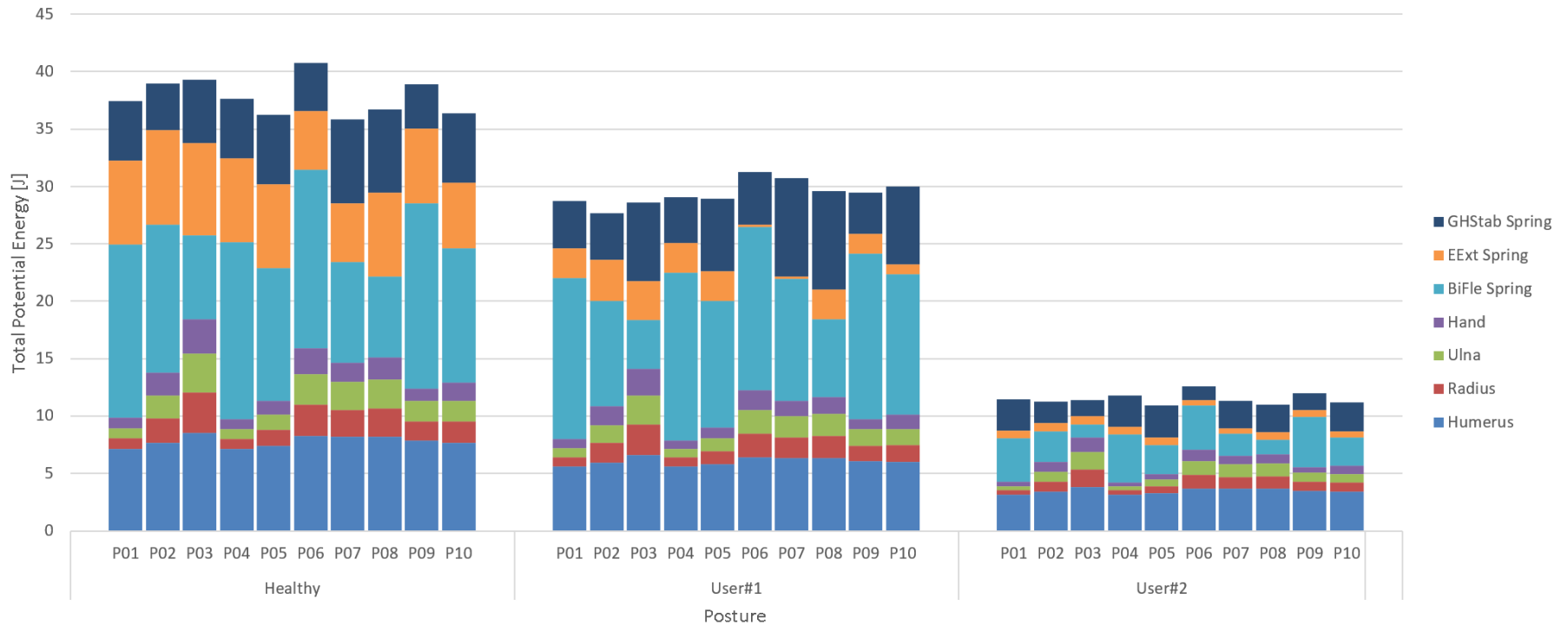


Results



Results

Potential Energy Variation Across Postures



pati



Discussion

- The optimized orthosis enabled all users to attain the desired postures *in-silico*.
- Due to the partial balance of the system, there is still some residual muscle activation required - but within everyone's capabilities.



Final evaluation

Fundamental science

- Range-of-motion method for assessment and model validation.
- Computational design method based on optimization.

Invention

- Several prototypes designed and built.
- Prototype tests ongoing in the USA.
- Patent application for a compact shoulder exoskeleton mechanism.

