



# Reducing Soldier Burden to Improve Performance and Reduce Injury - Exoskeletons

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# Brief Review of Last Year's Presentation

# Future Human Exoskeleton Test and Evaluation Criteria Categories

- 1) Soldier anthropometric considerations
- 2) Functional movement optimization
- 3) Effect on simulated operational task performance
- 4) Effect on operational performance
- 5) Physical interactions with other equipment (i.e. compatibility)
- 6) Injury risk assessment

## Take home message... (from Last Year)

- Human exoskeleton technologies continue to be developed and DND/CAF has an interest
- Traditional physiological performance measures should be combined with novel biomechanical and operationally-relevant measures to properly evaluate the value of any current/future human exoskeleton
- Combined traditional and novel measures can be used to assess important exoskeleton design parameters/constraints or objectives, and should be used when specifying procurement requirements for any future exoskeleton systems for the CAF

# **This Year's Presentation**

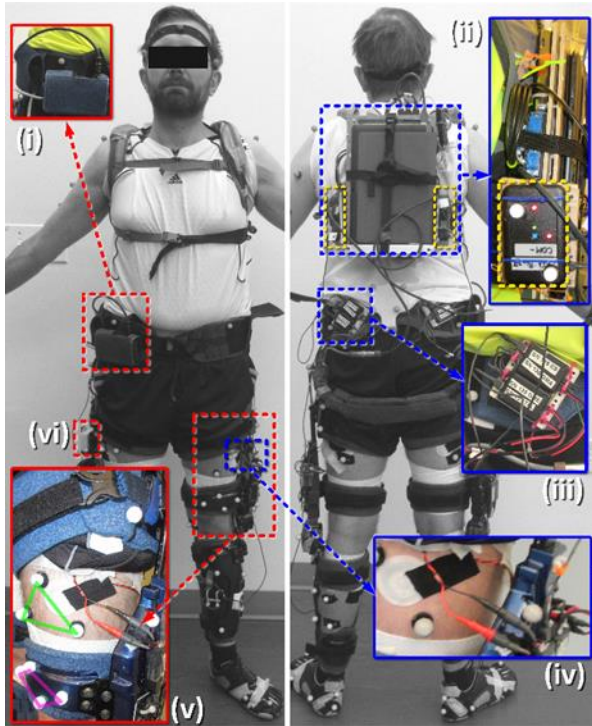
# Current Exoskeleton Technology

## ■ B-Temia Prowler



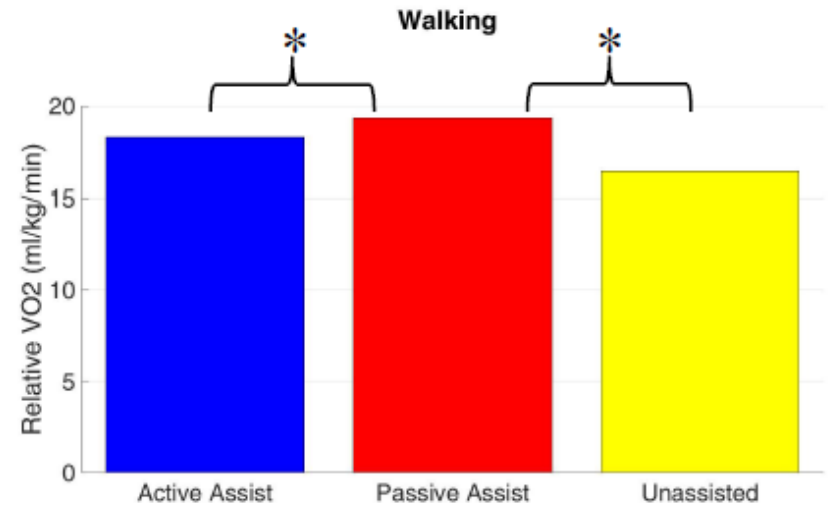
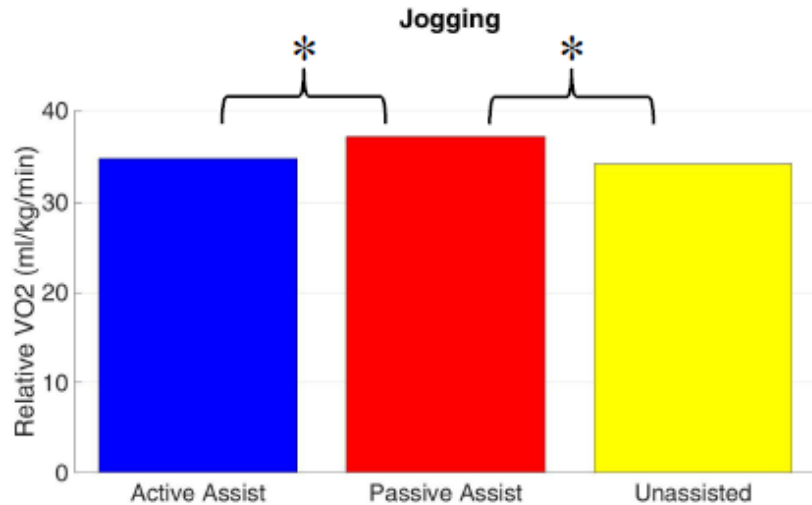
<http://www.b-temia.com/defense-security-soldier-protection/>

# New Evaluation Methods



Brandon et al. (2016) – Development of a system for biomechanical evaluation of lower-extremity exoskeleton during overground locomotion (*submitted*)

# Preliminary Results



Muggah et al. (2015) – The metabolic effects of a lower limb robotic exoskeleton.

*NBHRF*



# Development and Assessment Plan

- 1) Soldier anthropometric considerations
- 2) Functional movement optimization
- 3) Effect on simulated operational task performance
- 4) Effect on operational performance
- 5) Physical interactions with other equipment (i.e. compatibility)
- 6) Injury risk assessment

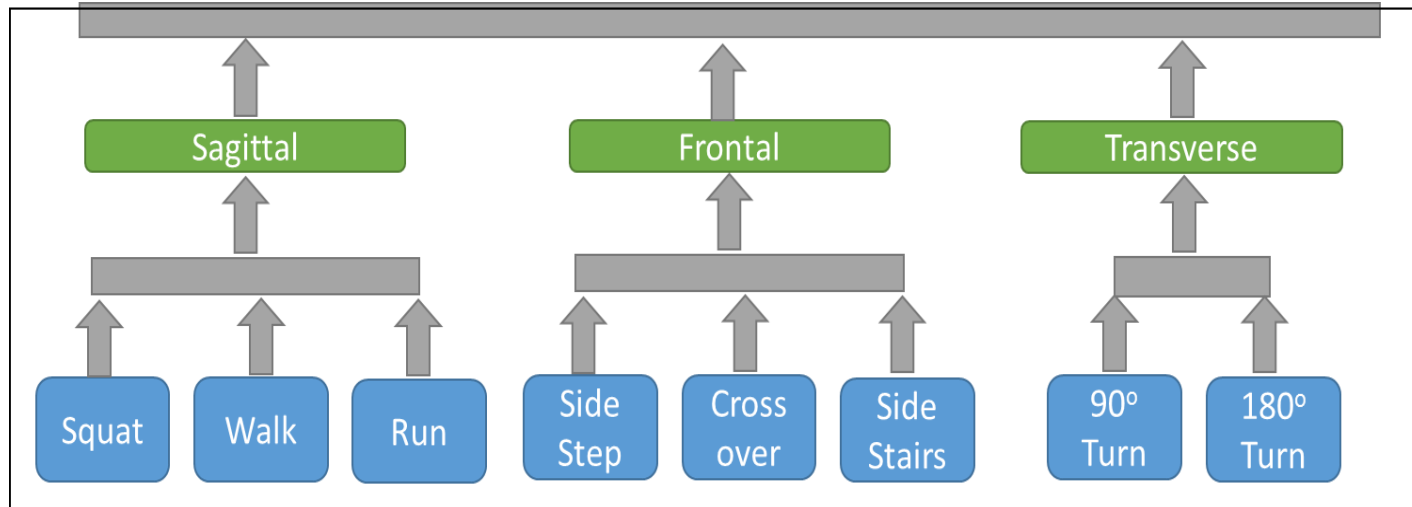
## ■ Academic Laboratory Environment

## ■ Applied Laboratory Environment

## ■ Field Environment

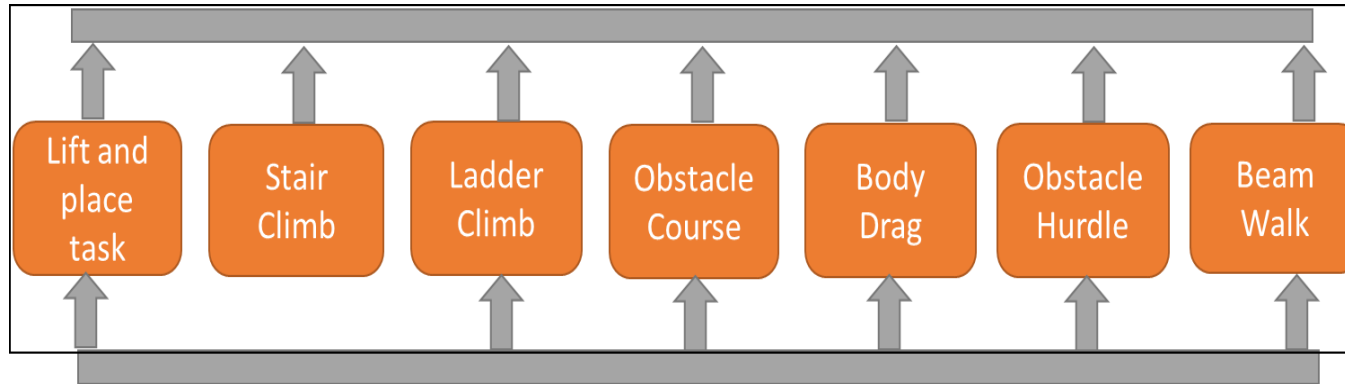
# Academic Laboratory Environment

## ■ Functional Movement Optimization



# Applied Laboratory Environment

- Simulated operational task performance

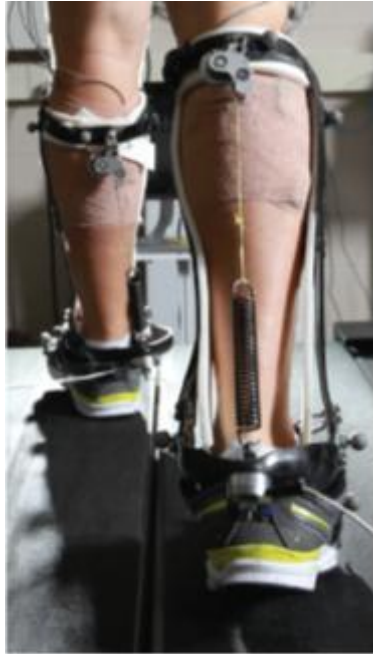


# Field Environment

- Operational task performance and Compatibility



# Injury Potential



Normal knee



Osteoarthritic  
knee

Robbins (2011) – Comparative diagnostic accuracy of knee adduction moments in knee osteoarthritis: A case for not normalizing to body size. *J Biomechanics*

# Summary

## ■ Theoretical Construct

- 1) Soldier anthropometric considerations
- 2) Functional movement optimization
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- 4) Effect on operational performance
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## ■ Implementation Plan

- Academic Laboratory Environment
- Applied Laboratory Environment
- Field Environment

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