NATO RTO Information Systems Technology Panel (IST-099 / RSY-024)
SYMPOSIUM ON EMERGED/EMERGING "DISRUPTIVE" TECHNOLOGIES
MADRID, Spain, 9-10 May 2011

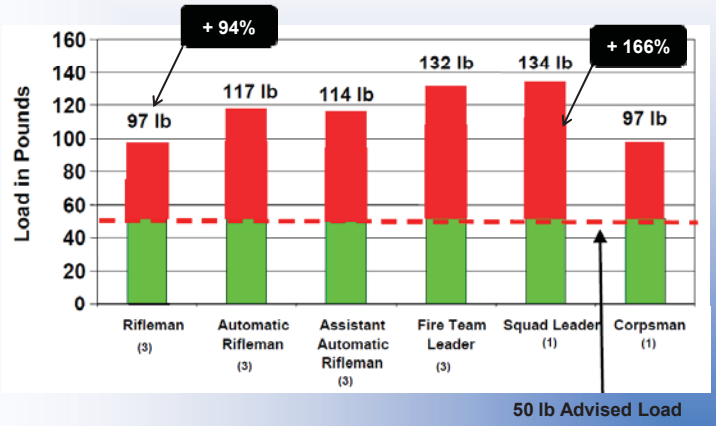
Initial Evaluation of the Dermoskeleton Concept: Application of Biomechatronics and Artificial Intelligence to Address the Soldiers Overload Challenge

Presented by St. Bédard
May 2011

Stéphane Bedard (1), David Tack (2) , Gilles Pageau (3), Benoit Ricard (3) and Matheson Rittenhouse (1)

(1) B-Temia Inc.; 2750, Einstein St., Suite 230, Québec (Qc) G1P 4R1, Canada
(2) Human Systems Incorporated; 111, Farquhar Street, Guelph (Ontario) N1H 3N4, Canada
(3) DRDC Valcartier; 2459, boul. Pie-XI nord, Val-Bélair, (Québec) G3J 1X5, Canada

SOLDIER OVERLOAD CHALLENGE
Actual Assault Loads



[1]

CONSEQUENCES: - Musculo-Skeletal (MS) Injuries
- Non-deployment

SOLDIER OVERLOAD CHALLENGE
Impacts & Consequences

- In US Army, 250,000 MS injuries per year [4]
- In US Army, around 75% of medical issues are MS injuries [x]
- In US Special Forces, 12% / month of soldiers suffers MS injuries [2]
- In US Army, 16% of non-deployment rate mainly due to MS injuries [3]
- In US Army, 5,000 and 10,000 additional soldiers in 2009 and 2010 respectively [3]

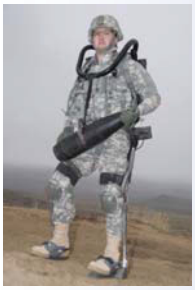
►HIGH COST IN REHABILITATION

►HIGH COST IN RE-DEPLOYEMNT STRATEGIES

SOLDIER OVERLOAD CHALLENGE
Current Solutions

1) Weight reduction of gears

2) Unmanned ground vehicules



3) Exoskeletons

SOLDIER OVERLOAD CHALLENGE
Emerging Approach - Dermoskeletons

ROBOTIZED ORTHOSIS-TYPE ASSISTIVE DEVICE SYPPLYING BIOMECHANICAL TORQUE AT JOINTS

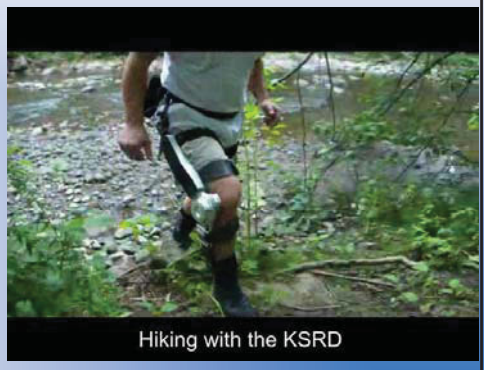
1) **Restore, maintain or enhance biomechanical capacity**
2) **Keep intact the ROM of the mobility**
3) **Assist specific or repetitive tasks requiring strength and endurance**
4) **Protect against acute and chronic MS injuries**

Picture courtesy of B-Temia Inc.

SOLDIER OVERLOAD CHALLENGE
Emerging Approach – K-SRD™

Assistive device using the dermoskeletal approach: KNEE STRESS RELEASE DEVICE (K-SRD™)


Squatting with the KSRD


Hiking with the KSRD

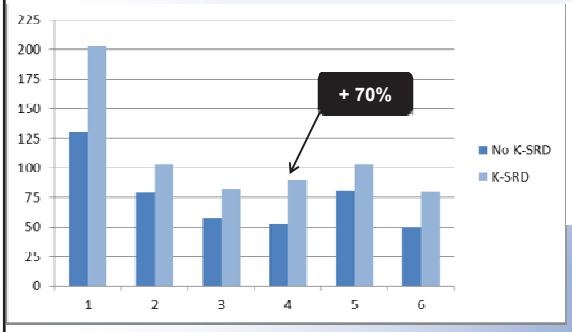
Photos courtesy of B-Temia Inc.

DERMOSKELETON INITIAL EVALUATION
Objective & Method

INITIAL EVALUATION OF THE K-SRD™ AS IT APPLIES TO AUGMENT MOBILITY AND TO REDUCE TO PHYSIOLOGICAL WORKLOAD

Method:	Aerobic & anaerobic tests in controlled environment
Device:	Knee Stress Release Device (K-SRD™)
Subjects:	Six (6) participants; healthy & fit; 20-29 of age
Protocol:	Two (2) conditions (W/O the device) Three (3) weight criteria (0lb, 25lb, 50lb)
Test 1:	Max repetition in squat movement (50lb) OUTCOME: Amount of squats
Test 2:	Stairs climbing; 20 mins @ 103 steps/min (50 lb) OUTCOME: Heart rate
Test 3:	Two steps up-and-down (CHFT); 10 mins (0, 25, 50 lb) OUTCOME: Heart rate

DERMOSKELETON INITIAL EVALUATION
Results – Test 1 Squat Movements

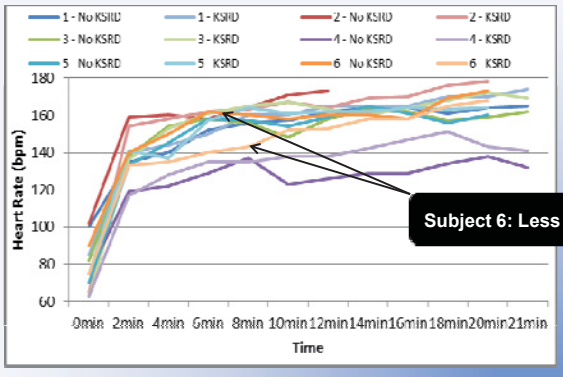


Participant #	Squats (n)		% Mech Adv.
	K-SRD	No K-SRD	
1	203	130	56.2
2	103	79	30.4
3	82	58	41.4
4	90	53	69.8
5	103	81	27.2
6	80	50	60.0

Mechanical Advantage

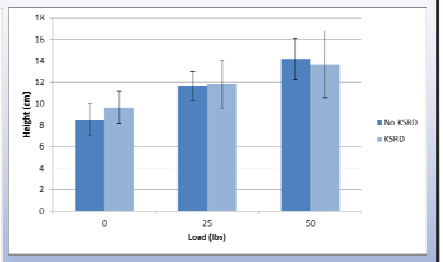
- **47.5% mean mechanical advantage while using the K-SRD™**
- **The K-SRD™ provide an obvious biomechanical benefice in squat**
- **The K-SRD™ = greater amount of squats or**
  The K-SRD™ = same number of squats with less effort

DERMOSKELETON INITIAL EVALUATION
Results – Test 2 Stairs Climbing



- Four (4) subjects shown higher heart rate with the K-SRD™; MORE physiological effort
- Subject 6 shown lower heart rate with the K-SRD™; LESS physiological effort
- Subject 2 shown no significant difference

DERMOSKELETON INITIAL EVALUATION
Results – Test 3 CHFT



Perceived Exertion Rate vs Load

- Load = 0 lb Increased heart rate < 10%
  Perceived exertion rate is higher with the K-SRD™
- Load = 25 lb Increased heart rate < 10%
  Perceived exertion rate shown no difference
- Load = 50 lb Increased heart rate < 5%
  Perceived exertion rate is LOWER with the K-SRD™

DERMOSKELETON INITIAL EVALUATION
Conclusions & Recommendations

- In squat movements, the K-SRD™ shown a significant biomechanical benefit for the user (48% mean mechanical advantage)
- In stairs climbing, the K-SRD™ did not show a physiological effort reduction; HOWEVER one (1) subject shown less effort while using the K-SRD™
- In CHFT, The K-SRD™ did not show a heart rate reduction; HOWEVER the increase is below 10% and 5 % for the 0-25 lb and 50 lb respectively

In Consequence

- Dermoskeletons would show positive attribute for muscular assistance
- Dermoskeletons would positively impact the biomechanical capability
- Dermoskeletons should be a novel emerging technology against soldiers overload challenge

RECOMMANDATION

- Development should focus to transfer the biomechanical benefit observed in squat towards the overall locomotion

DERMOSKELETON INITIAL EVALUATION
Acknowledgements & Thanks

- Defence Research Development Canada Toronto, Toronto (Canada)
- Human System Incorporated, Guelph (Canada)
- B-Temia Inc., Québec (Canada)
- Technical Programme Committee of the IST-099 Symposium

DERMOSKELETON INITIAL EVALUATION
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