A COMPARATIVE ANALYSIS OF MARK III WATER PUMP CARRIAGE SYSTEMS

Daniel J. Moser, MSc
Ryan B. Graham, MSc
Patrick A.Costigan, PhD
Joan M. Stevenson PhD

School of Kinesiology and Health Studies,
Queen's University, Kingston, ON

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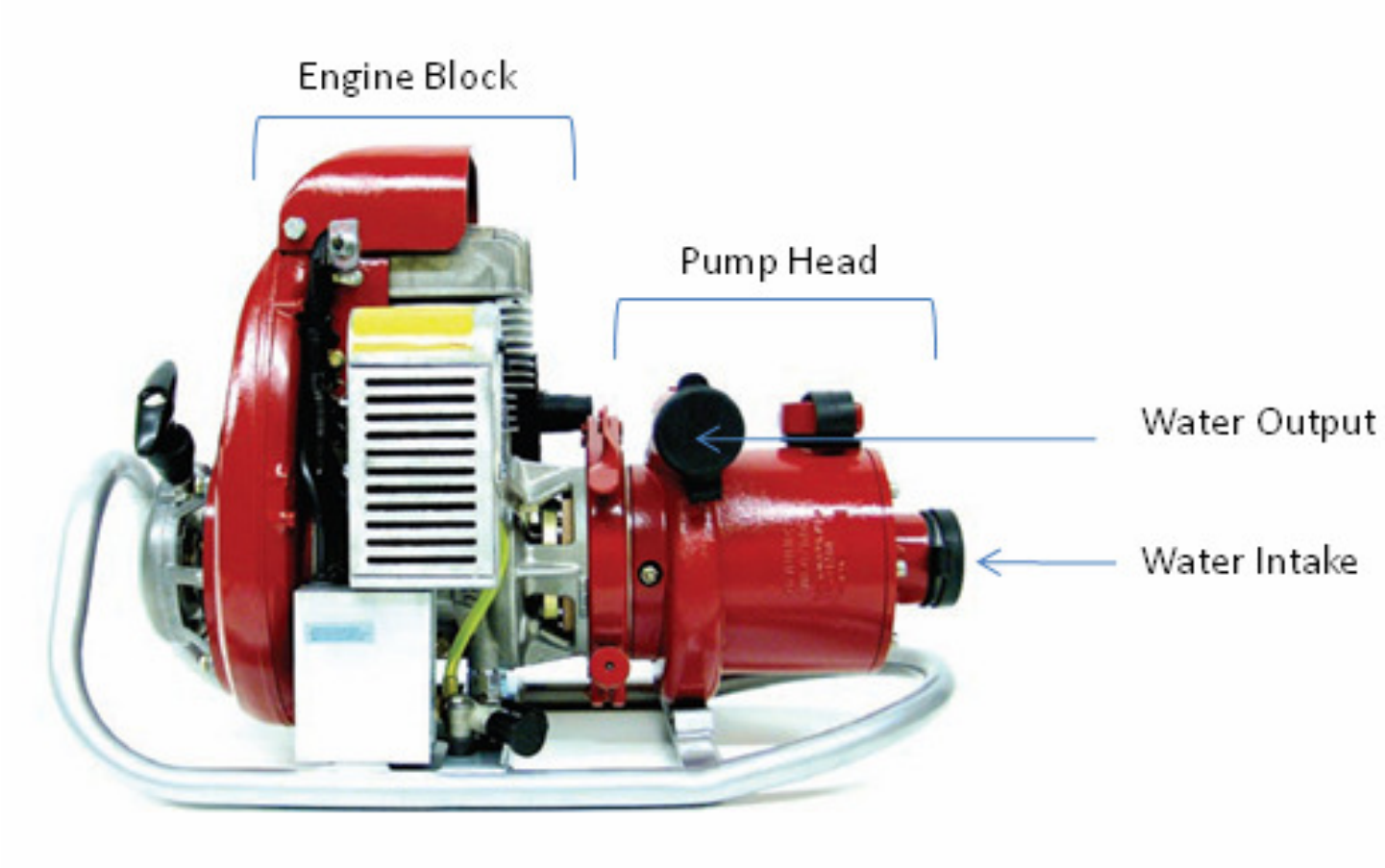
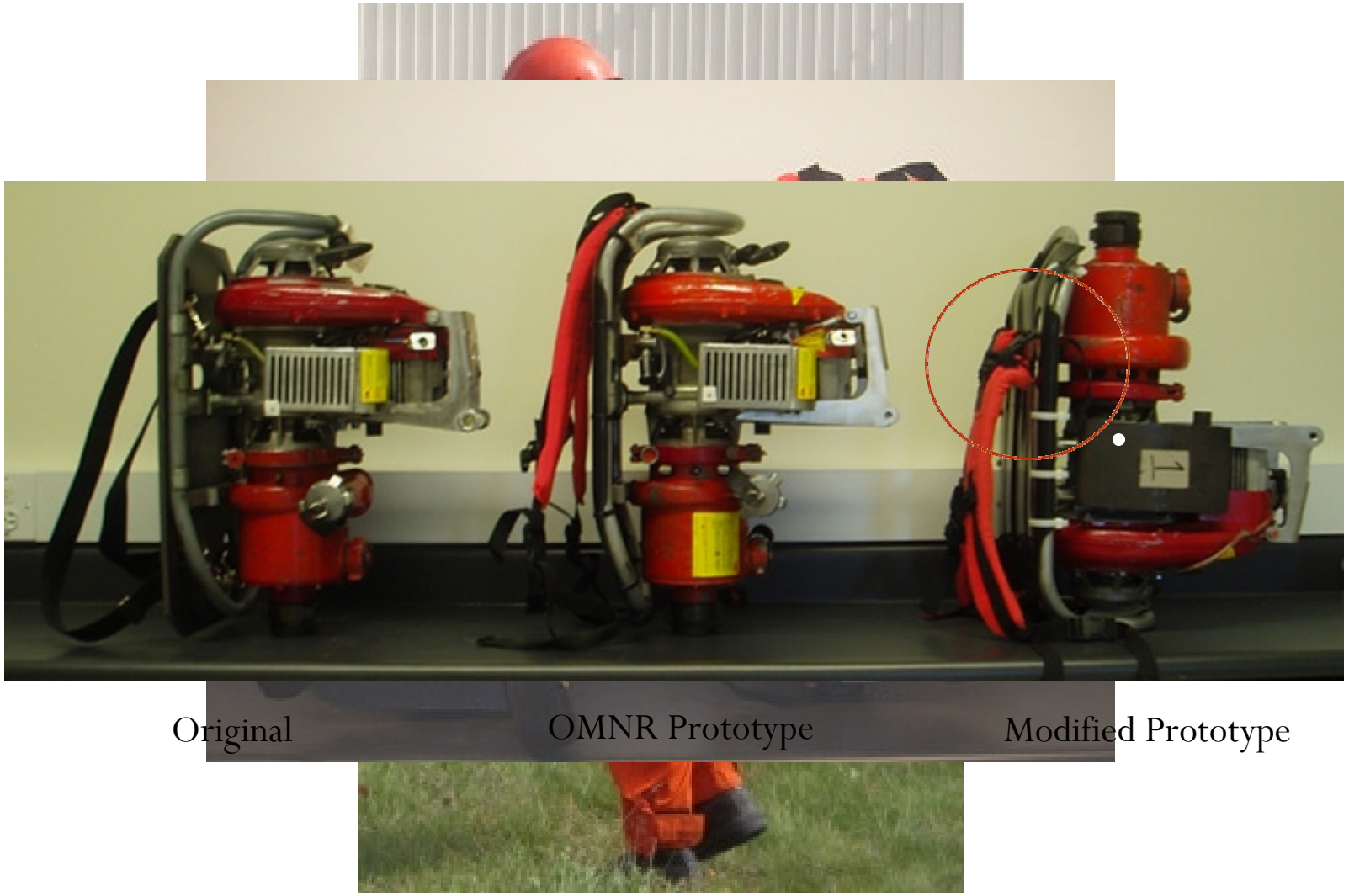
The Wildfire® Mark 3 Water Pump





Original OMNR Prototype Modified Prototype

Objectives

- To evaluate and compare the three M3 carriage systems in terms of SUBJECTIVE and OBJECTIVE data received during human-trial circuit simulations.

- Provide recommendations into carriage system features such as, strapping and load positioning, and how they can be utilized so that the Fire Rangers can benefit the most in terms of WORK EFFICIENCY and SAFETY.

Methods

FINISH START

Researcher

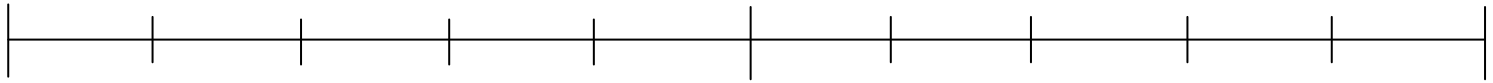
Subjective Ratings

Loading/Unloading

Discomfort

Stability

Overall



0

10

Very Easy	Extremely Difficult
Extremely Comfortable	Extremely Uncomfortable
Extremely Unstable	Extremely Stable
0	10

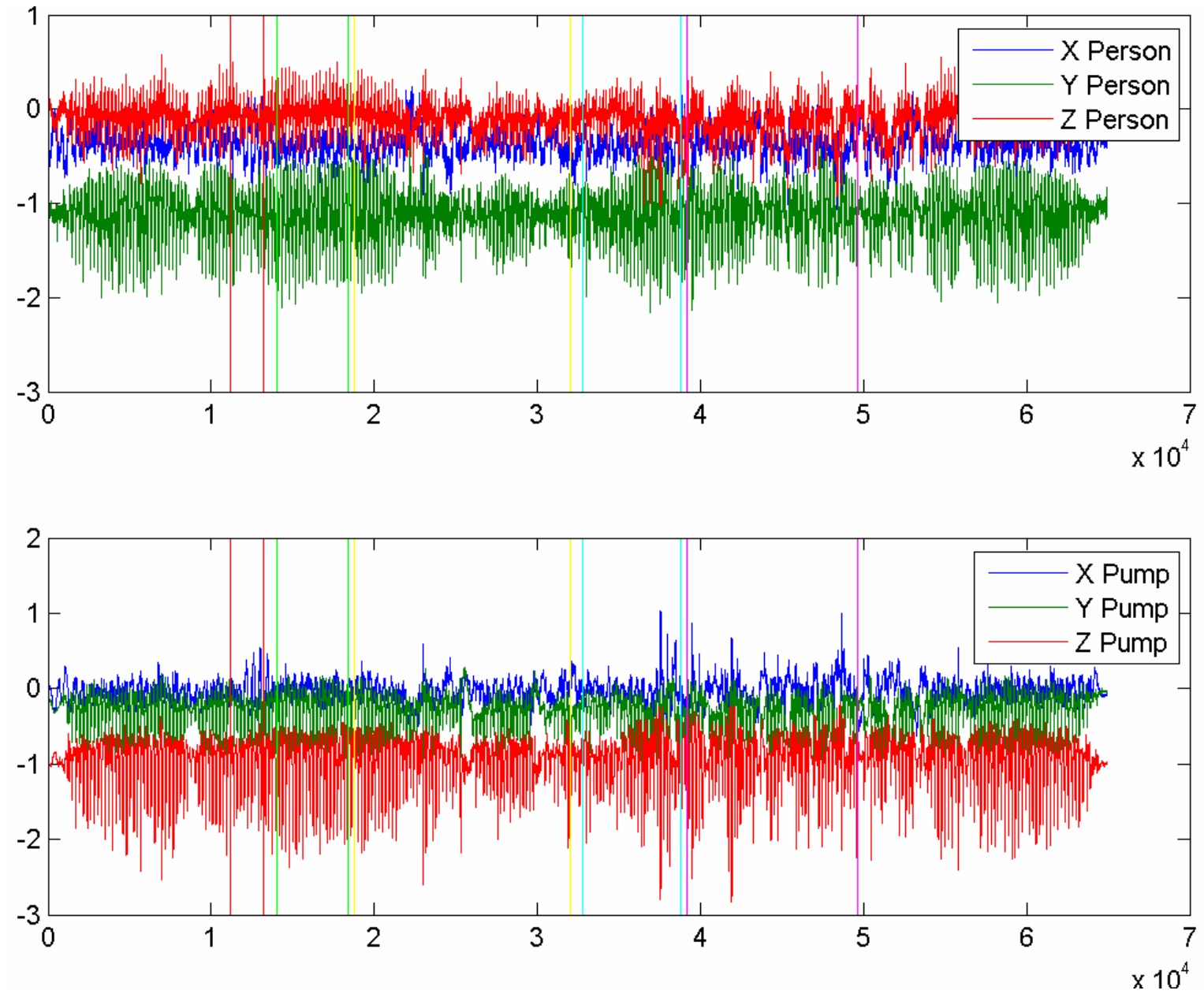
RANK

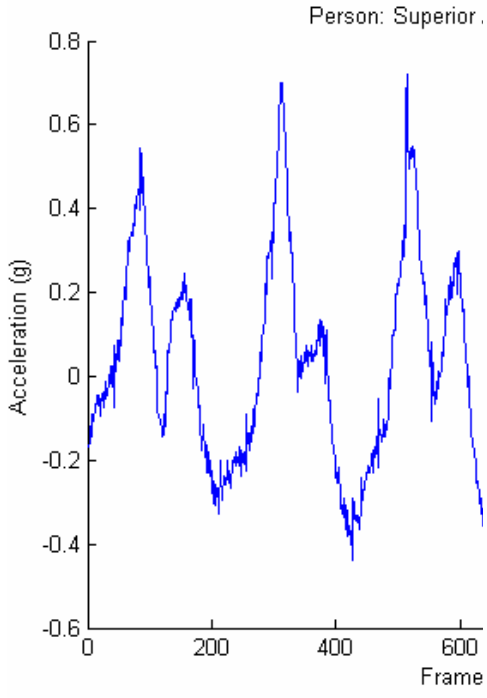
Original ____

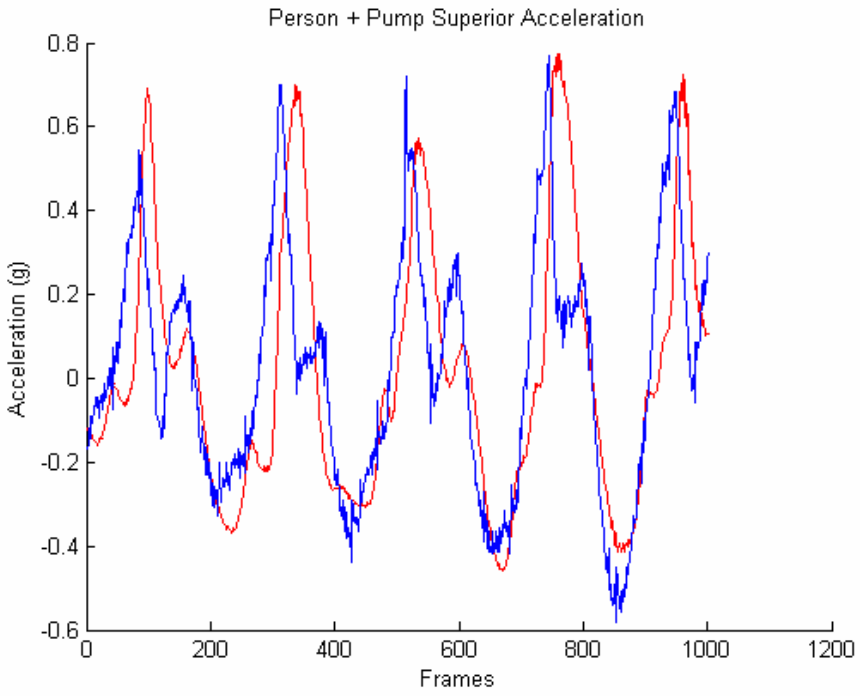
Modified ____

OMNR ____

Objective Results


X Person
Y Person
Z Person
x 10^4
X Pump
Y Pump
Z Pump
x 10^4

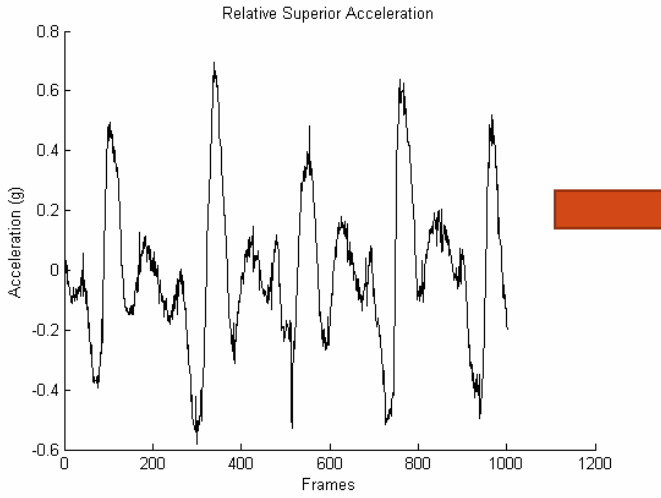

Person: Superior
Acceleration (g)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
200
400
600
Frame

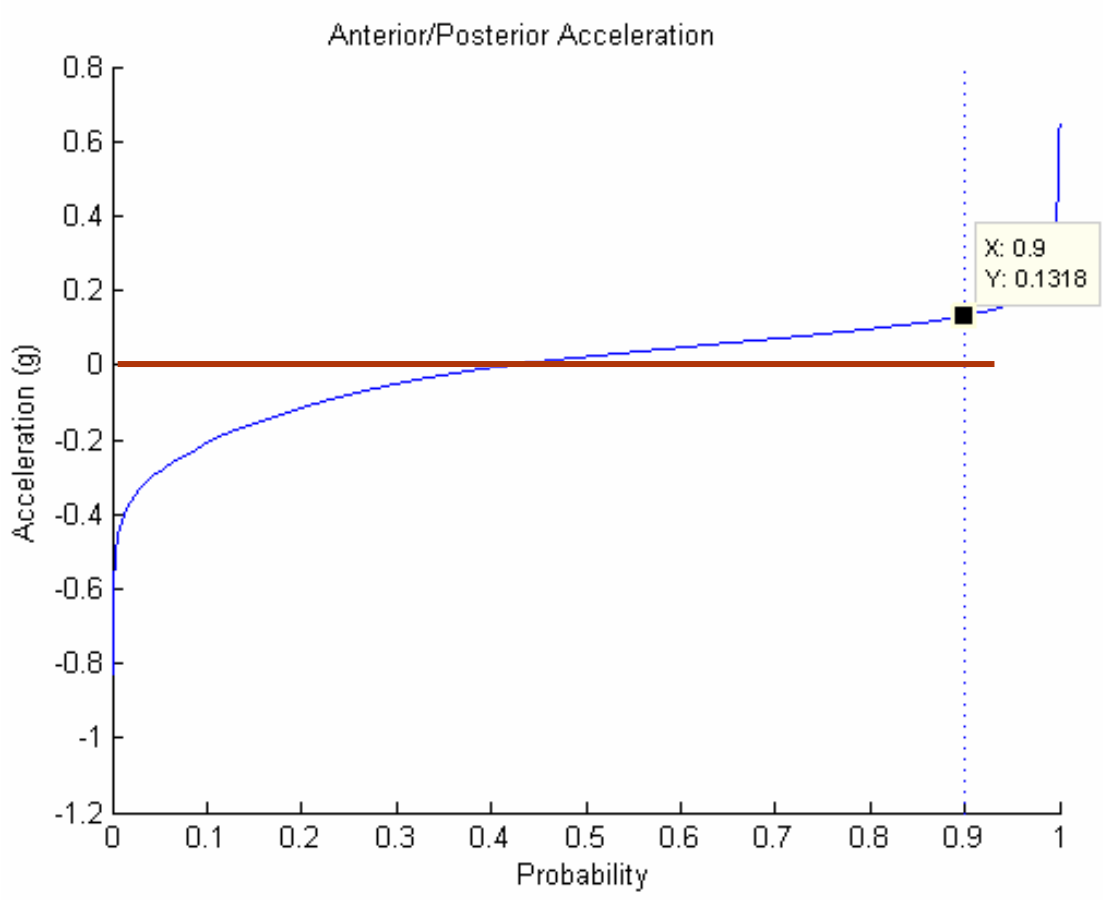

Person + Pump Superior Acceleration
Acceleration (g)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
200
400
600
800
1000
1200
Frames


uperior Acceleration
600
800
1000
1200
Frames

Acceleration Amplitude Distribution

Rank order accelerations from smallest to largest





Posterior Acceleration Amplitude

Anterior Acceleration Amplitude

Original

Original

*

OMNR Prototype

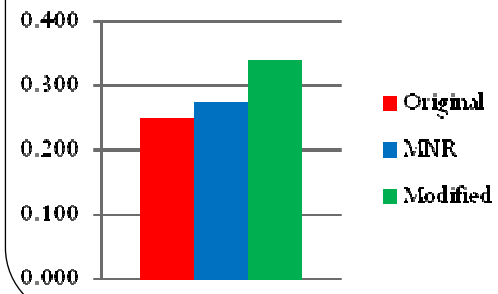
OMNR Prototype

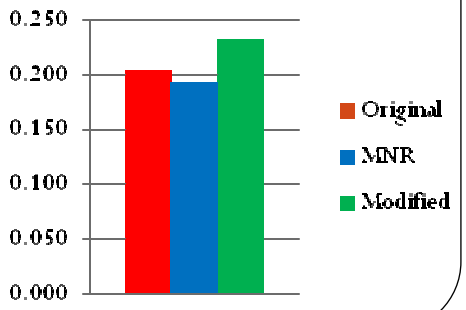
* *

Modified

Modified

* *





* Significantly greater than one other system

* * Significantly greater than two other systems

Right-Side Acceleration Amplitude

Left-Side Acceleration Amplitude

* Original

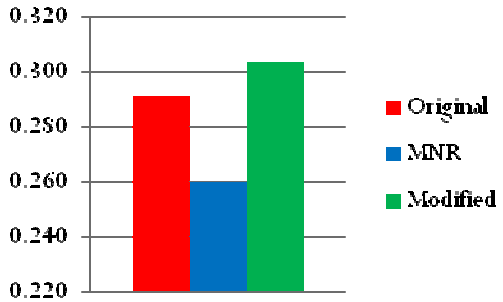
Original

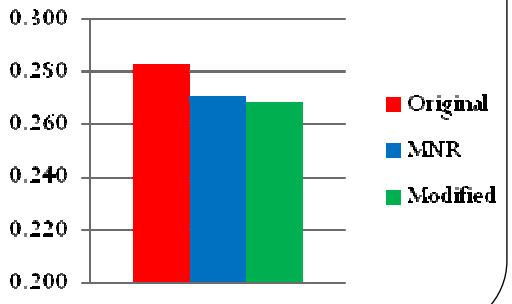
OMNR Prototype

OMNR Prototype

* Modified

Modified



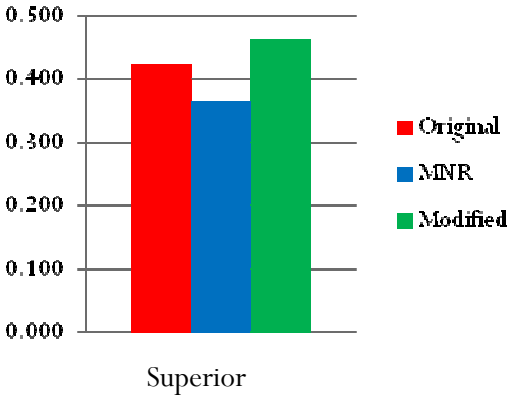


* Significantly greater than one other system

* * Significantly greater than two other systems

*

Original



Superior

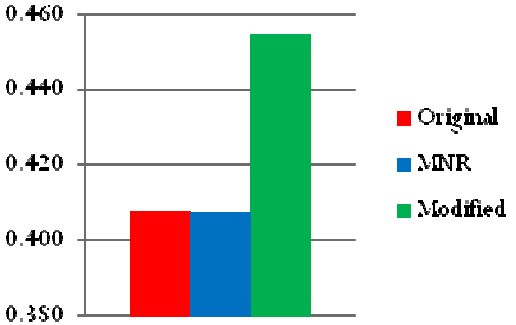
**

Modified

OMNR Prototype

Superior Acceleration Amplitude

Inferior Acceleration Amplitude



Inferior

Original

OMNR Prototype

Modified

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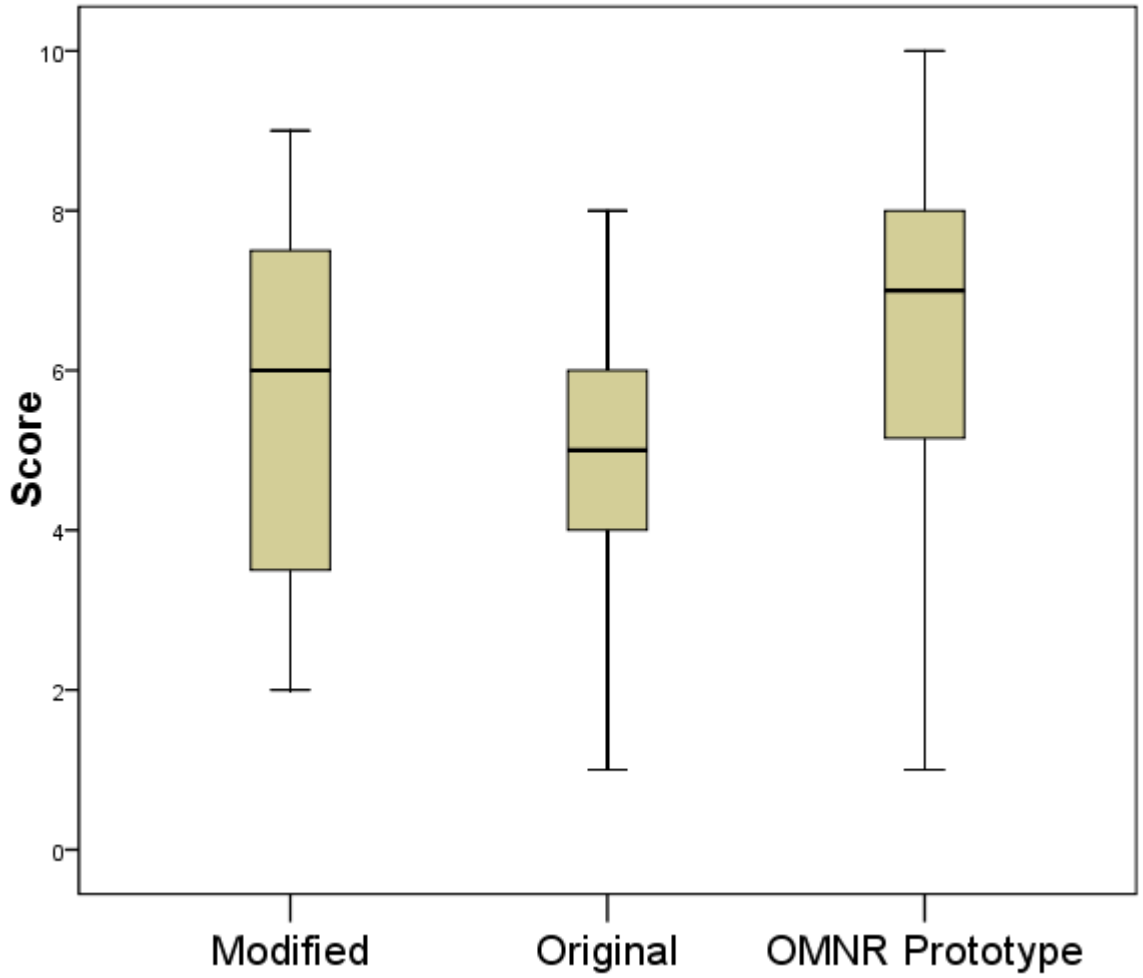
* Significantly greater than one other system

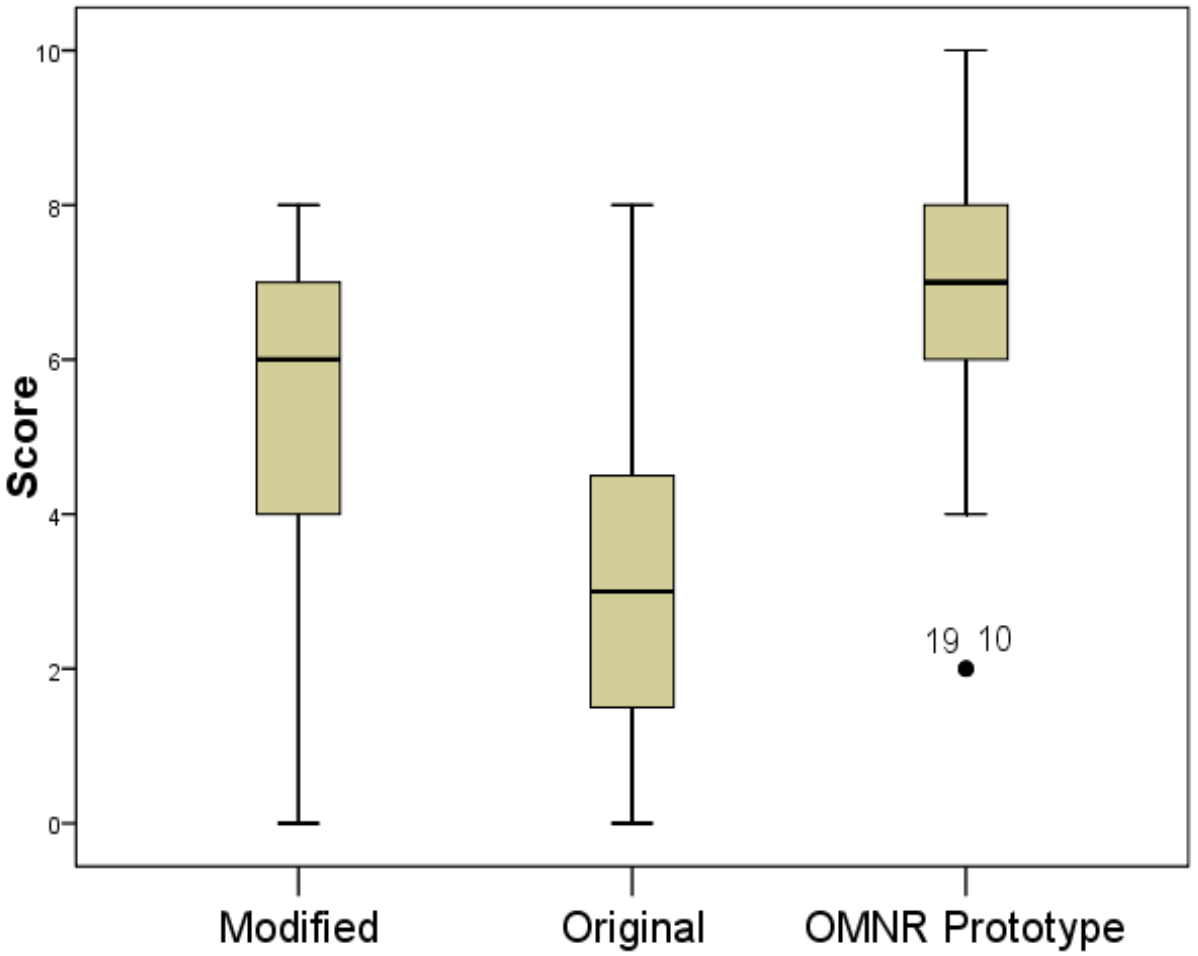
* * Significantly greater than two other systems

Subjective Results

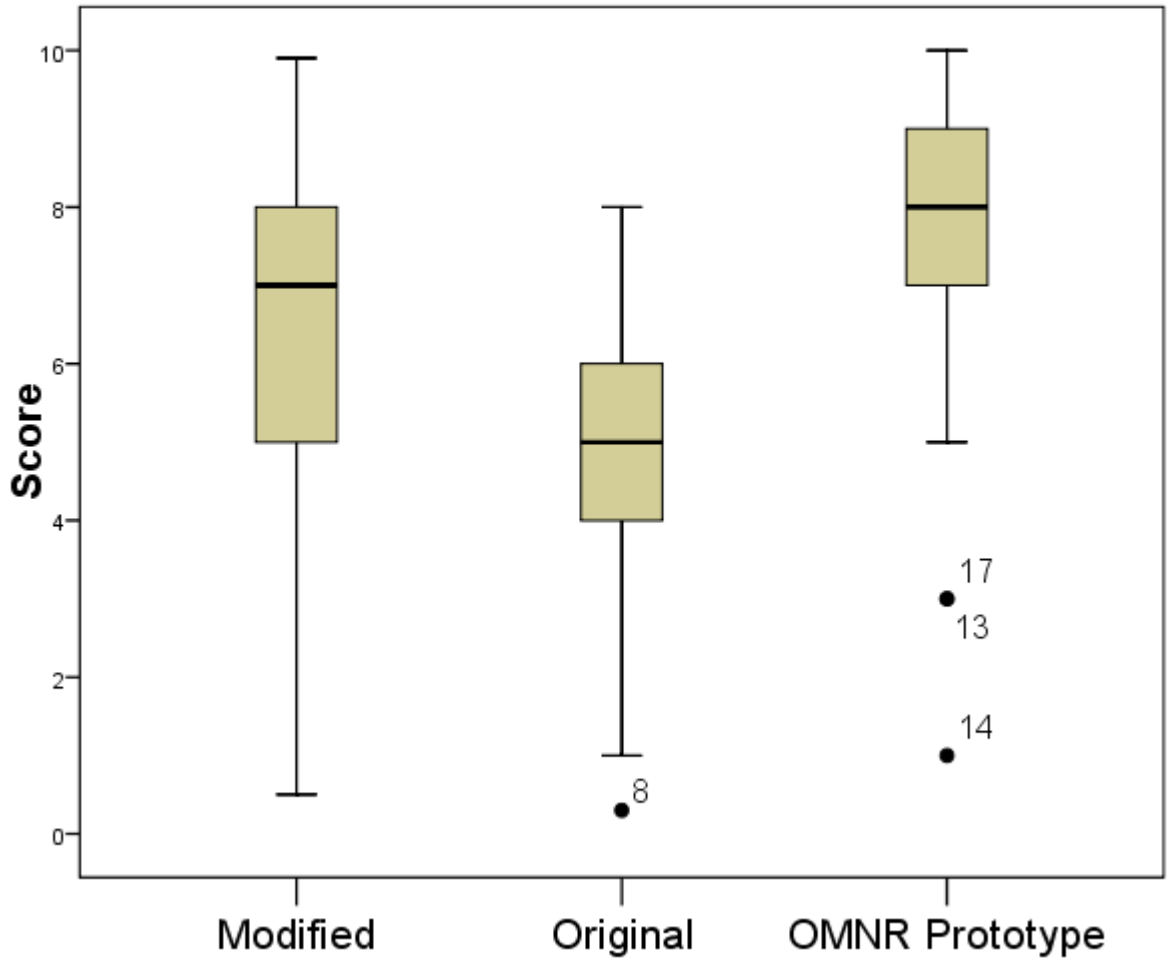
Ease of Donning /Doffing



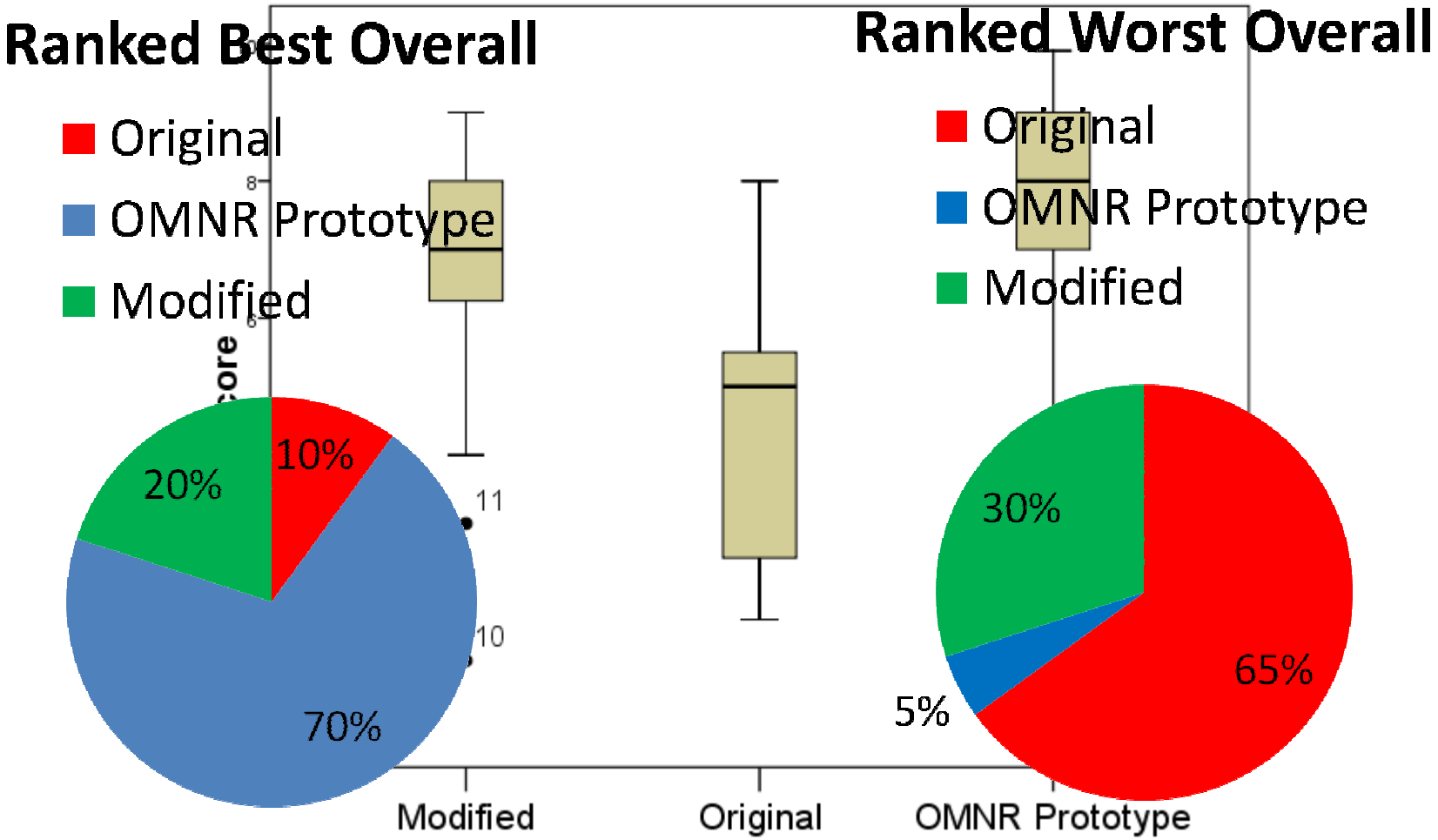
Comfort while Carrying



Stability while Carrying



Overall Score



Summary of Results

Analysis	Variables	Modified	Original	OMNR Prototype
Subjective	Ease of Loading/Unloading	2		
	Comfort	2		
	Stability	2		
	Overall	2		
Objective	Mean Anterior/Posterior Accel.	3		
	Mean Medial/Lateral Accel.	2		
	Mean Superior/Inferior Accel.	3		
	Anterior Accel. 50th	3		
	Posterior Accel. 50th	3		
	Left Side Accel. 50th	2		
	Right Side Accel. 50th	2		
	Superior Accel. 50th	3		
	Inferior Accel. 50th	3		
	Anterior Accel. 90th	3		
	Posterior Accel. 90th	3		
	Left Side Accel. 90th	1		
	Right Side Accel. 90th	3		
	Superior Accel. 90th	3		
	Inferior Accel. 90th	3		
	Anterior/Posterior Median Freq	3		
	Medial/Lateral Median Freq	2		
	Superior/Inferior Median Freq	1		
TOTAL SCORE		**53**		

Analysis	Variables	Modified	Original	OMNR Prototype
Subjective	Ease of Loading/Unloading	2	3	
	Comfort	2	3	
	Stability	2	3	
	Overall	2	3	
Objective	Mean Anterior/Posterior Accel.	3	1	
	Mean Medial/Lateral Accel.	2	3	
	Mean Superior/Inferior Accel.	3	2	
	Anterior Accel. 50th	3	1	
	Posterior Accel. 50th	3	1	
	Left Side Accel. 50th	2	3	
	Right Side Accel. 50th	2	3	
	Superior Accel. 50th	3	2	
	Inferior Accel. 50th	3	2	
	Anterior Accel. 90th	3	2	
	Posterior Accel. 90th	3	1	
	Left Side Accel. 90th	1	3	
	Right Side Accel. 90th	3	2	
	Superior Accel. 90th	3	2	
	Inferior Accel. 90th	3	2	
	Anterior/Posterior Median Freq	3	1	
	Medial/Lateral Median Freq	2	1	
	Superior/Inferior Median Freq	1	2	
TOTAL SCORE		**53**	**46**	

Analysis	Variables	Modified	Original	OMNR Prototype
Subjective	Ease of Loading/Unloading	2	3	1
	Comfort	2	3	1
	Stability	2	3	1
	Overall	2	3	1
Objective	Mean Anterior/Posterior Accel.	3	1	2
	Mean Medial/Lateral Accel.	2	3	1
	Mean Superior/Inferior Accel.	3	2	1
	Anterior Accel. 50th	3	1	2
	Posterior Accel. 50th	3	1	2
	Left Side Accel. 50th	2	3	1
	Right Side Accel. 50th	2	3	1
	Superior Accel. 50th	3	2	1
	Inferior Accel. 50th	3	2	1
	Anterior Accel. 90th	3	2	1
	Posterior Accel. 90th	3	1	2
	Left Side Accel. 90th	1	3	2
	Right Side Accel. 90th	3	2	1
	Superior Accel. 90th	3	2	1
	Inferior Accel. 90th	3	2	1
	Anterior/Posterior Median Freq	3	1	2
	Medial/Lateral Median Freq	2	1	3
	Superior/Inferior Median Freq	1	2	3
TOTAL SCORE		**53**	**46**	**32**

Discussion

- A superior load carriage system minimizes any differences in relative motion in all directions thus providing maximal control (Hinrichs et al. 1982; Stevenson et al. 2004).

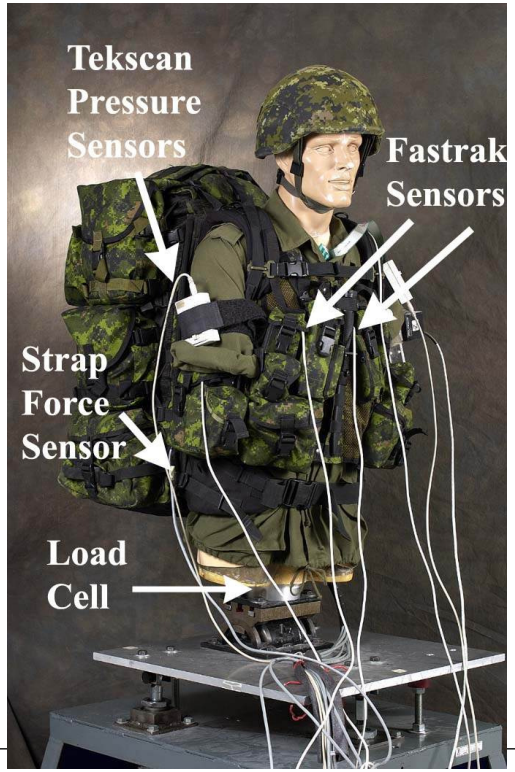
- The payload (weight being carried) and the carrier's body should move in unison in order to provide stability and to minimize energy expenditure (Hinrichs et al. 1982).

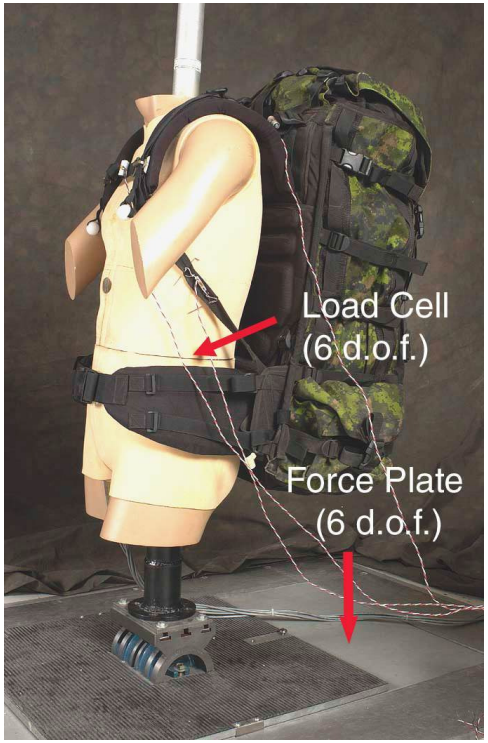
- A harmonic system avoids the potential for local tissue damage and minimizes any distraction that may be associated with repetitive striking of the weight against the body (Hinrichs et al. 1982).

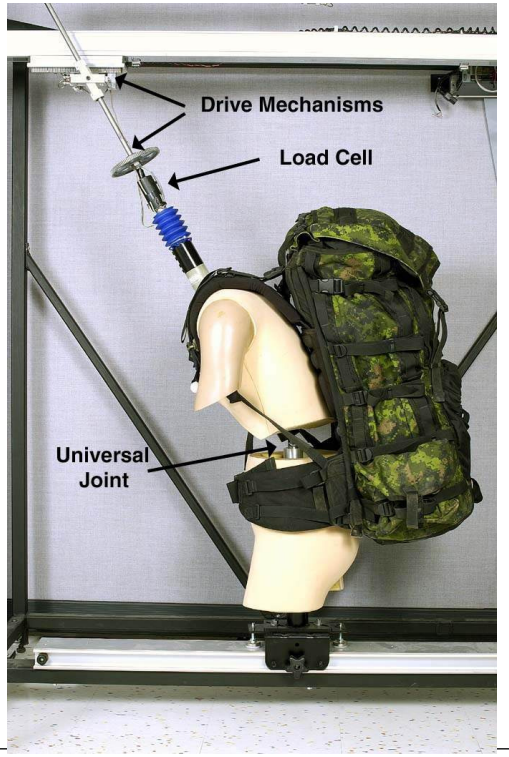
Analysis	Variables	Modified	Original	OMNR Prototype
Subjective	Ease of Loading/Unloading	2	3	1
	Comfort	2	3	1
	Stability	2	3	1
	Overall	2	3	1
Objective	Mean Anterior/Posterior Accel.	3	1	2
	Mean Medial/Lateral Accel.	2	3	1
	Mean Superior/Inferior Accel.	3	2	1
	Anterior Accel. 50th	3	1	2
	Posterior Accel. 50th	3	1	2
	Left Side Accel. 50th	2	3	1
	Right Side Accel. 50th	2	3	1
	Superior Accel. 50th	3	2	1
	Inferior Accel. 50th	3	2	1
	Anterior Accel. 90th	3	2	1
	Posterior Accel. 90th	3	1	2
	Left Side Accel. 90th	1	3	2
	Right Side Accel. 90th	3	2	1
	Superior Accel. 90th	3	2	1
	Inferior Accel. 90th	3	2	1
	Anterior/Posterior Median Freq	3	1	2
	Medial/Lateral Median Freq	2	1	3
	Superior/Inferior Median Freq	1	2	3
TOTAL SCORE		**53**	**46**	**32**

Recommendations (Objective)

- Can the Mass and Moment of Inertia of the pump be lightened?
- What is the durability of the materials used in any redesign?
- Can the Pump/Fire Ranger interface be further improved?







Recommendations (Subjective)

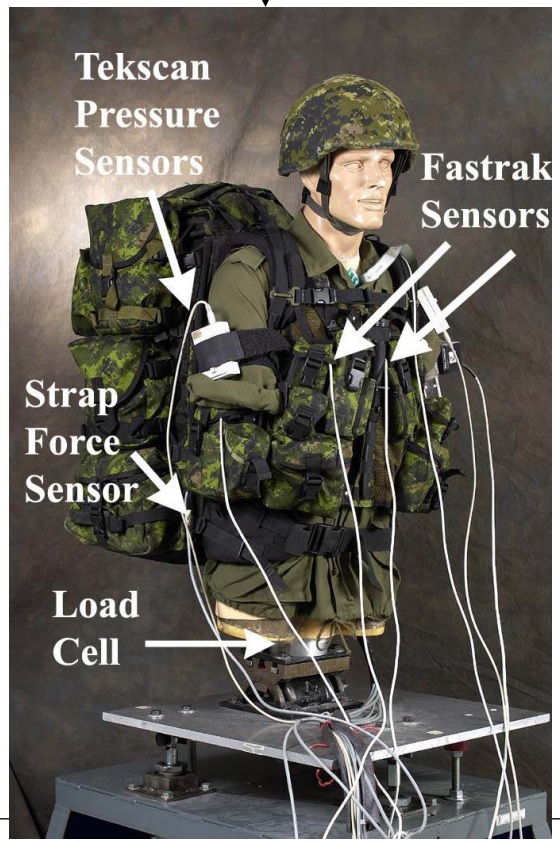
- Safety/Convenience of loading/unloading trucks and helicopters
- Allow actual field testing with more Fire Rangers

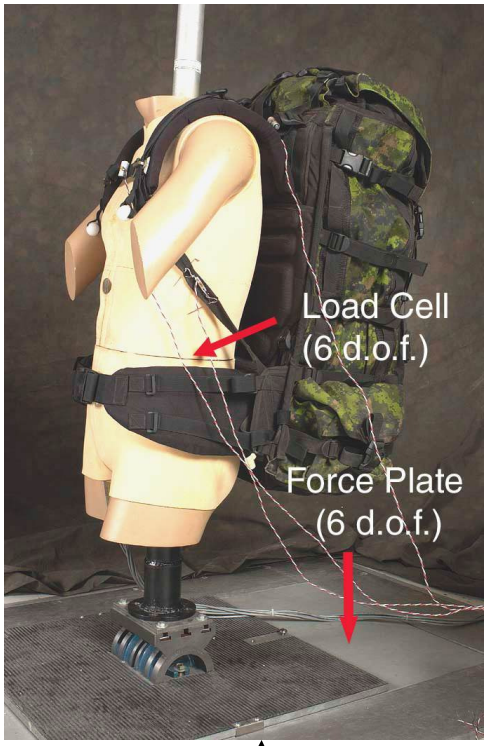
OVERALL RECOMMENDATON

OMNR Prototype be implemented into the fire suppression system.

Objective Assessment Tools

Load Carriage Simulator





Load Distribution Mannequin

Compliance Tester

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Thank You!

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