

*Human simulation addressing
physical performance & injury
prevention*

THE **SCIENCE** OF **SPORTS**

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Deviation from Neutral

Spine

Right Arm

Left Arm

Neck

Right Leg

What is Human Simulation?

CHANGING MEDICINE.
CHANGING LIVES.®

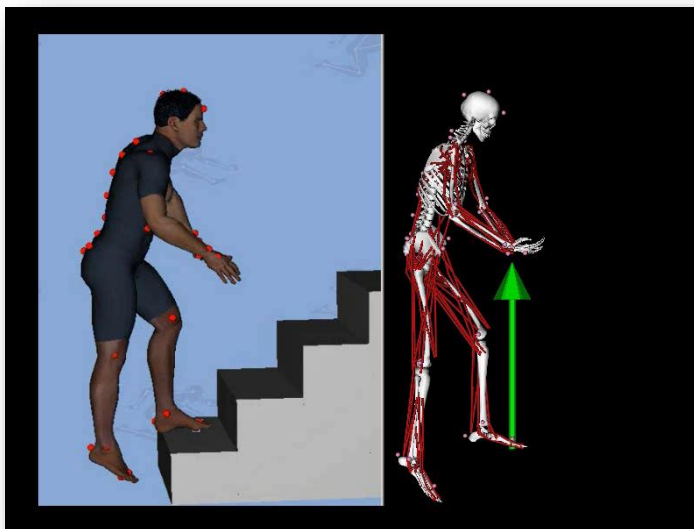
Task



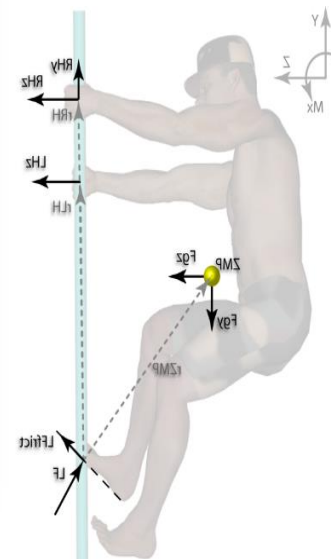
Modeling



Simulation



Analysis

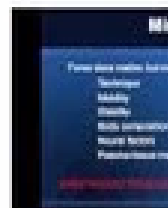




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Center for the Intrepid



No Backpack



90 Kg (198 lb) Backpack



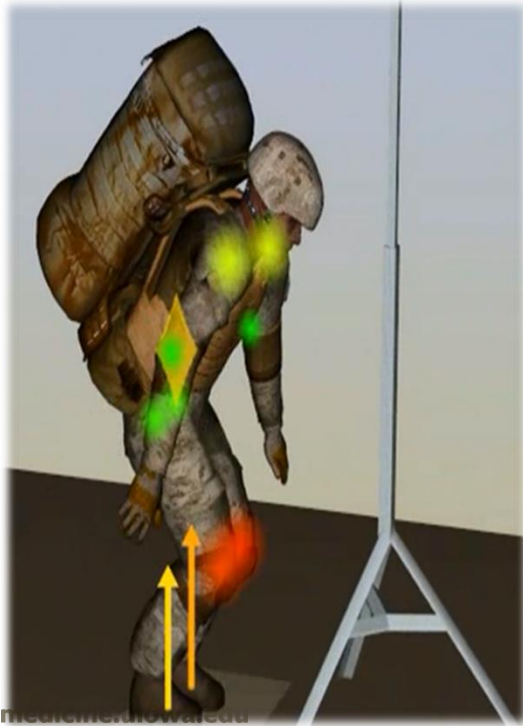
100 Kg (220 lb)
Backpack



Human simulation can reduce injuries

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- Majority of injuries (~ 86.5%) are non-battle injuries.
- In 2006 (Hauret, et al.) reported 743,547 MSK injuries



2

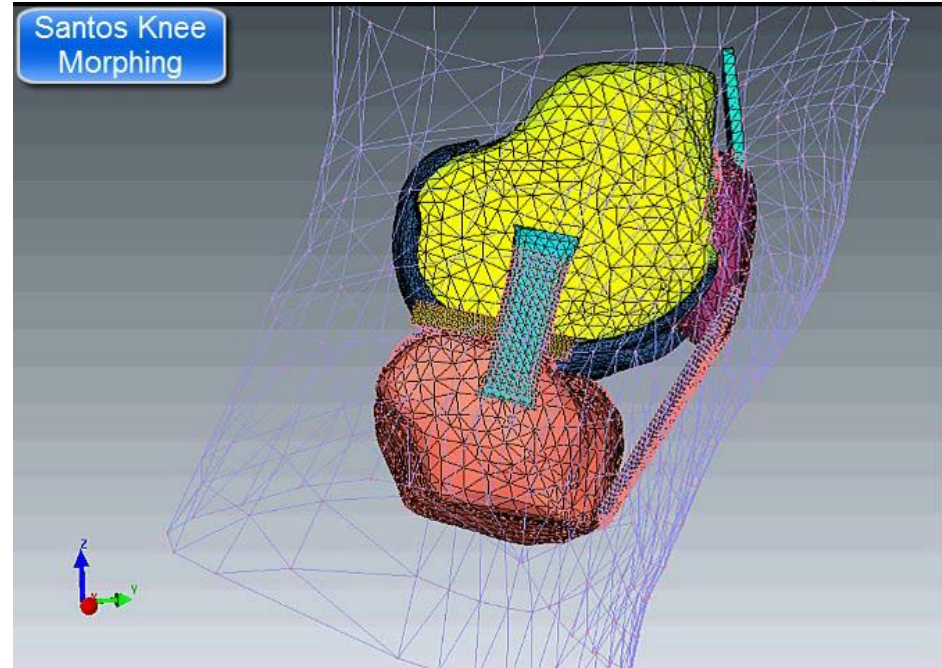
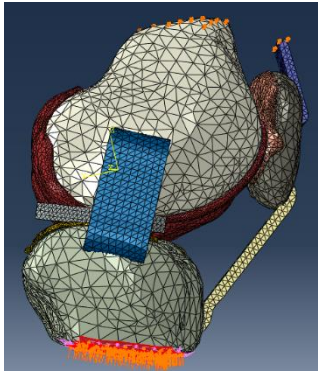
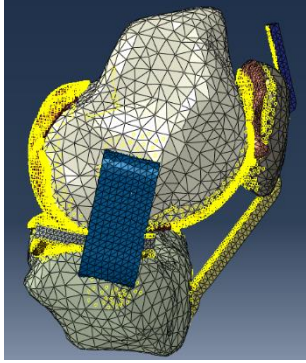
Reduce injuries

Human
Performance
Protection
Sustainment



Knee Model

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Loading

Contact surfaces

Integration of Human Physiology and Santos

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Total Equipment Weight: 49.83 Pounds

Name	Quantity	Weight	
^ Total By Group			
Clothing:	10	9.83	
Equipment:	5	39.48	
Additional Items:	0	0	
^ Clothing			
USMC_R_boot	1	2.05	X
Knee_pad_R	1	0.5	X
Elbow_pad_L	1	0.5	X
Frog_glove_R	1	0.165	X
Frog_glove_L	1	0.165	X
EFCE_shirt	1	1.2	X
Elbow_pad_R	1	0.5	X
USMC_L_boot	1	2.05	X
Knee_pad_L	1	0.5	X
EFCE_pants	1	2.2	X
^ Equipment			
IMTV Vest M	1	14.37	X
Ammo Pouch	1	1.9	X
Tourniquet	1	0.13	X
First Aid Kit	1	1	X
USMC Assault Pack	1	22.08	X
^ Additional Items			
(Empty List)			

Inventory Manager



Factors To Be Modeled

Multiple terrain options

Different fitness levels

Walking inclines

Walking speeds



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Energy expenditure and other physiology parameters as outputs

Environmental conditions (heat, humidity, wind, altitude)

Relevant Physiology Parameters

Physiological Performance

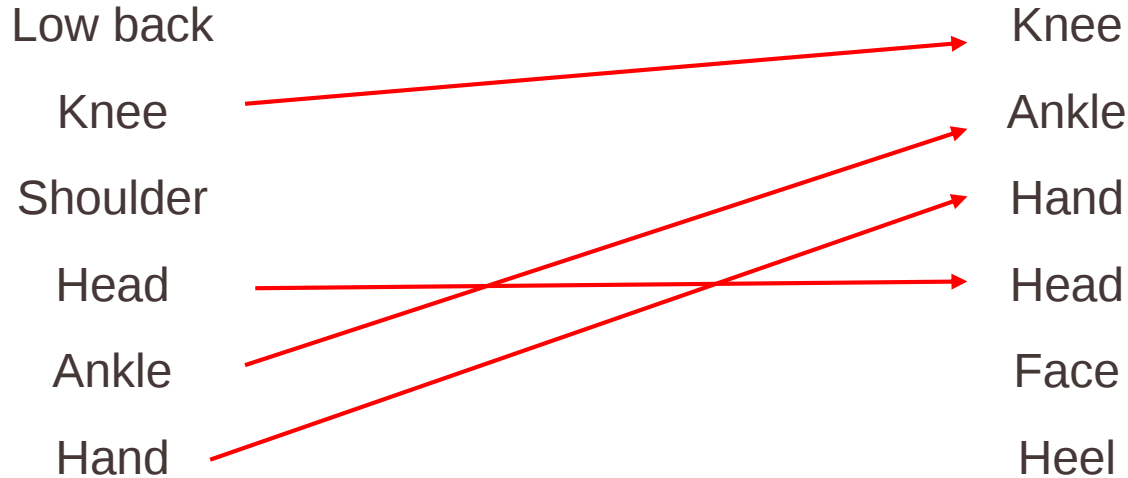
- Heart rate
- Energy expenditure
- Perceived exertion
- Hydration status
- O₂ consumption & work capacity
- Thermal outputs (core temperature)



Injury Overlap – Military vs Athletics

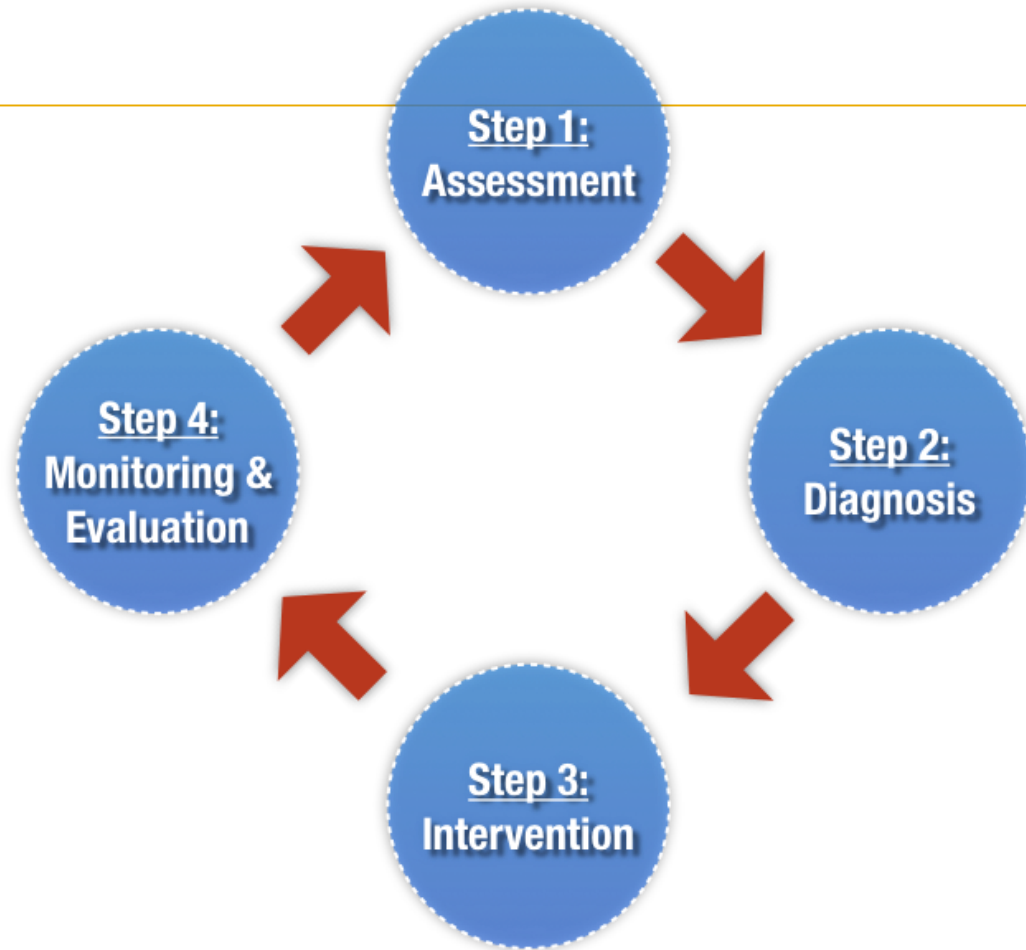
**Body areas injured during
12-mo deployment to Afghanistan**

**Top body areas injured
in sports**

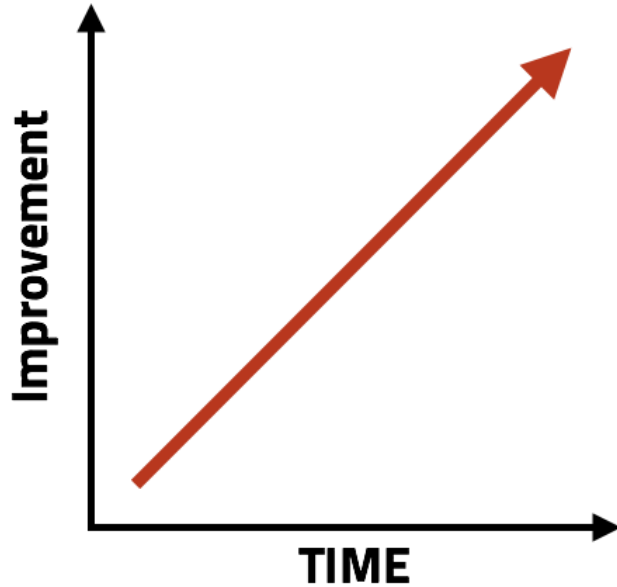


Process of Operations

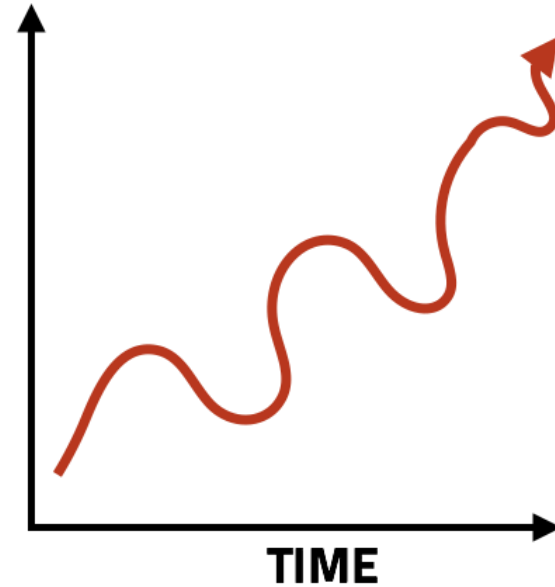
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Monitoring



What we want it
to be like



What we know is
reality

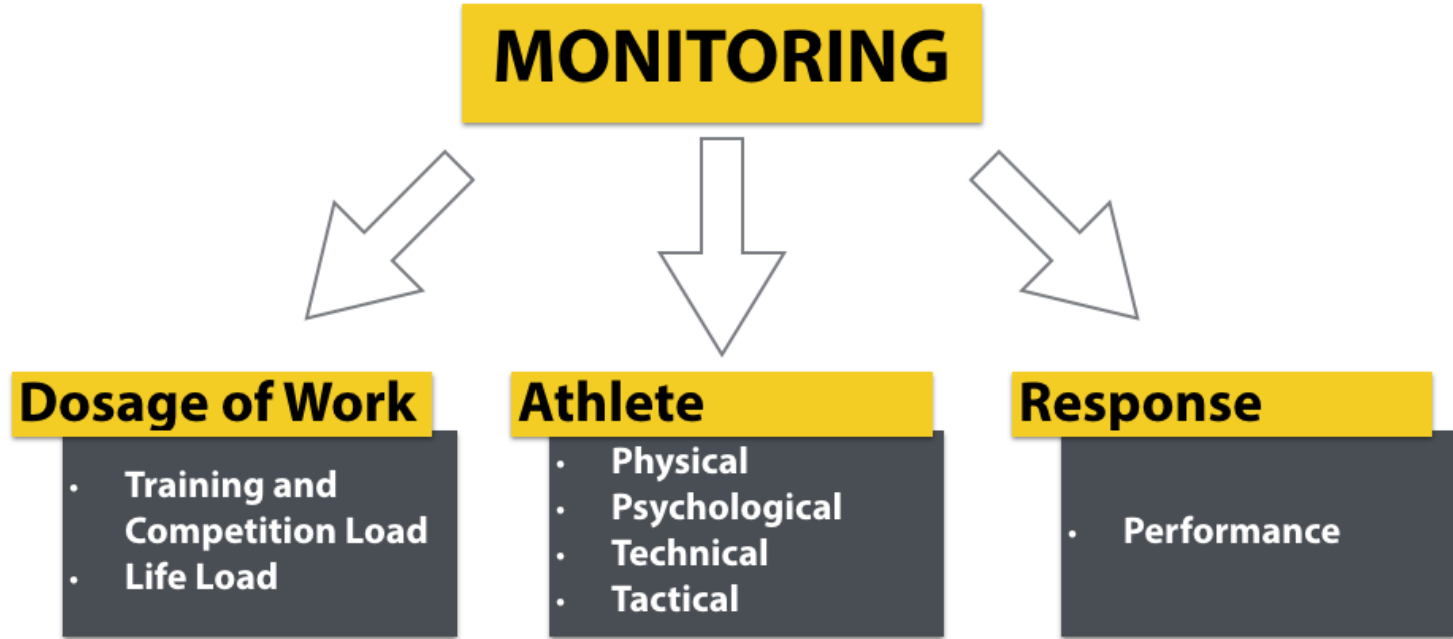
“The responses from any training will not result in readily predictable fitness outcomes.” *JOHN KIELY*

Complicated vs Complex

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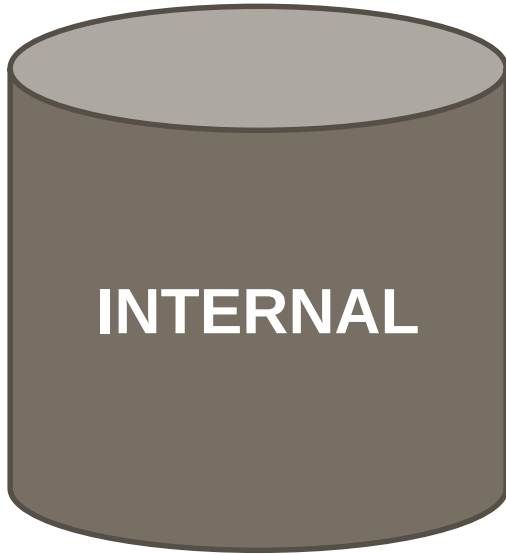


What is Monitoring?



IOWA Monitoring

Some ways we utilize monitoring to better support our student-athletes



IOWA Monitoring – Subjective Questionnaire

INTERNAL Applications

Duration of Sleep:  None 8+ Hours

Rate the quality of your sleep:  Didn't Sleep Not Interrupted And Excellent

Rate your nutrition from yesterday:  0-1 Meals, No Snacks, <2 Cups Fluid 3 Meals, 2-3 Snacks, >10 Cups Fluid

Rate your level of fatigue:  Severe None

Rate your level of stress:  Severe None

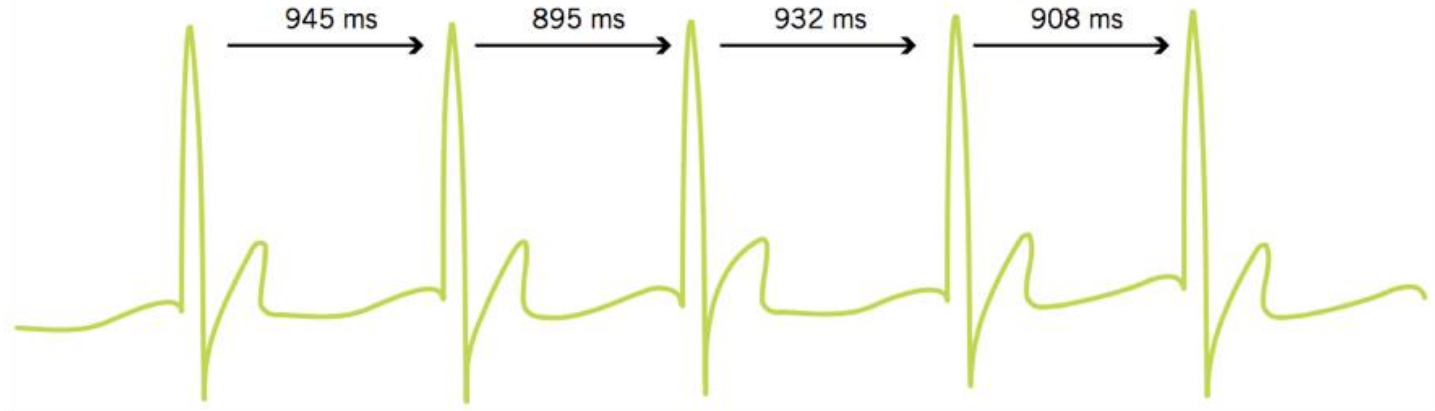
School Stress:  Severe None

Wellness Composite Score:

Comments:

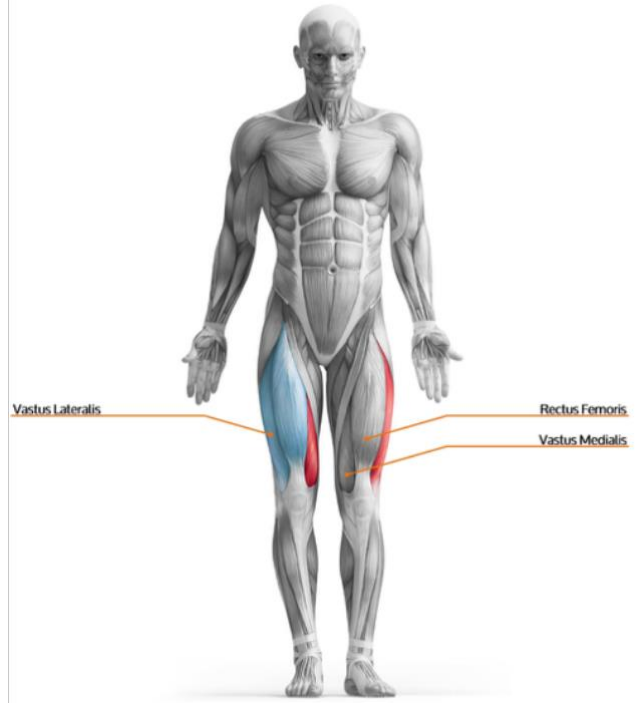
IOWA Monitoring – Heart Rate Variability

INTERNAL Applications



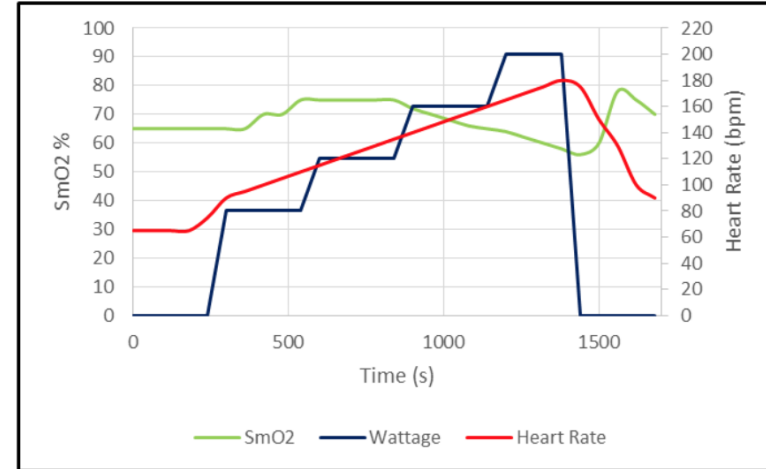
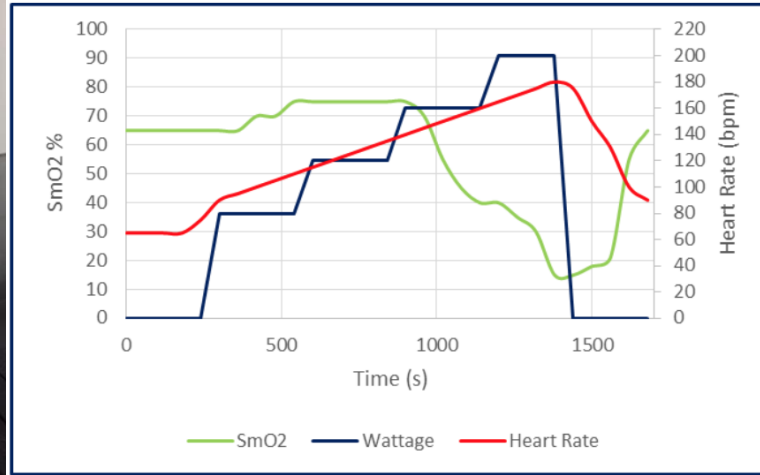
IOWA Monitoring – Local Muscle

INTERNAL Applications



IOWA Monitoring – Local Oxygen Sensor

INTERNAL Applications



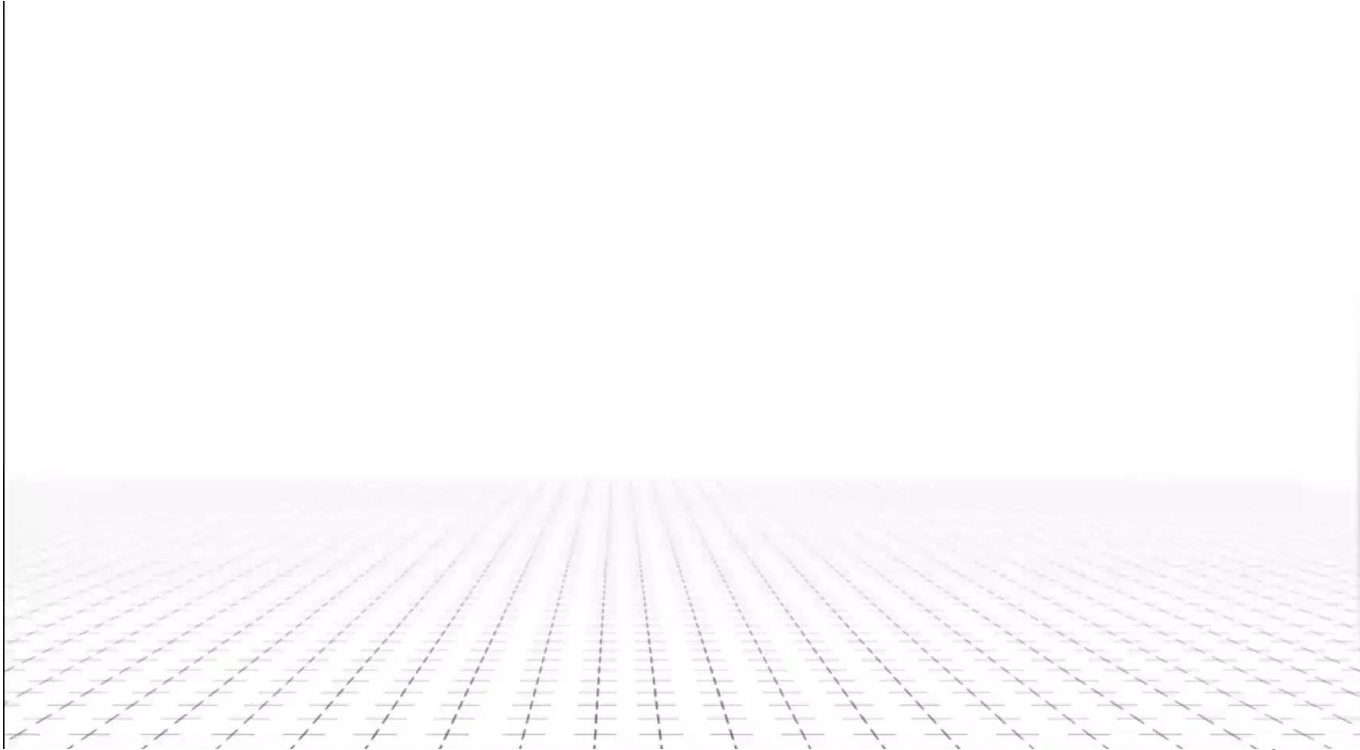
IOWA Monitoring – Player Tracking

EXTERNAL Applications



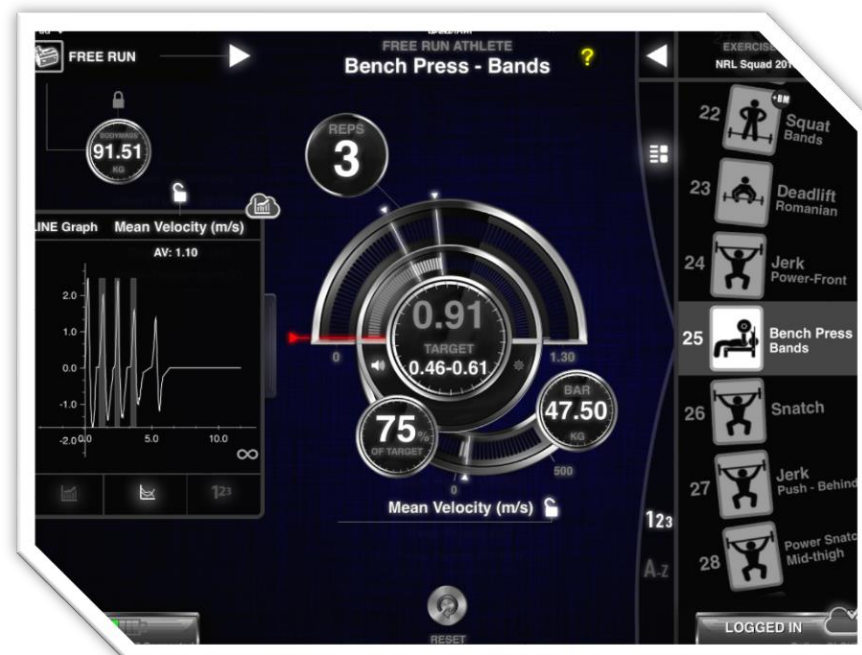
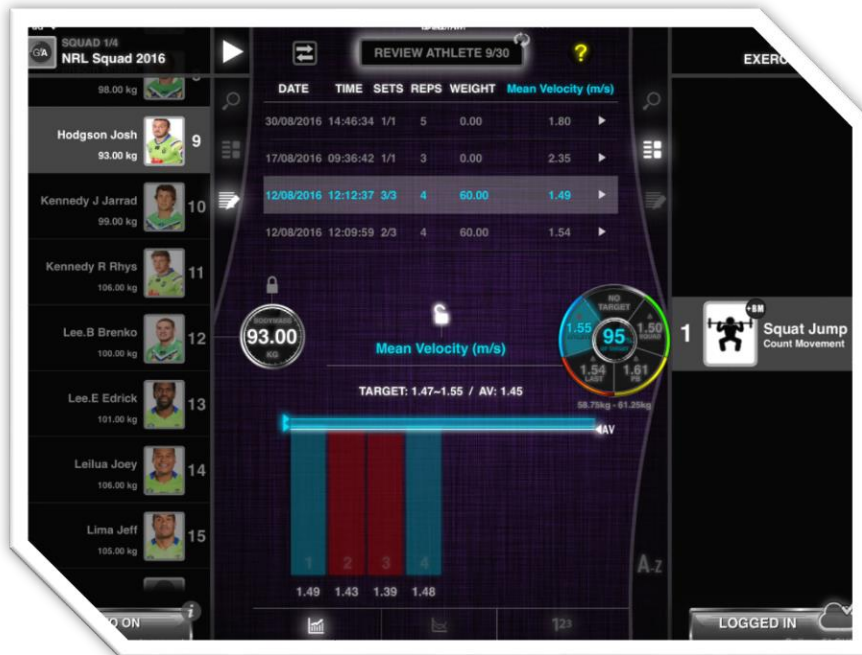
IOWA Monitoring – Jump Analysis

EXTERNAL Applications



IOWA Monitoring – Weight Room

EXTERNAL Applications

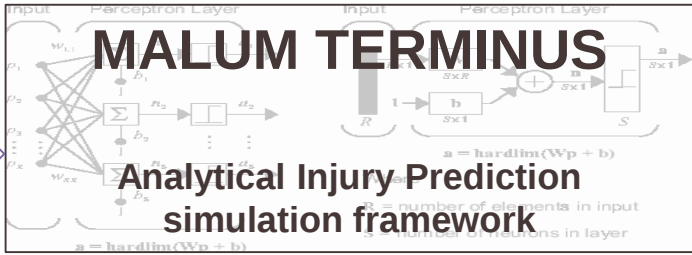


FUTURE with VSR



Subject 1

- Age, Gender
- Weight
- Strength
- Flexibility
- Physiology
- Training Load
- Past injuries
- ...



- Propensity for Injury
- Physiological performance
- Biomechanical performance

+ Heuristics and Intuition

