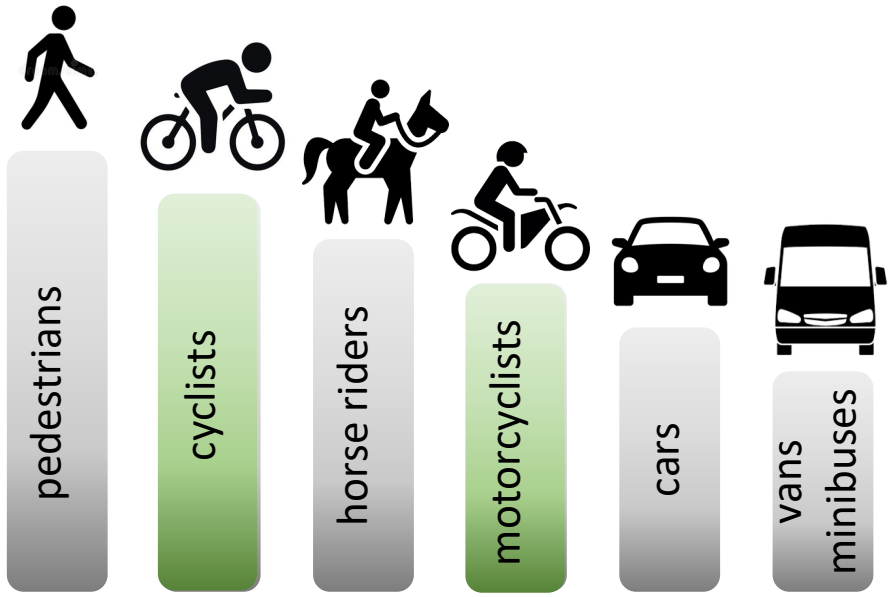
Positioning Human Body Models based on experimental data

MARIA OIKONOMOU[1], ATHANASIOS LIORAS[2], LAMBROS RORRIS[3], JOHAN IRAEUS[4], ATHANASIOS MIHAILIDIS[1]

[1]Aristotle University of Thessaloniki, [2]BETA CAE Systems SA,
[3]BETA CAE Systems International AG, [4]Chalmers University of Technology

BETA
SIMULATION SOLUTIONS

Introduction



Hierarchy of Road Users

Lessened protection **Capability restrictions**

Higher casualty rate

Human Body Models (HBMs)

- Finite Elements Models
- Accurately Represent Human Body
- Multiple HBMs Models
- Specific Postures: Occupant & Pedestrian

Move to Alternative Positions

Contents

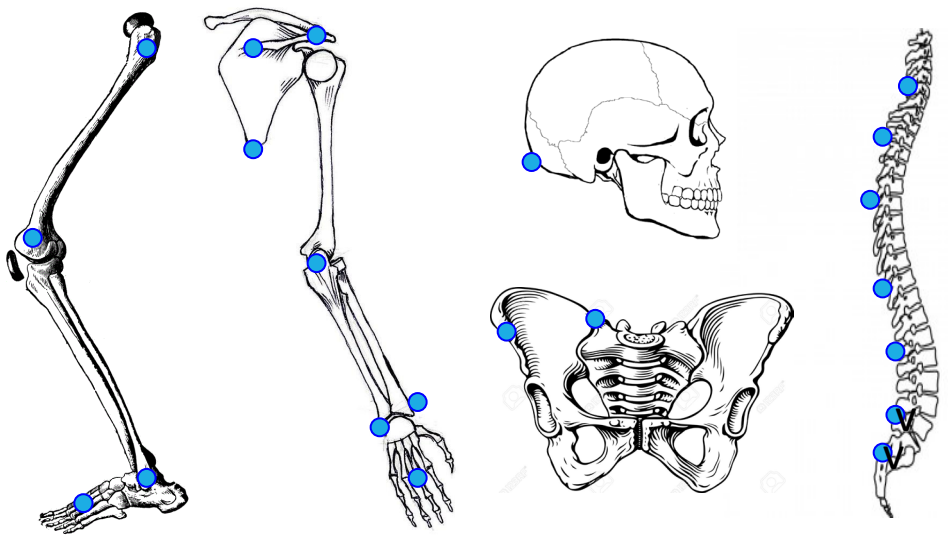
- Correlation between HBM & Subject
- Extraction of Experimental Data
- Data Analysis
- Optimized Positioning of HBM
- Implementation in a bicyclist
- HBM's & Subject's Posture Comparison

Easy Entry Bike

Racing Bike

Correlation between HBM & Subject

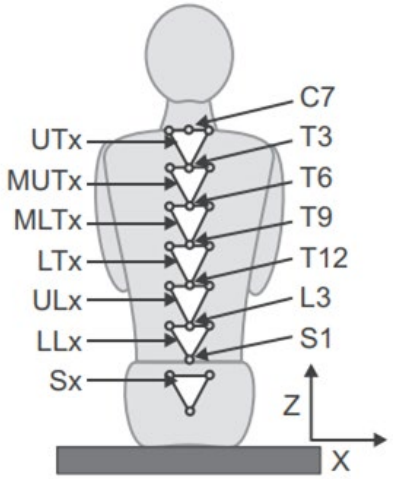
- ANSA Articulation Tool ⇨ Bones' Anatomical Landmarks
- Whole Body Positioning ⇨ Positioning of Anatomical Landmarks

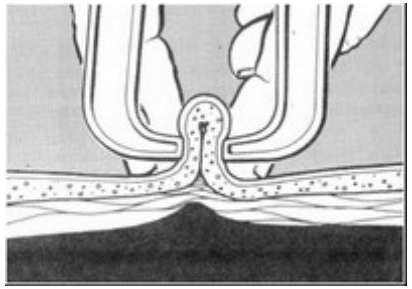


Extraction of Experimental Data

- Imaging Techniques
- Skin Marker Techniques

Error:
"Non-Bone" Measurements



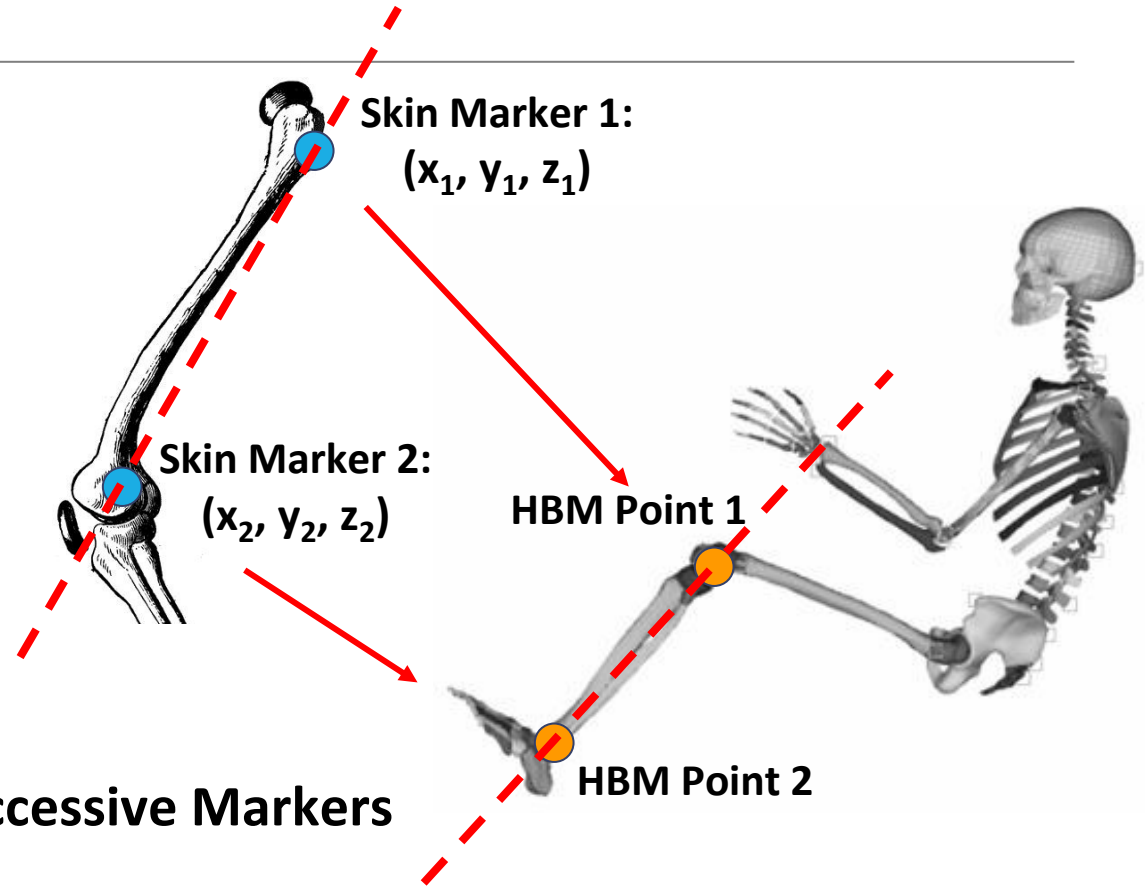


Skinfold Thickness

Data Analysis

- Anatomical Differences

⇨ Not Direct use of Subject's Coordinates



- **Same slopes:**

  Successive HBM's Points & Subject's Successive Markers

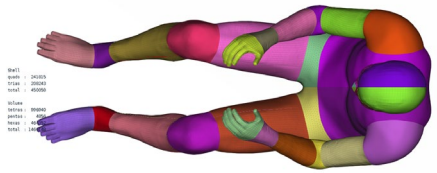
Optimized Positioning

- Repetitive Articulation Procedure
  - Non constant articulation step
- Calculation of Slopes' Differences

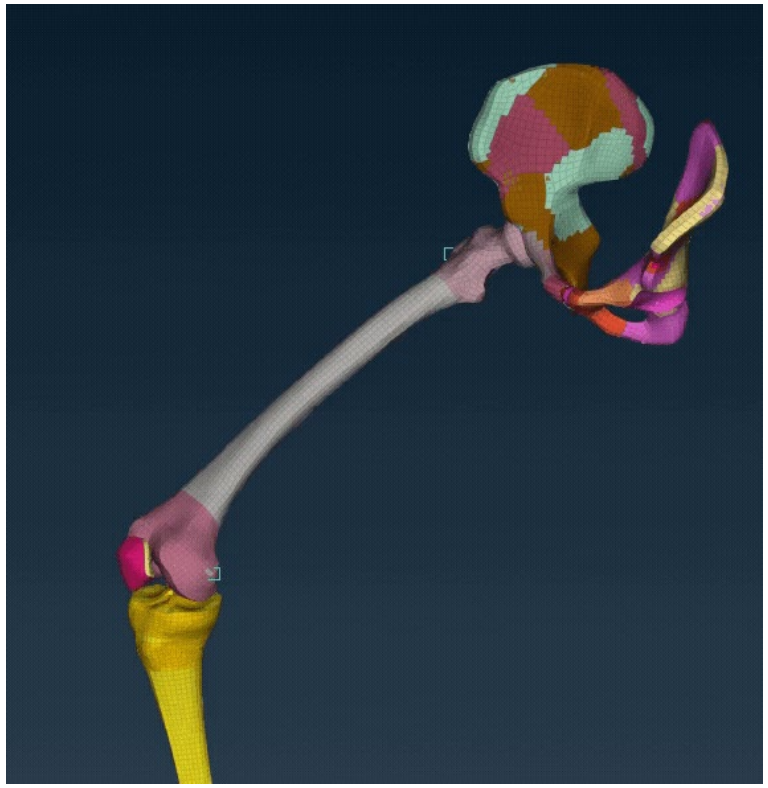
⇨ **Minimize Slope Error XZ & XY plane**

- **Final HBM position:** Minimum overall error

XZ Plane

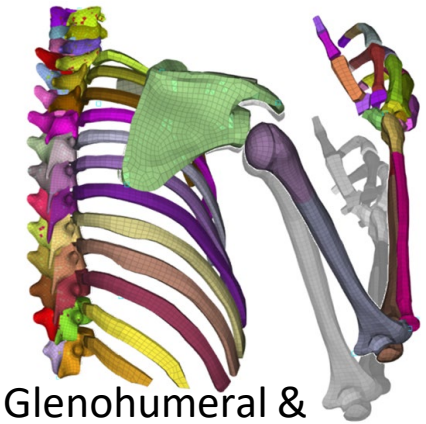


XY Plane

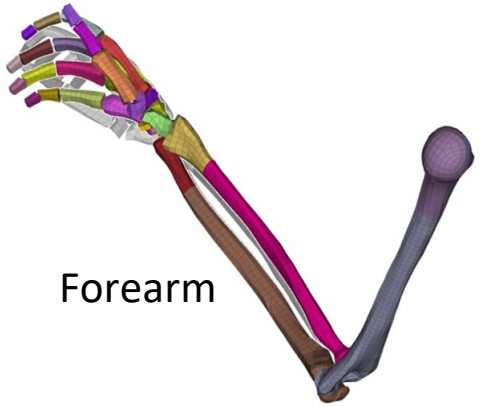


Articulated Body Parts

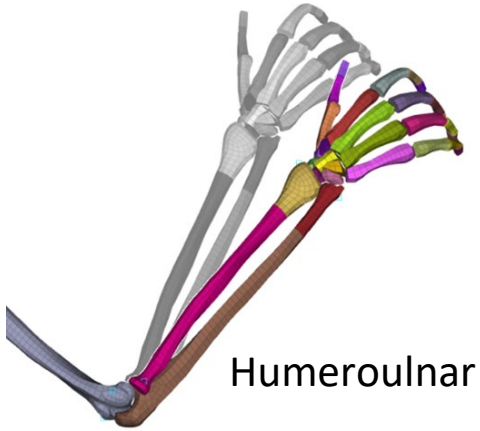
Spine & Pelvis



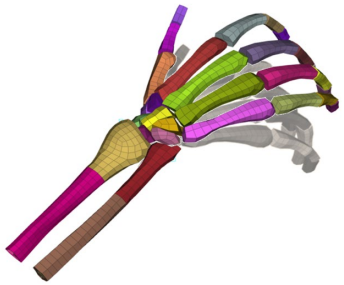
Glenohumeral & Shoulder



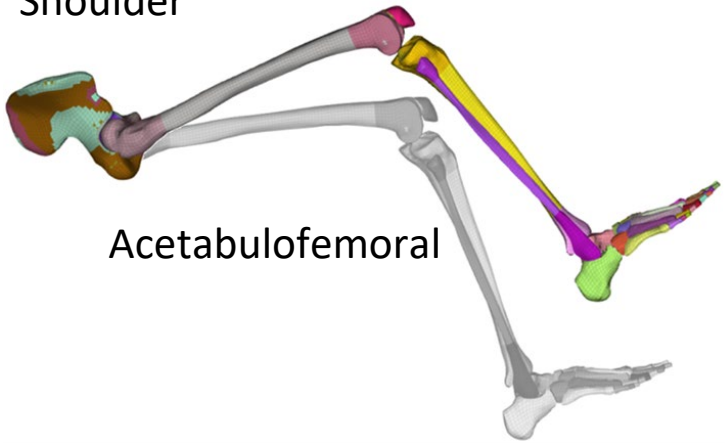
Forearm



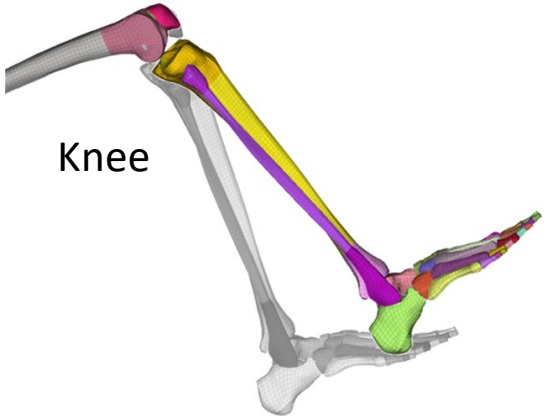
Humeroulnar



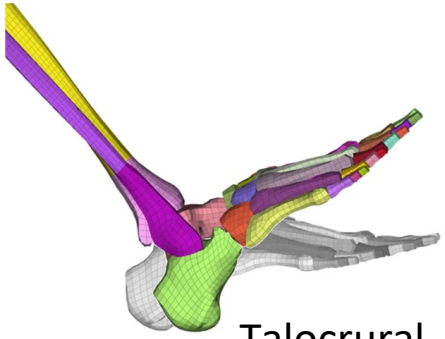
Radiocarpal



Acetabulofemoral



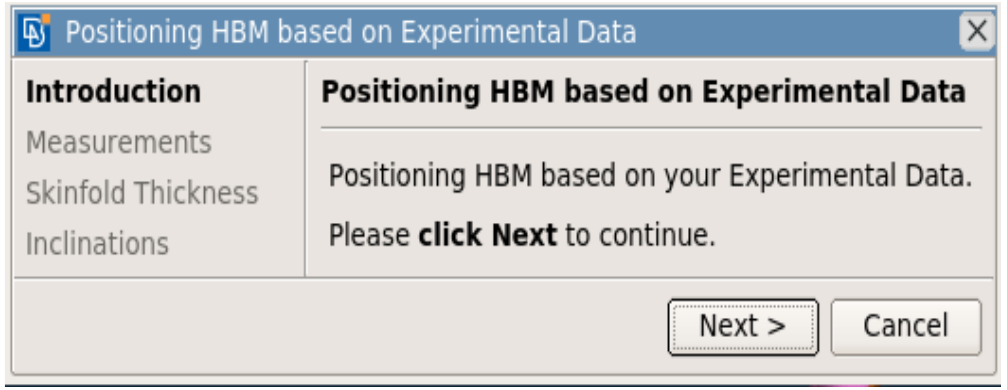
Knee



Talocrural

Method


Experiment
ANSA Script Editor
Optimal HBM Positioning


Positioning HBM based on Experimental Data
Introduction
Measurements
Skinfold Thickness
Inclinations
Positioning HBM based on Experimental Data
Positioning HBM based on your Experimental Data.
Please click Next to continue.
Next >
Cancel

Implementation

- Skin Marker Technique

- THUMS AM50 Occupant:
  - Height: 178.6cm
  - Weight: 78.5Kg

- Volunteer:
  - Height: 177.2cm
  - Weight: 80.2Kg

Easy Entry Bike

Racing Bike

Implementation

- **Experimental Process**
  - The Volunteer rides the bike
  - Skin Markers Placement
  - Pictures Capturing
  - Skinfold Thickness Measurements

Easy Entry Bike

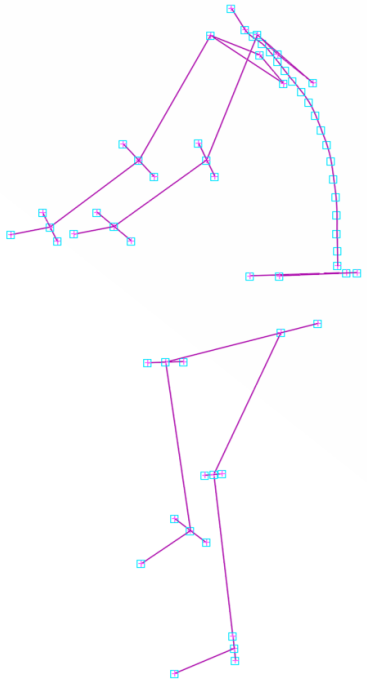
Racing Bike

Implementation

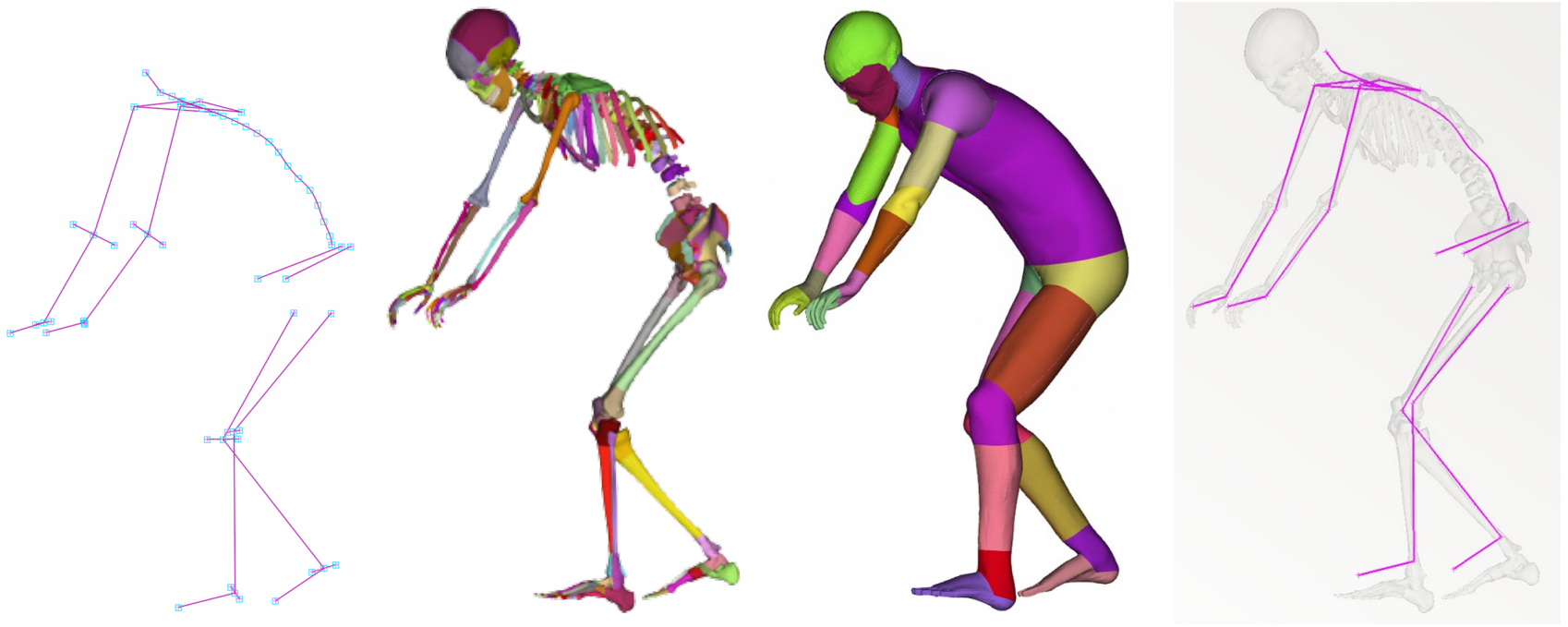
- **Data Collection and Analysis**
  - Photogrammetric Method
  - Camera Calibration

    (intrinsic & extrinsic parameters)
  - Markers Coordinates

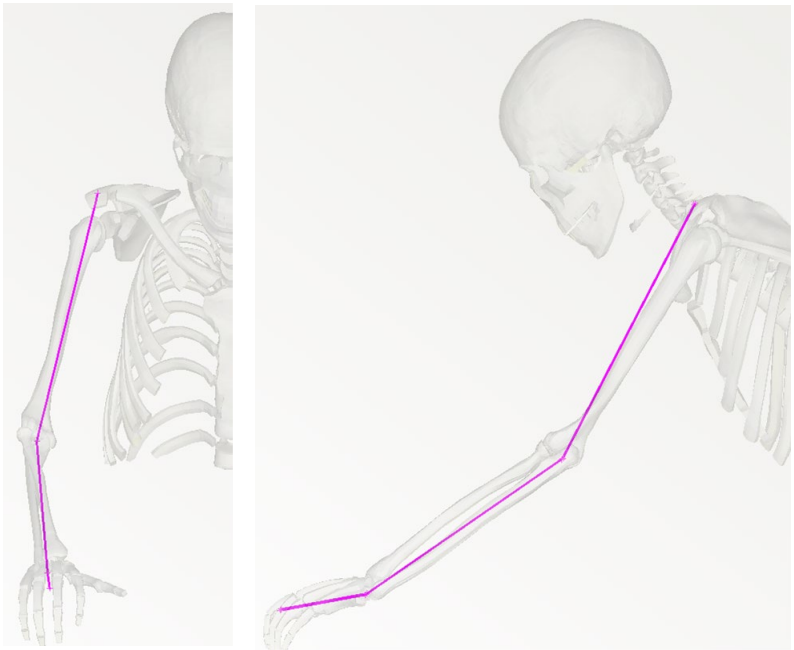
Easy Entry Bike



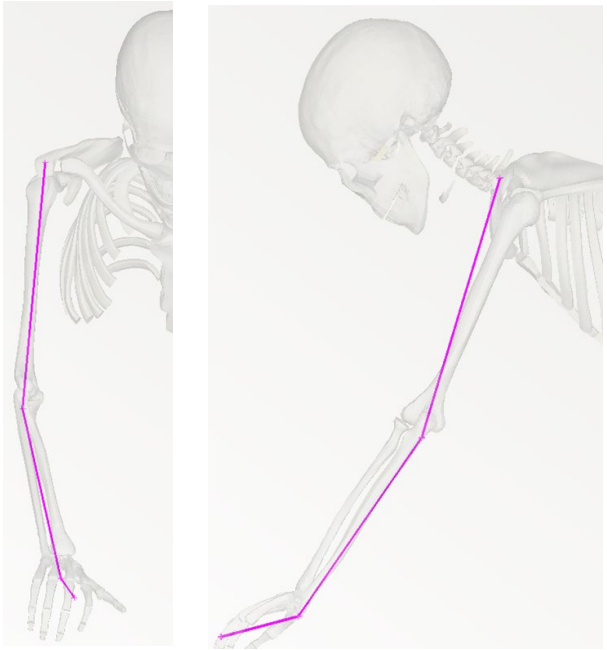
Racing Bike



Arms



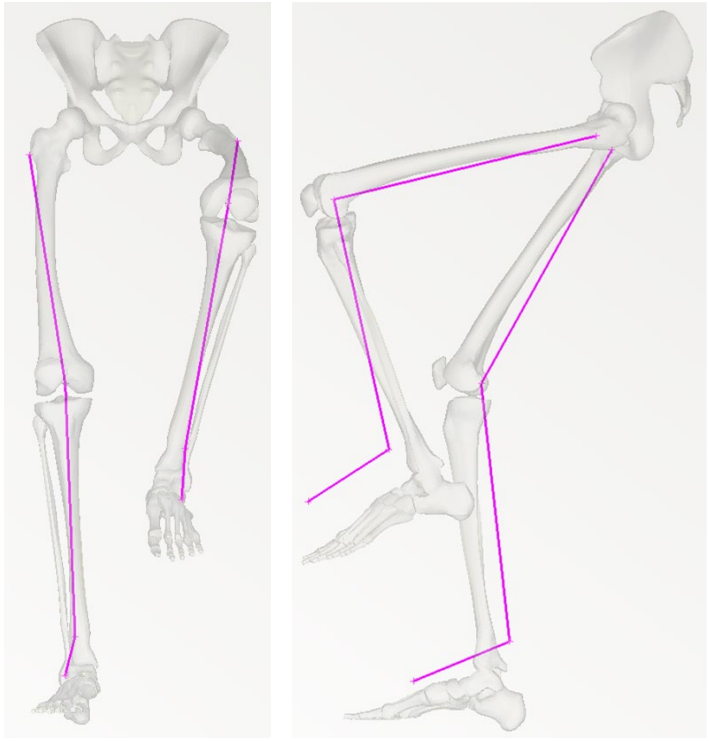
Easy Entry Bicyclist Posture



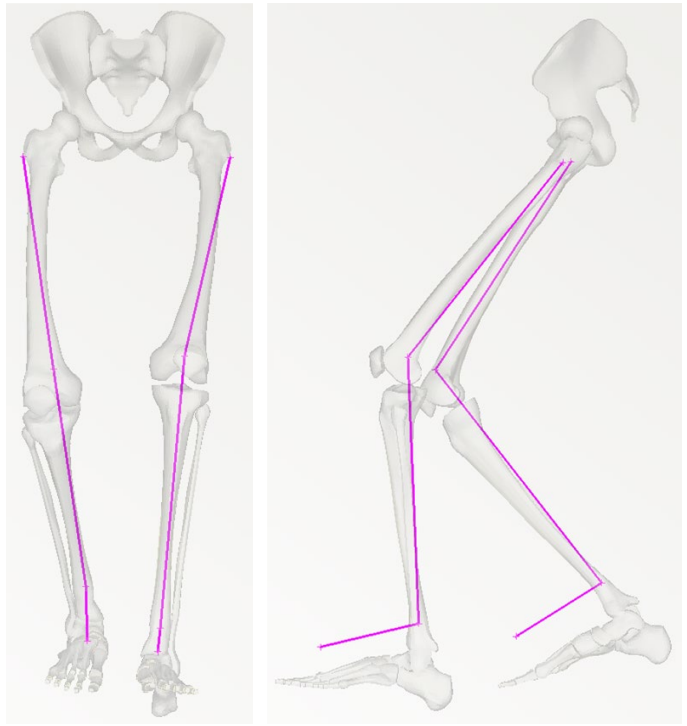
Racing Bicyclist Posture

Absolute Differences [deg]				
		Angle XY	Angle ZX	Angle YZ
Easy Entry Bike	Humerus	0.75	2.75	1.89
	Radius/Ulna	0.53	0.44	1.12
	Hand	5.5	4.89	1.27
Racing Bike	Humerus	0.51	0.52	0.02
	Radius/Ulna	1.01	0.17	2.54
	Hand	0.59	0.28	0.38

Legs



Easy Entry Bicyclist Posture

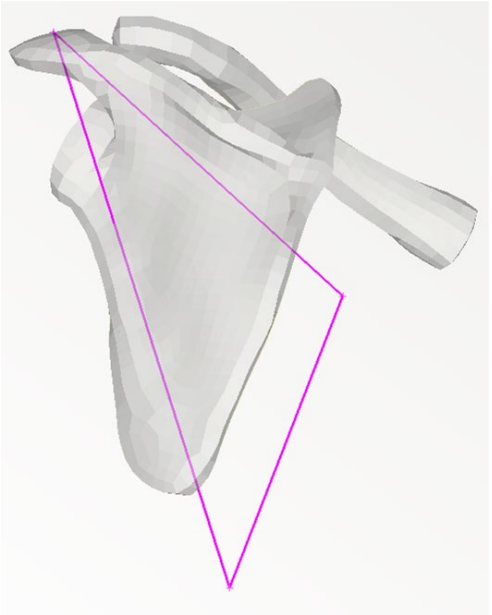


Racing Bicyclist Posture

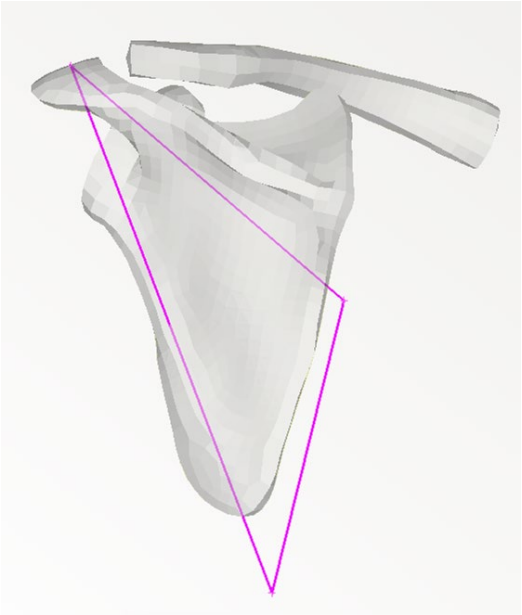
Absolute Differences [deg]					
			Angle XY	Angle ZX	Angle YZ
Easy Entry Bike	Left	Femur	0.28	0.29	0.12
		Tibia	5.28	5.5	1.16
		Foot	5.1	5.16	0.74
	Right	Femur	2.77	2.83	0.03
		Tibia	2.62	3.12	0.3
		Foot	3.12	3.04	0.06
Racing Bike	Left	Femur	0.65	1.03	0.96
		Tibia	1.5	0.06	1.68
		Foot	0.21	0.13	1.6
	Right	Femur	4.5	4.46	0.44
		Tibia	0.08	0.03	0.67
		Foot	0.03	0.02	1.32

BETA SIMULATION SOLUTIONS

Scapula



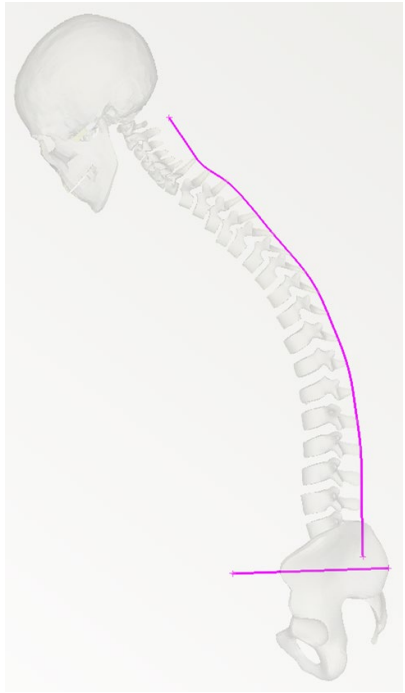
Easy Entry Bicyclist Posture



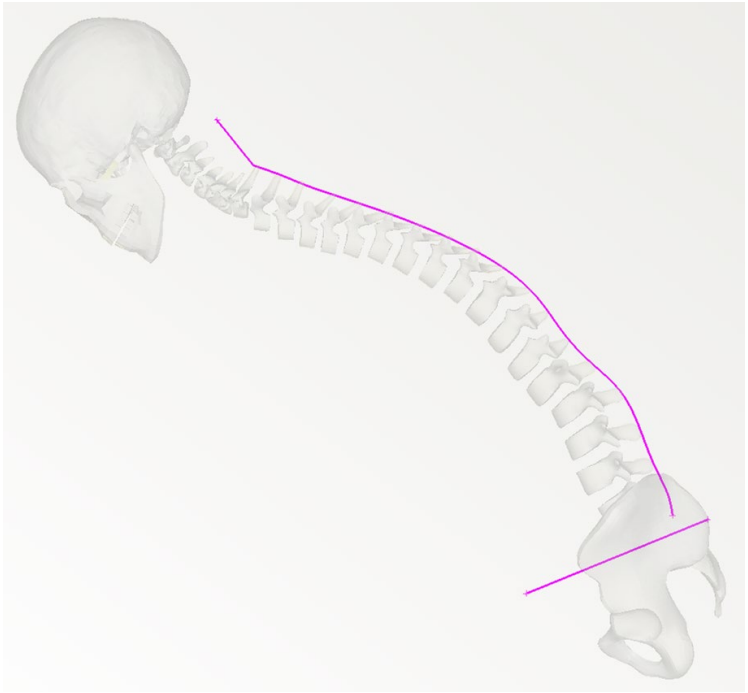
Racing Bicyclist Posture

Absolute Differences [deg]				
		Angle XY	Angle ZX	Angle YZ
Easy Entry Bike	GH-SI	7.98	9.58	4.02
	SI-SS	2.1	3.77	11.59
Racing Bike	GH-SI	3.2	1.05	0.75
	SI-SS	0.96	4.45	10.74

Spine & Pelvis



Easy Entry Bicyclist Posture



Racing Bicyclist Posture

Absolute Differences [deg]		
		Angle XY
Easy Entry Bike	Cervical Spine	5.98
	Pelvis	3.69
Racing Bike	Cervical Spine	4.2
	Pelvis	0.96

Conclusion

- Fully Automated Procedure
- Easily Applicable
- Industrialize Application

Virtual library :

HBMs & Bikes

Thank you for your attention!

BETA
SIMULATION SOLUTIONS