Sports Engineering & Rehabilitation Devices

6 CFU. Mechanical Eng., Bioengineers, ICT.

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University of Padova, Italy

Aim of the course is to present methods and tools for approaching the study of sport equipments and rehabilitation devices by means of theoretical lectures, applied workshops and practical experiences during Laboratory sessions.

LECTURES:

- In person, with blackboard, slides, interactive discussions.

WORKSHOPS:

- Musculo-skeletal modeling, motion capture data analysis, product development, given by experts from research and companies.

LABORATORIES:

- Sports & Rehabilitation Engineering Lab. "Hands-on" approach to load, motion and physiological data acquisition.

COURSE GROUP PROJECT: (OPTIONAL)

- Group experience on a given topic to experience sensor data collection, analysis and presentation on real research topics or company products.
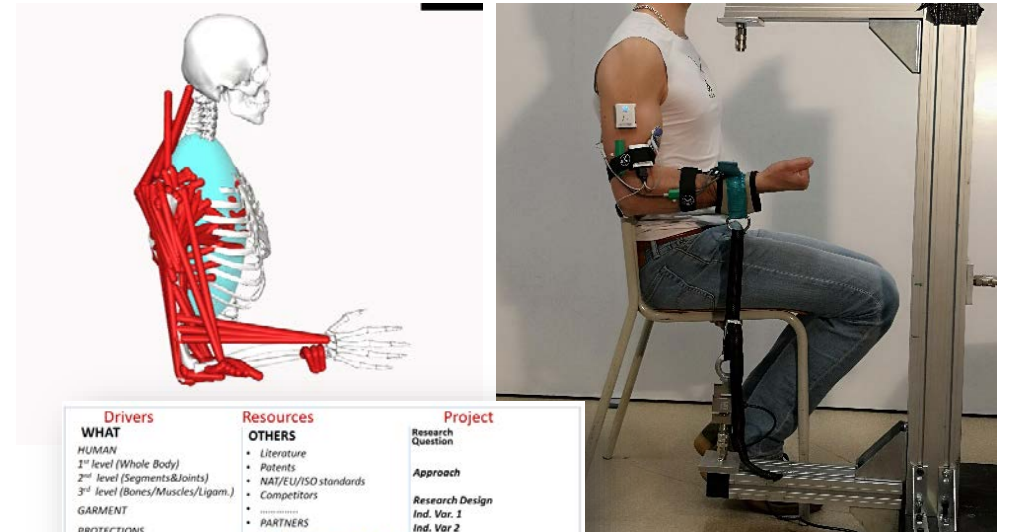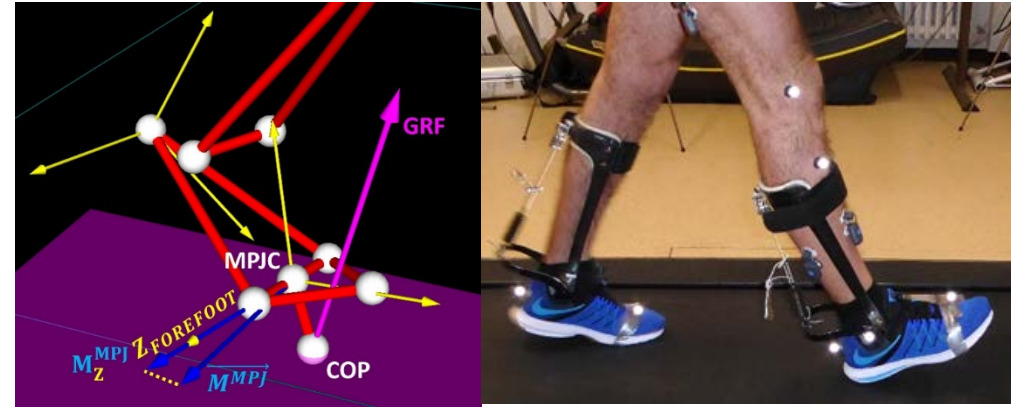
FUNDAMENTALS:

- **Functional anatomy** of the musculoskeletal system.

- **Muscle** Mechanics

- Quantitative **anthropometry**

- **Modelling** equilibrium and motion of segments of the human body.

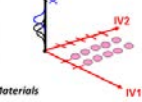- Analysis of **gait** and **running**.
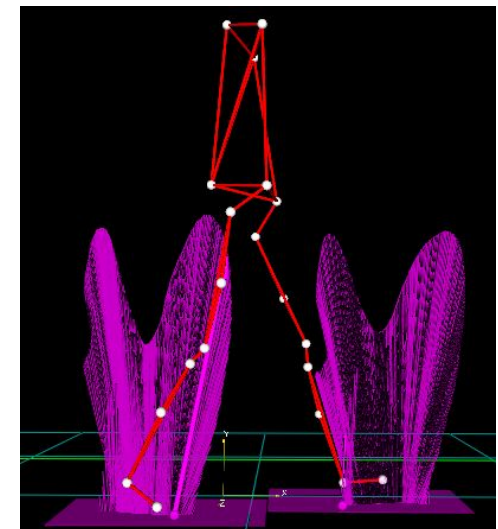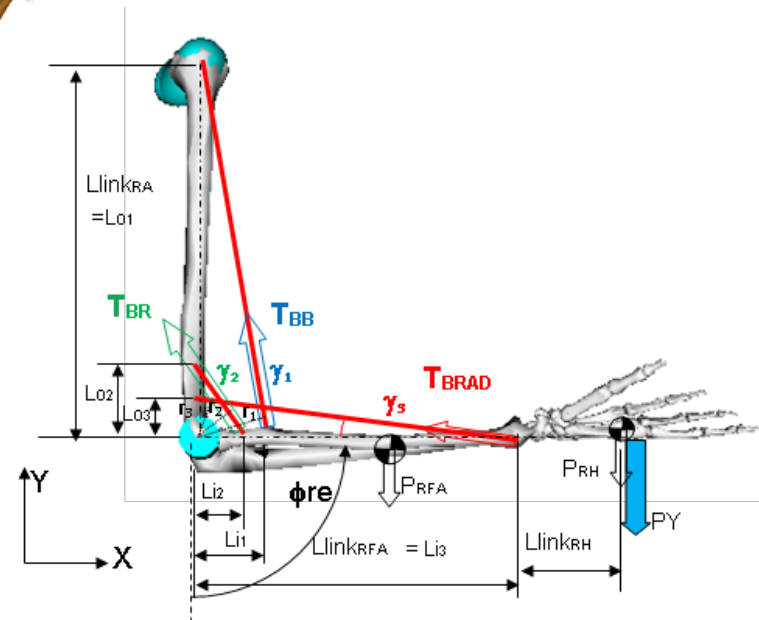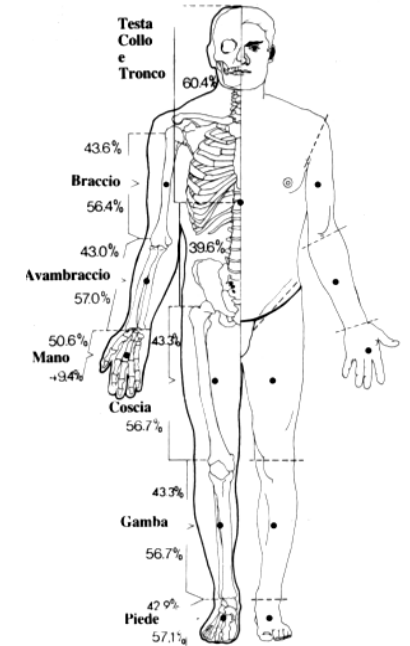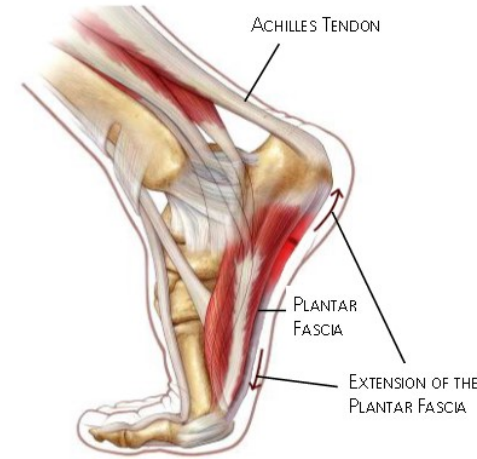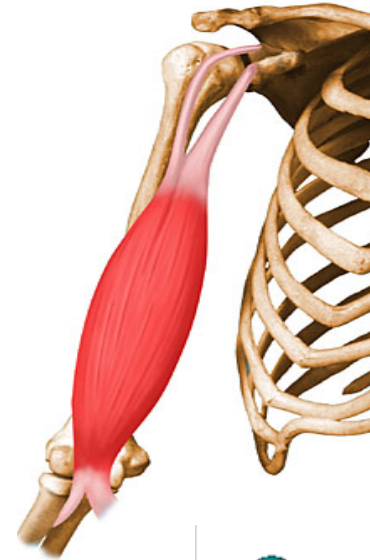
METHODS:

- **Kinematic**, **kinetic** and **physiological** analysis of sport and rehabilitation exercises

- **Motion capture** systems, **inertial sensors**, force **platforms**, **pressure** insoles and mats, **electromyography**, data analysis.

- Strain gauge multi-component load cells for **load acquisition** at the human body and equipment **interfaces**.

- **Musculoskeletal** simulation **codes**.

- Design of a **research project** for the statistical evaluation of sport and rehabilitation devices.

APPLICATIONS:

- **Classification** of sport equipments and rehabilitation devices.

- Identification of **performance**, **comfort** and **safety** parameters of sport – rehabilitation equipments.

- Safety **standards**, implementation of standard tests methods.

- Functional evaluation of **sport equipment** and **assistive technologies** such as orthoses, prostheses and training or rehabilitation machines.

- Smart **sensors** and **software** applications for sport performance and rehabilitation.
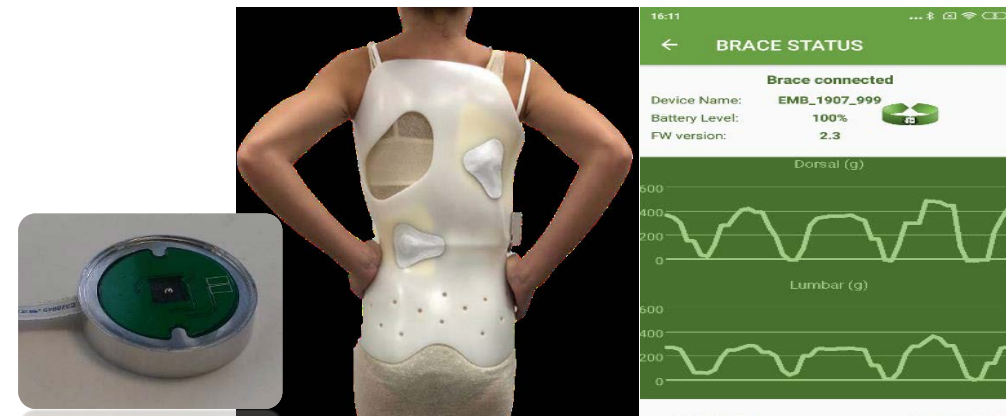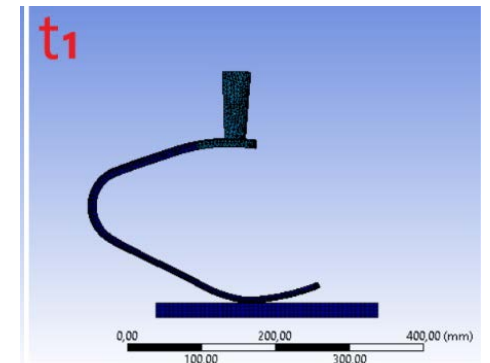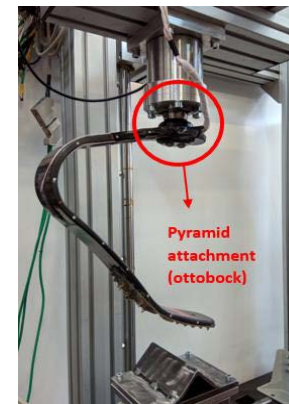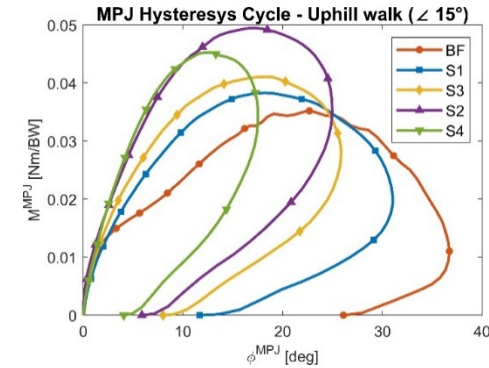
- Structural and Dynamic evaluation
  - Bicycle Fatigue Life prediction
  - Comfort analysis of Bicycle components
- Functional evaluation of Sports Equipments
  - Comparative analysis of Treadmills
  - Field load acquisition on alpine paralympic skis
- Evaluation of Protective Equipments
  - Impact tests on Helmets
  - Development of an Instrumented Human Head surrogate
  - Development of Airbag test methods
  - Development of Knee braces test methods
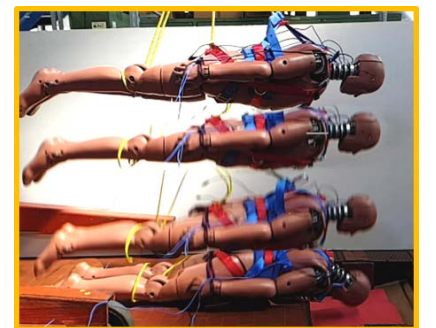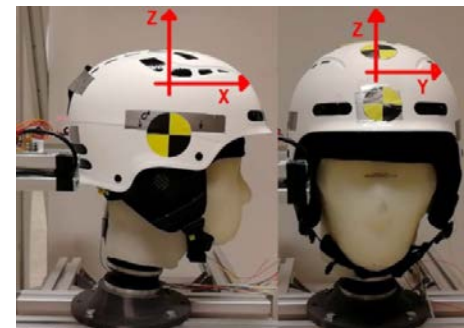
- Wheelchair safety and efficiency units
  - Field data collection on Wheelchairs
  - Analysis of Wheelchair propulsion
- Active and passive Assistive Technologies
  - Passive Exoskeletons design
  - Active Exoskeletons evaluation
- Prosthetics
  - Analysis of running prostheses
  - EMG driven hand prosthesis
  - Gait classification for prosthetic knee
  - Active prosthetic foot design
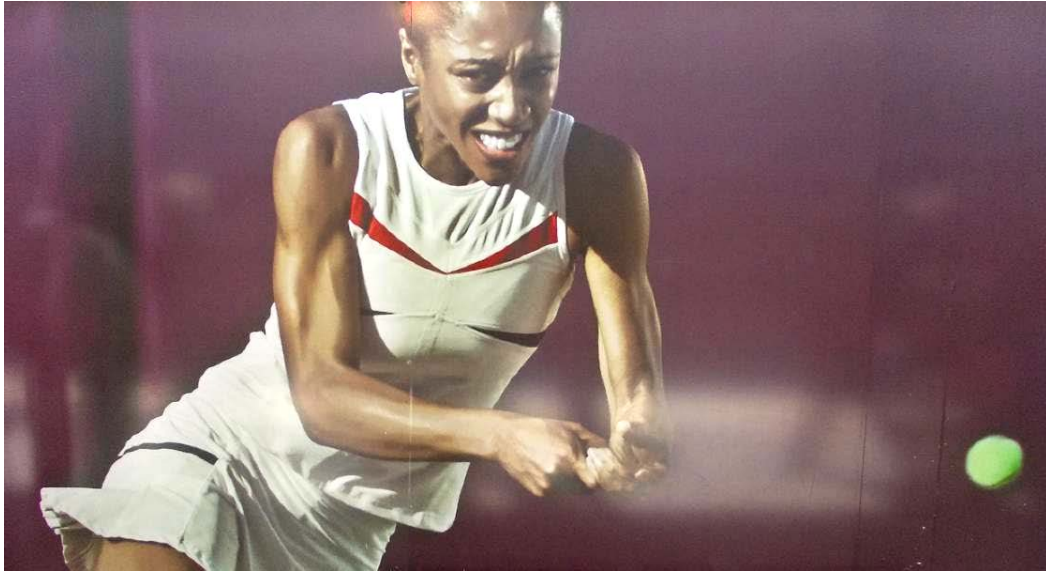
Can you imagine…
Sports without Equipments..?

Can you imagine…
Sports without Engineers..?

Nicola Petrone

Associate Professor in Machine Design & Sports Rehabilitation Engineering

Teaching:

- Machine Design & Laboratory (3rd BS Mech Eng) (IT)
- **Sport & Rehabilitation Engineering (2nd MS Mech Eng) (EN)**
- Elements of Biomechanics (School of Medicine) (IT)

INTERNATIONAL COMMITTES

- Member of ISO TC 149-SC1-WG4 mountain bicycles since 1995.
- Convenor WG3 Racing Bicycle CEN TC333-bicyles Since 1999.
- Member ISEA (International Sports Engineering Association) Executive Committee since 2008.
- Chairman ISO TC 173-SC1-WG1 Wheelchairs, 2012-2016
- SBS expert in ISO TC 159 Ergonomics since 2016

Which experiment would you plan first ?

Which results would you trust more?

Which tests would the athlete like more?

Which training method would you suggest is better ?

Which test would you choose to evaluate functional performance?

Which tests would the athlete like more?

Which method would you suggest to test the barriers and nets?

Which method could be applied indoor?

Which effect would the environmental conditions have on tests?

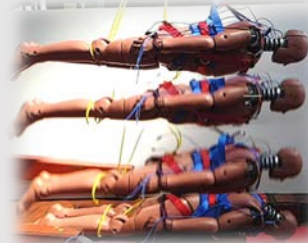# Our Research Fields…. Our Research Questions…

Complex
Inaccurate

Real

MEASURE

Easier
Reliable

Simulation
MEANINGFUL?

OUTDOOR

INDOOR

IN VITRO

IN VIVO

REPRESENTATIVE?

Research
Tests?

Conventional
Reliable/applicable

Real
Complex/Unethical

MEASURE