

# Neuromechanics of Cycling: opportunities for optimizing performance

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## **Abstract :**

The pedaling movement can be considered as relatively intuitive and hence easy to perform by everybody. On the other hand, among coaches, specialists or scientists many still believe and suggest that the “effectiveness” during this task can be improved and therefore can afford to propose some “methods” to train technique in cyclists. The aim of this session is to present the different opportunities to measure some biomechanical variables of the cycling task and to discuss about the real benefits and limitations of each of them regarding the performance. In this context, the purpose is to describe the main indexes of the pedaling biomechanics and of the muscle coordination of the lower limbs that can help to characterize the “technical aspect” of pedaling.

From the very simple (external power output) to the more complex variables (effective force profile, index of effectiveness, specific joint power) up to a neuromechanical integrative approach, we will focus on the following items: a clear definition of the concept, the tools needed for an accurate measurement and the state of scientific knowledge (and/or illustration) about its potential interest for the cycling performance. The ultimate approach using musculoskeletal models will also be mentioned just to give an idea of the potential interest to use them in a cycling performance enhancement endeavor.

The session will be organized in different parts alternating talks illustrating biomechanical aspects of pedaling performance and practical demonstrations in real time. Drawing on the expertise of the different speakers, an effort will be made to discuss about i) the practical issues of measurement (and processing) and to a larger extent about ii) the future opportunities for optimizing coordination and performance in this task (especially in sprint cycling). For that, the presentation will provide recent supporting concrete examples regarding the world-class level performance in sprint track cycling.



**Sylvain DOREL** is an Associate Professor at the University of Nantes (France), and is a member of the Laboratory “Movement, Interactions, Performance” (EA 4334). He has a background in Human Movement Sciences (PhD in 2004 at the University of St-Etienne, France) and worked as researcher at the French National Institute for Sports (INSEP, France) from 2005 to 2010. His research focuses on the muscle biomechanics and the neuromuscular adaptations of the motor function. His main field of research aims to better understand the interaction between muscle properties and the muscle coordination during poly-articular movements.

Several studies over the last eight years concerned the Neuromechanics of the pedaling task with specific interest into the top level performance in sprint track cycling. These studies were carried out in close collaboration with the French sprint cycling team. He has published almost 35 peer-reviewed papers and serves as reviewer for 15 international journals and on editorial board of “Journal of Science and Cycling”.



**Mathieu BOUCHER** is a bio-engineer and he is the Founder-partner and Chairman of Sensix Company (from 2008, Poitiers, France). He has a background in bio-engineering (PhD in 2005 at the University of Poitiers, France) and has complementary skills in Robotica modelisation and intelligent features. His area of expertise concerns the biomechanical research, the design of mechanical system and electronics board and the Human-Machine interface software programming. In this line, he developed numerous instruments recording mechanical parameters or the human performance such like a pedal dynamometer which offers the opportunity to measure effort generated by a cyclist thanks to a 6-component sensor integrated under the cliplless pedal of a cycle.



**Vincent FOHANNO** is a biomechanical research engineer at Qualisys AB (Goteborg, Sweden). He has a background in Human Movement Sciences (PhD in 2011 at the University of Poitiers, France). His research focuses on numerical methods used to estimate the joint kinematics and personalize human models. This work is related to the biomechanics of cyclic sport movements, especially rowing, kayaking, cycling and running, in a way to provide useful feedbacks to coaches/athletes and solutions to the measurement of the athlete performance in ecological conditions.



**Guillaume RAO** earned a M.Sc. in Engineering and Ergonomics of Human Movement (Aix-Marseille University) and a Ph.D. in Human Movement Sciences (Aix-Marseille University), He is currently associate professor in Biomechanics both at the Sport Sciences Department of Aix-

Marseille University and at the Institute of Movement Sciences (UMR CNRS 7287) in Marseille, France. He is currently involved in the development of the TechnoSport research center in Marseille, dedicated at gathering sport scientists, medical doctors, sport brands and sport players around a single place to foster innovation in sport gear. His work focuses on understanding the lower limb and foot functions in animals and human beings. He regularly use motion capture, biomechanical modeling and nonlinear analysis techniques to assess descriptive variables of the locomotion such as local dynamic stability, joint kinematics, muscle activations and forces, muscle fibre behavior, and joint and ligament strain. Based on these analyses, he is looking for answers to fundamental questions about the functioning of the human body in order to develop sport equipment and clinical methodological routines.