

## ***Sports Engineering: Optimizing Equipment and Performance***

by Prof. John McPhee, University of Waterloo

### **Lecture**

“Faster, higher, stronger” is the Olympic motto, and today’s athletes are fitter than ever. However, the biggest gains in sports performance have come from advances in equipment, not the athlete. In this talk, Prof. McPhee describes how computer models and AI are used to optimize sports equipment and performance, with applications in golf, baseball, Olympic cycling, wheelchair basketball, and hockey.

### **Biography**

Dr. John McPhee is a Professor of Systems Design Engineering and the Canada Research Chair in Biomechatronic System Dynamics at the University of Waterloo. He is ranked in the top 2% of scientists worldwide by Stanford University, and has worked with Cleveland Golf, the US Golf Association, Golf Digest, Ping Golf, the Canadian Sports Institute (wheelchair basketball and curling), Trajekt Sports, Bladetech Hockey, DeepDarts, ResearchGradeSports, and Fencing Canada. In 2023, he received the premier Gold Medal Award from Professional Engineers Ontario.

### **Motion Research Group at the University of Waterloo**



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## Background Material on the WorldWideWeb

PGA tour golf statistics: [www.pgatour.com/stats/](http://www.pgatour.com/stats/)

Golf drive simulator: [morg.shinyapps.io/Driver\\_model](http://morg.shinyapps.io/Driver_model)

Baseball pitching robot: [TrajektSports.com](http://TrajektSports.com)

Flexible hockey blades: [BladetechHockey.ca](http://BladetechHockey.ca)

Automated dart scoring: [DeepDarts](http://DeepDarts) (available on the Apple Store)



## Papers

Athlete size and performance	A. Bejan et al, <i>The Constructal Evolution of Sports with Throwing Motion: Baseball, Golf, Hockey, and Boxing</i> , International Journal of Design and Nature and Ecodynamics, v.8, no.1, 2013.
Golf models and equipment	J. McPhee, <i>A Review of Dynamic Models and Measurements in Golf</i> , Sports Engineering, v.25, no.2, 2022.
Olympic track cycling	C. Jansen and J. McPhee, <i>Predictive Dynamic Simulation of Olympic Track Cycling Standing Start Using Direct Collocation Optimal Control</i> , Multibody System Dynamics, v.49, pp.53-70, 2020.
Wheelchair basketball	C. Brown and J. McPhee, <i>Predictive Forward Dynamic Simulation of Manual Wheelchair Propulsion on a Rolling Dynamometer</i> , ASME Journal of Biomechanical Engineering, v.142, no.071008, 2020.
Wheelchair curling	B. Laschowski, N. Mehrabi, and J. McPhee, <i>Inverse Dynamics Modelling of Paralympic Wheelchair Curling</i> , Journal of Applied Biomechanics, v.33, pp.294-299, 2017.
Golf impacts	A. Caldwell and J. McPhee, <i>Three-Dimensional Golf Clubhead-Ball Models for Drivers and Irons</i> , Sports Engineering, v.27, no.16, 2024.
Disc golf	A. Turner, A. Caldwell, K. Webster, C. Dickerson, and J. McPhee, <i>Launch Speed and Spin versus Player Skill Level for Disc Golf Throws</i> , Engineering of Sport Conference, Loughborough, UK, 2024.
Fencing	K. Zhu, A. Wong, and J. McPhee, <i>FenceNet: Fine-grained Footwork Recognition in Fencing</i> , Computer Vision in Sports (CVsports) Conference, New Orleans, USA, 2022.