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Computational Modeling and Analysis of the Fluid Dynamics of Competitive Swimming

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In order to swim efficiently and/or fast, a swimmer needs to master the subtle cause-and-effect relationship that exists between his/her movements and the surrounding fluid. This is what makes swimming one of the most technical of all sports. For the most part, science has played little if any role in helping swimmers and coaches improve swimming techniques or even to better understand the fluid dynamics of human swimming. Experiments of free swimming humans are extremely difficult to conduct and computational modeling approaches have, in the past, been unable to address this very complex problem. However, the development of a new class of numerical methods, coupled with unique animation and analysis tools is making it possible to analyze swimming strokes in all their complexity. The talk will focus on describing a relatively new numerical method that has been developed to solve flows with highly complex, moving/deforming boundaries. Numerical simulations are used to perform a detailed analysis of the dolphin kick. This stroke has emerged as an important component of competitive swimming in recent years and our analysis has allowed us to extract some useful insights into the fluid dynamics of this stroke. In addition, we also address the continuing debate about the role of lift versus drag in thrust production for human swimming.