

# Bending It Like Bernoulli<sup>1</sup>

The colored “strings” you see represent air flow around the soccer ball, with the dark blue streams behind the ball signifying a low-pressure wake. Computational fluid dynamics and wind tunnel experiments have shown that there is a transition point between smooth and turbulent flow at around 30 mph, which can dramatically change the path of a kick approaching the net as its speed decreases through the transition point. Players taking free-kicks need not be mathematicians to score, but knowing the results obtained from mathematical facts can help players devise better strategies.

The behavior of a ball depends on its surface design as well as on how it’s kicked. Topology, algebra, and geometry are all important to determine suitable shapes, and modeling helps determine desirable ones. The researchers studying soccer ball trajectories incorporate into their mathematical models not only the pattern of a new ball, but also details right down to the seams. Recently there was a radical change from the long-used pentagon-hexagon pattern to the adidas +Teamgeist™. Yet the overall framework for the design process remains the same: to approximate a sphere, within less than two percent, using two-dimensional panels.

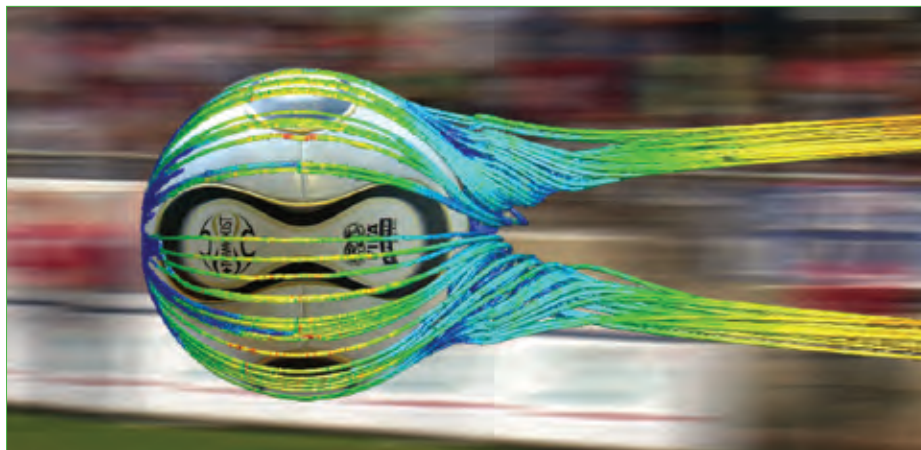


Image courtesy of the University of Sheffield and Fluent, Inc.

**For More Information:** “Bending a Soccer Ball with CFD,” Sarah Barber and Timothy P. Chartier. SIAM NEWS, July/August 2007.

<sup>1</sup> Daniel Bernoulli (BurrNOOlee) was a Swiss mathematician who did pioneering work in fluid flow.



The **Mathematical Moments** program promotes appreciation and understanding of the role mathematics plays in science, nature, technology, and human culture.