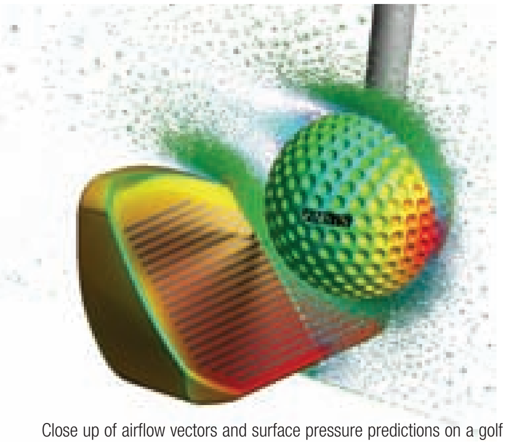
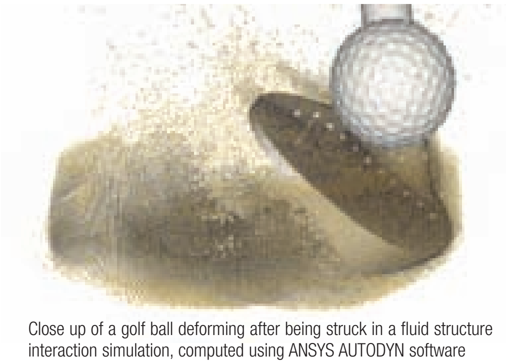
Sporting Swifter, Higher and **Stronger Performances with Engineering Simulation**

Computer-aided engineering plays a major role in the world of sports.

By Keith Hanna, ANSYS, Inc.



Close up of airflow vectors and surface pressure predictions on a golf ball and #3 iron just after being struck, computed using ANSYS CFX software



Close up of a golf ball deforming after being struck in a fluid structure interaction simulation, computed using ANSYS AUTODYN software

The sports and leisure Industry has seen some profound changes during the last 25 years, especially in the areas of new product design, innovation and development. Indeed, there has been an explosion of professional sporting and leisure activities, driven by consumers having more disposable income to spend and multi-channel 24-hour TV, hungry for content and information. In the last decade alone, the amount of money pouring into elite sport has hit staggering heights. The seven-time German Formula 1 Motor Racing World Champion, Michael Schumacher, has been estimated to have earned $1 billion throughout his 15-year career, and the American golfer, Tiger Woods, is not that far behind. Major sporting events are now linked with major business opportunities, and the worldwide sports and leisure industry is estimated to be worth about $500 billion per year while growing at 3 percent per annum.

The push to involve science and engineering in sports has been led by motor racing in a quest for that elusive fraction of a percentage point improvement in performance that can lead to victory. New engineering tools and disciplines like computer-aided engineering (CAE) are now major transforming agents for this industry. CAE allows for virtual design and testing techniques to be applied to all aspects of sport and leisure equipment development. Modern CAE software tools provide a cost-effective way of assessing new products and product innovations in what were previously lengthy product design turnaround times.

Many elite athletes, teams and sports equipment manufacturers now are realizing that they can derive competitive aerodynamic and structural advantages from advanced fluid flow and structural modeling technologies. Computational fluid dynamics (CFD) in particular is an integral part of the CAE process in many sports today, where the technology leads to performance gains that easily justify the financial outlays for hardware and software.

It is generally known that cyclists riding in a pack expend significantly less energy when drafting behind another rider. In a recent study by Dale Apgar at Dartmouth College, CFD was used to study four cyclists in a line (left) and in a small peloton (right). The results showed that in the line configuration, the last cyclist experiences 46 percent less drag than the lead rider. In the four-man peloton, the two side riders experience more drag than the first rider, suggesting difficulty for other cyclists to overtake the leader. The result may not be true for larger pelotons. Pressure contours on the individual cyclists, shown above, were used to compute the drag.

An increasing drive toward cheaper, easier to use CAE software coupled with the ready availability of increasingly more powerful computers have led to an expansion in numerical simulation for numerous sporting applications. CAE now is being used routinely to help explain physical phenomena in both competition and training scenarios. It is indispensable in the design of better equipment, where it is used to improve safety, comfort and efficiency.

In the world of Formula 1 racing, for example, the leading teams are pushing toward once unimaginable 1 billion cell CFD calculations. The BMW Sauber F1 Team recently announced the launch of its 1,056 processor supercomputer, Albert[2], one of the largest industrial computing installations in the world, aimed solely at doing CFD calculations. Indeed, the team chose the supercomputer route rather than building a second wind tunnel as their preferred way forward for aerodynamic race car design and improvement.

In the world of America's Cup Yachting, the coast of Valencia, Spain, soon will see some of the richest multinational teams vying to win one of the oldest and most prestigious sports trophies in the world. ANSYS has had the privilege of supplying two teams in the last decade who, between them, have been winners of the last three America's Cups: Team New Zealand (twice) and the Swiss team Alinghi. These teams have used ANSYS software to design their ship hulls, appendages and sails to millimeter tolerances. In 2007, nearly all of the Americas Cup competitors will have used ANSYS software in one form or another prior to the start of the competition.

In this sports and leisure industry supplement, a variety of CAE applications are illustrated that emphasize the widespread use and importance of this exciting technology. Both solid mechanics and fluid dynamics phenomena are represented in applications that range from bicycles to alpine skis, ice axes to racing oars, and surfboards to mouthguards. Ventilation schemes for sports arenas are reviewed, as are important design considerations for fitness equipment. In each case, the application has benefited in some way from ANSYS engineering simulation software. With the Summer Olympics in Beijing fast approaching in 2008 and the soccer World Cup in South Africa in 2010, computer simulation will be strongly impacting this industry in the years to come. Whether it is multinational equipment giants or niche elite sport teams, many will recognize the benefits that Simulation Driven Product Development can bring to their business or sporting goals. ■

Suggested Reading

Hanna, R.K.: Going Faster, Higher and Longer in Sport with CFD. 1st International Conference on Engineering in Sport, Sheffield, U.K., 1996.