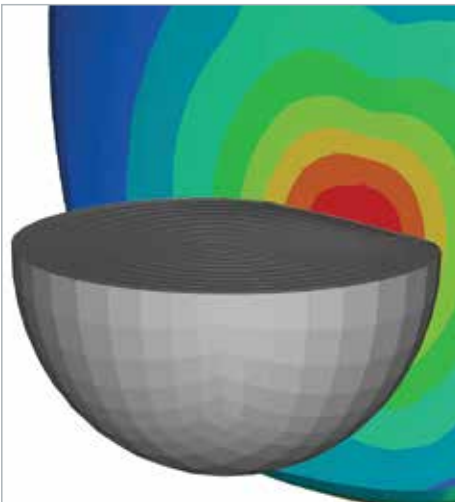


Cleveland Golf Drives Product Innovation Through Simulation and Optimization Using HyperWorks



Cleveland
GOLF

SRIXON

Key Highlights

Industry

Sporting Goods

Challenge

Meet changing regulations for golf club design and consistently introduce new products that are precisely engineered for shape, feel, balance, sound and performance.

Altair Solution

Employ the HyperWorks suite of software for CAE design simulation

Benefits

- Time savings
- Design optimization
- Increased rate of development

Designing the Next Golf Club

Much more goes into a golf club than simply wood, iron and graphite. To shape the performance, the distinctive appearance, the personalized feel and even the sound of the club striking the ball, manufacturers must precisely engineer every aspect of the design.

Once, this was a very painstaking process, entailing months of prototype building and evaluation. Today, however, simulation-driven design has dramatically reduced development time for new golf clubs while allowing them to meet strict regulations more efficiently.

Market-leading golf club manufacturer Cleveland Golf, based in Huntington Beach,

Calif., is a pioneer in the design and production of advanced clubs and the developer of the number-one wedge in the golf industry. The company's engineering research team uses simulation to virtually assess and tune the performance of forward-looking designs to develop market-leading woods, irons, wedges and putters.

"Design engineers come to us with projects, and we run analyses on everything from wall thickness to the center of gravity location," says Brian Schielke, a mechanical engineer with Cleveland Golf. "We work to tweak the original shape provided by the designer. An extreme new shape might take months to develop, but a shape that is not as severe may require just a couple weeks."

Cleveland Golf Success Story



“With simulation software like HyperWorks, we have been able to dramatically increase our rate of development. This not only allows us to produce better products but also it frees up our time and allows us to look into the future for the next great technology in golf.”

John Rae,
Research Manager
Cleveland Golf

Regulatory and Business Obstacles

Cleveland Golf continues to expand its use of simulation because it operates in a difficult regulatory and business environment.

The United States Golf Association (USGA) imposes limitations on golf club heads.

It mandates, for example, the size of the grooves in wedges and irons and constrains the dimensions of the head. It also determines the permitted coefficient of restitution (COR) – or springiness – that is allowed in clubs.

“When the USGA made these rules, no company was designing clubs that approached the size or COR limits,” says Scheilke’s engineering colleague, Alex Timmons. “But as clubs have improved, we’ve reached those limits and have the capability to go beyond them. Now we need to figure out how to continue to improve clubs without going

beyond the limits.” Adding to the challenge, the USGA recently changed the rules specifying groove size, impacting how future clubs will be designed.

From the standpoint of the economic obstacles, consumers are carefully examining their expenditures and are not buying as many clubs as they did in the past; so Cleveland Golf needs to create more new and innovative products, not just variations on existing clubs.

“Increasingly in this economy, it can be challenging for manufacturers to differentiate themselves from their competitors,” Timmons observes, “Using simulation is Cleveland Golf’s greatest asset. It allows us to test multiple iterations of a club design in ways we couldn’t try without simulation. Just a tiny amount of measurable improvement makes a big difference, and simulation helps us get there.”

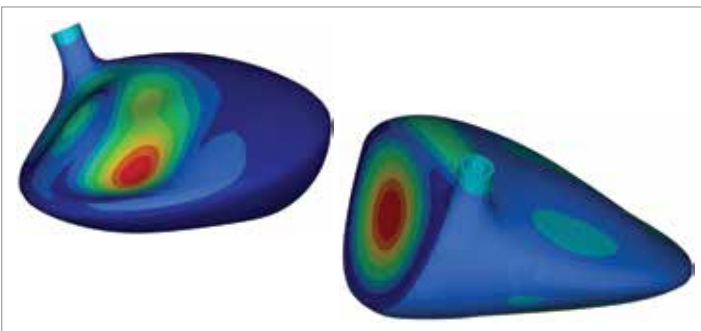
Shaping and Balancing with HyperWorks

Using Altair HyperWorks computer-aided engineering (CAE) suite of software to conduct simulations, the Cleveland Golf research team balances a variety of design variables, including:

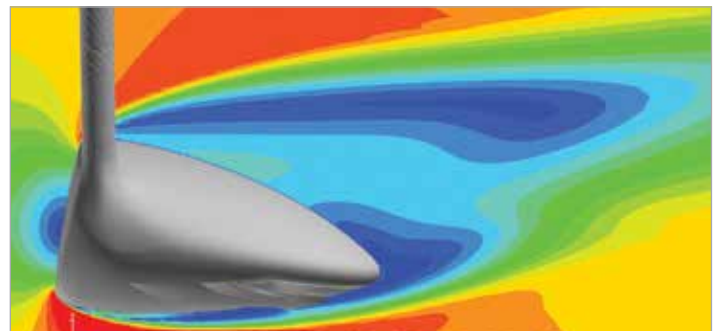
- Materials
- Size
- Shape
- Weight placement
- Thickness patterns
- Placement of internal ribs for durability, sound and feel

To carry out their work and to simplify the process of manipulating these factors, team members rely heavily on HyperWorks applications.

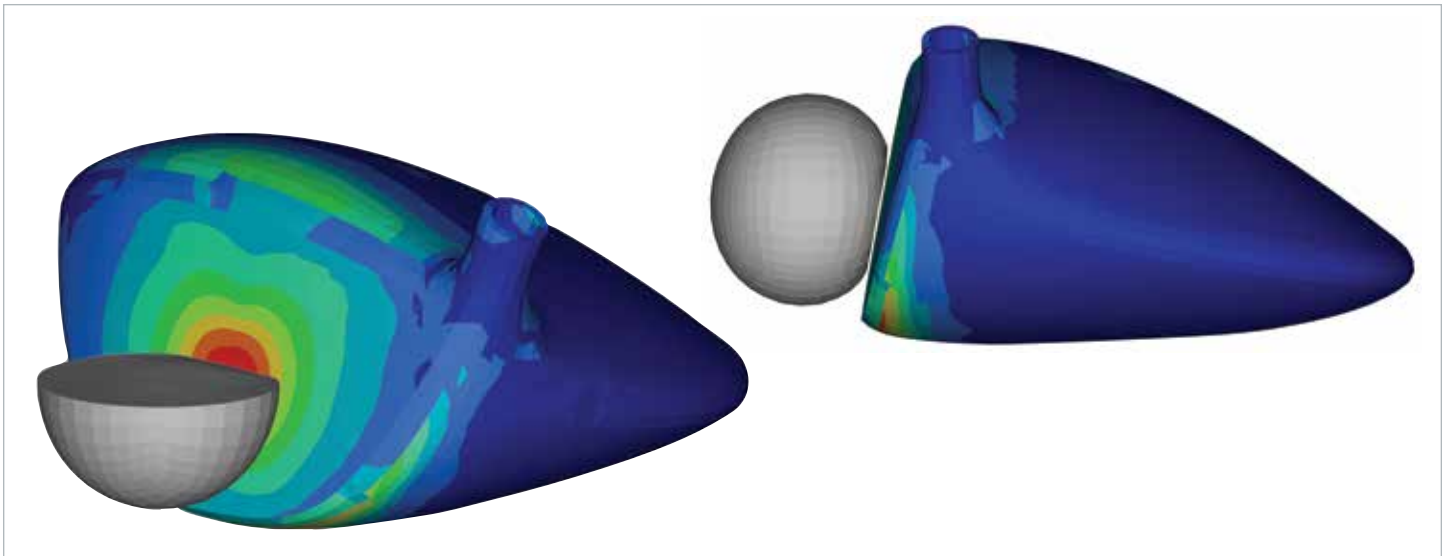
“HyperMesh allows us to clean up the geometry and trim surfaces easily,” notes Timmons. “Geometry mapping is a really nice function, too.



Modal analysis using OptiStruct® shows the location and frequency of the clubs vibrations, leading to how the club will sound and feel.



Cleveland Golf uses AcuSolve® to evaluate the club’s aerodynamics.



Running impacts using RADIOSS shows the launch characteristics of the ball as well as stresses on the head.

We can bring in a new shape from CAD and mesh the whole club head in five minutes and run it again. With OptiStruct, we can set design variables and objectives; and it tells us where to put thicknesses in the club as well as the center of gravity location.”

The team members also use HyperStudy, which allows them to optimize material properties, along with AcuSolve® to explore the club’s aerodynamics.

Simulation-Driven Design with Blue-Sky Concepts

Creatively factoring these variables into simulations has helped Cleveland Golf grow to become an iconic and innovative leader in club design.

“We do a lot of research on abstract products,” Schielke says. “We not only research what the market wants today but also drive the market with blue-sky concepts that the market may want five years from now. Simulation is the easiest and most cost-effective way for us to carry out this kind of innovation. We’re really using simulation to drive design, to determine the attributes of the club to correspond with what we want to achieve.”

In addition to evaluating the structural performance of prototypes, Cleveland Golf uses simulation to predict the sound that the club head makes when striking the ball,

employing modal analysis using the HyperWorks OptiStruct® solver. “We look at sound as much as performance,” Timmons says. “The club must sound and feel good. We can change the shapes, grid configurations, and thicknesses to dial in the sound.”

The engineers know the sound golfers like in existing clubs. So, they compare new club designs with previous parts in running their sound analyses. They also use a robot that strikes golf balls consistently, enabling the engineers to test different design iterations and to measure the sound coming from the club. Additionally, engineers rely to a considerable extent on player testing for feedback on sound and feel and to compare Cleveland Golf clubs with others in the market.

A Crowning Achievement Through Simulation

Throughout the club design process, HyperWorks has helped Cleveland Golf both accelerate its time to market and improve the quality of its clubs.

For example, to create a distinctive appearance, engineers wanted one club to have a higher, more bulbous crown than the traditional club and to feel and sound softer than the previous model. The club also needed to deliver a lower spin, but raising club weight with a heavier crown would increase spin. Using HyperMesh and shape

optimization to examine a variety of club shapes, as well as thickness locations to keep the center of gravity lower, Schielke and Timmons were able to maintain the high crown and still achieve the performance parameters.

Simulation Saves Months of Design Time

Cleveland Golf Research Manager John Rae noted, “With simulation software like HyperWorks, we have been able to dramatically increase our rate of development. This not only allows us to produce better products but also it frees up our time and allows us to look into the future for the next great technology in golf.”

In fact, simulation both slashes design times and improves the final design.

“With simulation we’ve saved months of design time and might never have come to the right design without it,” Schielke says.

Looking forward, Schielke predicts engineers will use simulation to cut the weight of clubs even further, while maintaining their traditional look. “Simulation will play a huge role in weight reduction,” he anticipates, “and we increasingly will be simulating the shaft, the grip, the whole club, not just the head. Our focus is shifting from the club head to the entire club and the swing. We’re trying to bring the best engineering that we can to golf clubs.”

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About Altair

Altair's vision is to radically change the way organizations design products and make decisions. We take a collaborative approach to solving diverse and challenging problems through the strategic application of technology and engineering expertise. Developing and applying simulation technology to synthesize and optimize product development processes for improved business performance is our specialty.

From computer-aided engineering to high performance computing, from industrial design to cloud analytics, for the past 29+ years Altair has been leading the charge to advance the frontiers of knowledge, delivering innovation to more than 5,000 corporate clients representing the automotive, aerospace, government and defense industries and a growing client presence in the electronics, architecture engineering and construction, and energy markets.

About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

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