

THE RECIPE FOR ULTIMATE FORGIVENESS: A WHITE PAPER.

Innovative Titanium Exo-Cage and New Triaxial Carbon Crown Among Numerous Key Ingredients in Callaway's New Big Bertha Fusion Driver

The first modern metalwoods, introduced 30-some-odd years ago, were little more than hollow, thick-walled shells, yet they succeeded at positioning the bulk of the head's weight in the perimeter. That raised the head's moment of inertia (MOI) dramatically compared to wooden woods, making metalwoods far more stable and resistant to twisting on mis-hits. Perimeter weighting also pushed the center of gravity (CG) low and deep, making it dramatically easier to launch the ball on a high, long, straight flight.

Even Tour professionals, who strike the ball with far greater precision than the average amateur, seek forgiveness in their equipment, particularly the driver. Why? Of all clubs, the driver weighs the least and has the longest shaft. That's good for promoting fast swing speed for distance, less good for clubhead control, making it hard to make center-face contact consistently.

Callaway's New Recipe for Forgiveness

A forgiving club delivers good results even on off-center hits -- it "forgives" your imperfect impact. Forgiveness is typically associated with high MOI, which equates to the clubhead's resistance to twisting on off-center hits. MOI is typically increased by concentrating weight in the head's perimeter. How the head is shaped has a direct effect on boosting MOI while also creating a performance-enhancing CG location.

Clubface behavior can also contribute to forgiveness. A clubface design that promotes fast ball speed across a larger part of the face also forgives off-center hits. (Ball speed within three MPH of maximum, center-face contact is Callaway's definition of "fast ball speed.")

Another facet of forgiveness is draw-bias. Many golfers have difficulty squaring the face to the ball at impact, and instead leave it open, leading to clockwise sidespin that makes the ball bend to the right, which steals distance. Engineering draw-bias into a golf club reduces the amount of clockwise spin imparted when the face is open, reducing the amount the shot curves. In other words, if you're a slicer, draw-bias will reduce your slice and make your shots go straighter, netting you more distance and helping you find more fairways.

Thus, Callaway's new recipe for forgiveness consists of these ingredients:

- **Super-High MOI Head Shape**
- **Low & Deep CG**
- **Increased Draw-Bias**
- **Fast and Forgiving Face Design**
- **Fast Swing Speed**
- **Optimal Shaft Length**

How Weighting and the New Shape Affect MOI

Increasing a clubhead's MOI remains rooted in positioning more of the head's weight in the perimeter, and in developing new shapes that allow for an extremely deep CG location. Callaway has a long history of mining extraneous weight from a club head and repositioning it in the perimeter to make clubs more forgiving and easier to launch.

“Big Bertha Fusion’s new shape maximizes the dimensions of the head from a performance standpoint while minimizing weight, and makes possible an extremely deep CG location, all while conforming to USGA rules,” said Dr. Alan Hocknell, Senior Vice President of Callaway R&D. “That’s a very difficult challenge to meet, and results in a driver that golfers can swing faster and launch the ball more easily with, promoting more distance.”

Titanium Exo-Cage + Triaxial Carbon = More Forgiveness

Callaway pioneered the use of carbon composite materials in metalwoods as another avenue for making the head strategically lighter in some areas and heavier in others to raise MOI and improve CG location. That includes drivers like the ERC Fusion, FT-3, RAZR Hawk and Big Bertha Alpha.

However, our best example is the new Big Bertha Fusion driver. The head consists of a cage made of aerospace-grade titanium, called an Exo-Cage, that’s fitted with a crown and two large panels in the sole made of our new, proprietary composite material called triaxial carbon. Lighter and less dense than titanium, these triaxial carbon components allow Callaway engineers to reposition a full 35 grams* in strategic areas of the head to increase MOI, lower the CG and enhance draw-bias. The result is our most forgiving and easiest to launch driver in our history.

“Big Bertha Fusion’s revolutionary head design is made possible by Callaway’s long history of incorporating carbon composite materials into clubheads for the purpose of improving performance,” said Dr. Hocknell. The Callaway Composite Lab was opened in 1996 to make custom graphite shafts for Tour Staff professionals; within a year Callaway engineers were experimenting with incorporating composite materials into metalwood heads. The first Callaway driver with carbon composite technology was introduced in 2002; there has been a driver in the lineup that incorporates carbon composite materials every year since then. In 2004 Callaway R&D started research on what became our proprietary Forged Composite technology, an advanced composite material that was eight years in development before we deemed it ready for use in production clubs -- the 2011 Diablo Octane and RAZR Hawk drivers.

Big Bertha Fusion is the first major in-line club to employ triaxial carbon, which is 65% lighter** than titanium. Triaxial carbon consists of millions of carbon fibers bound together to create strong threads, which are woven into a complex triangular weave pattern. Triaxial carbon sheets are molded and shaped using a proprietary Callaway process to create the crown and sole panels installed in the Exo-Cage. Overall, 42.4% of the Big Bertha Fusion’s surface is triaxial carbon. Of all previous Callaway drivers with carbon composite crowns, Big Bertha Fusion’s crown is the lightest.

The innovative Exo-Cage is itself a feat of modern metalwood engineering. Hours and hours of computer modeling, prototyping and robot testing were devoted to designing a lightweight cage structure strong enough to withstand the intense stress of impact. “The Exo-Cage consists of very strong, thin and consistent parts that create a powerful framework that gives the head the resilience necessary to withstand the rigors of impact,” said Dr. Hocknell.

A Long Head Shape That’s Also Exceptionally Fast

Head shapes that stretch the length between the front (face) and back are difficult to make aerodynamic. Callaway’s Speed Step technology alleviates that problem. Located on the crown, close to the top-edge of the clubface, the Speed Step is precisely shaped and positioned to improve airflow over the crown to make the head move faster. Introduced in the XR driver, Speed Step technology resulted from a collaborative effort between Callaway’s R&D team and Boeing aerospace engineers.

Clubface Design Another Key Ingredient to Increased Forgiveness

Big Bertha Fusion’s clubface forgives mis-hits because of Callaway’s next-generation R•MOTO face technology. By precisely varying the thickness of the face in strategic areas, R•MOTO dramatically expands the part of the face that delivers fast ball speed. That allows Callaway engineers to expand the sweetspot into the areas of the face where golfers most commonly make contact on mis-hits -- high and toward the toe; low and toward the heel.

Giving golfers significantly more ball speed on off-center impacts gives next-gen R•MOTO technology a crucial role in Big Bertha Fusion's overall forgiveness package.

Better Draw-Bias Promotes Straighter Flight

Another dimension of forgiveness concerns the club's ability to promote straighter shots by discouraging a slice. The slice is a notorious distance killer, which means a chronic slicer will automatically gain distance by achieving a straighter ball flight.

Draw-bias, which is created by properly positioning the right amount of weight in the head's heel area, reduces the amount of slice-spin imparted by an open face, resulting in a straighter shot. "It's part of our definition of forgiveness," said Hocknell. "Draw-bias forgives the golfer's inability to square the face to the ball at impact."

For golfers adept at squaring the face at impact, Big Bertha Fusion's draw-bias produces a distance-enhancing draw.

Two Stock Shaft Lengths

Big Bertha Fusion is the first driver Callaway has offered in two stock shaft lengths, 44.5" and 45.5". (Different lengths continue to be available on custom orders too.) The reasoning is simple. The length of a club directly affects both the speed at which you can swing the head, and the control you have over the head, making its shaft length a trade-off between power and control. That's why precision clubs like the short-irons have shorter shafts compared to the longer clubs like hybrids, fairway woods and drivers that require more head speed.

It may seem counterintuitive but some golfers will net more distance from the shorter, 44.5" shaft, because the additional clubhead control helps them find the fastest part of the face more often. On the other hand, slower, more rhythmic swingers often have good club control, potentially making them stronger candidates for the 45.5".

The best way to find out which length is best for you is to get on a launch monitor that calculates "smash factor," which is a measure of the quality of contact you typically make. The closer to the middle of the face you average, the higher your smash factor. Predictably, Tour pros demonstrate a much higher smash factor than the average amateur, but amateurs can definitely find ways to raise theirs, and one way is by gaining more clubhead control.

That said, it's hard to accurately predict whether a slightly longer or shorter shaft will work better for a given golfer. "We've performed a lot of real player testing on shaft length, and often we'll be surprised by someone who performs much better than expected with a longer shaft, or better with a shorter shaft," said Gibbs. "Although you can speculate which length will be better for you based on your swing characteristics, you really won't know until you try them side by side."

"Shaft length is a club spec that a great many amateurs don't give much thought to," said Hocknell. "Instead they accept whatever stock length the driver comes in. We decided to offer an easy choice, because if it gives golfers another opportunity to gain distance, we want them to have that option."

Conclusion

Average golfers hit the ball off-center far more often than dead-center. Because of that, the better your driver performs on off-center hits, the more distance and accuracy you'll average. Big Bertha Fusion is engineered to deliver extreme forgiveness in many more ways than the average driver. Big Bertha Fusion is more stable and resistant to twisting on off-center hits. Its face delivers more ball speed and distance on off-center hits. Its draw-bias negates slice-spin and promotes draw-spin. Its light weight and advanced aerodynamics promotes more swing speed. All of that makes Big Bertha Fusion the most-forgiving, easiest to hit driver we've ever created, helping you average more distance and accuracy to promote lower scores.