

THE EFFECTS OF DRIVER HEAD MASS ON BALL SPEED

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Introduction

When fitting a player for a driver, the search for the longest drive and highest ball speed nearly always considers shaft length and flexibility, and driver head size and forgiveness (measures of the moment of inertia, or MOI). An often-overlooked parameter, with very little discussion or experimentation in the field, is the mass of the driver head itself and its effect on performance. Theoretical calculations propose there is an optimal driver mass for energy and momentum transfer, but the few published experimental results are conflicting: one study¹ proposed that a light driver head would benefit every type and caliber of player, while another study² proposed that a heavy driver head performs better for players with faster swing speeds. To clarify these results, this work used both player testing data and computer simulation to investigate the effects of driver head mass variation, including the variations in driver head MOI that accompany changes in head mass.

Methods

Players with a range of handicaps (-4 to 9) and average club head speeds (93 to 116 mph) hit a standard 206-gram driver and collected ball flight and swing data using a Foresight GC2 launch monitor and Vicon motion capture system. An impulse momentum model of impact was used with controlled swings/inputs from experiment to verify the standard driver's ball speed values for varying impact locations with patterns confirmed in literature³. After validation, this model used the collected player and club data to simulate a player test with a range of driver head masses (and adjusted MOI) to generate ball speed, carry distance, offline distance, backspin, and sidespin rates, among other metrics. Finally, a sensitivity analysis quantified parameter dependence and determined the applicability to club fitting and design processes in general.

Results and Discussion

The preliminary investigation verified patterns of ball speed across the club face and validated the method. The simulated player test demonstrated that optimal driver head mass depends mainly on two parameters: the player's sensitivity of club head speed to changes in driver head mass, and club head speed with the standard driver. The player's standard club head speed determines the relationship (positive or negative correlation, peak location, etc.) between club mass and ball speed for given club head speed sensitivity values, which in a separate test ranged from a 0.6 to 1 mph decrease in club head speed per 10-gram increase in club mass. Figure 1 illustrates these findings: the opaque green trendlines in (A) and (B) show a 95 mph swing produces a maximum ball speed at 206 grams while a 115 mph swing produces a maximum at 226 grams when accounting for impacts around the face. These are slightly higher optimal weights than would be found when only looking at center strikes; additionally, ball speeds are reduced by 3-5 mph (see Figure 1: translucent versus opaque trendlines).

Overall, if a player's club head speed is not very sensitive to the mass of the driver head, then regardless of their standard driver club head speed, a heavy driver head is optimal. This result is intuitive; if a player is able to swing a heavier club with relatively little difference to the standard driver, the greater energy and momentum from the heavier driver yields greater ball speed and distance. This conclusion, though, may pose problems when considering factors such as playability, fatigue, overall set cohesion, and consistency, which weren't considered in this study but are suitable topics for further investigation.

Significance

Results from this study clarify previous reports on the optimal driver head mass for a player and provide useful insights for assessing driver models and configurations. Results can be used in various applications in both the club design and fitting processes.

Acknowledgments

This research uses proprietary data from PING, Inc.

References

¹: Kerr-Dineen, L. "Will a lighter clubhead help – or hurt – your swing?" ²: MacKenzie, S., Ryan, B., and Rice, A. "The Influence of Clubhead Mass on Clubhead and Golf Ball Kinematics" ³: Dewherst, P. *The Science of the Perfect Swing*

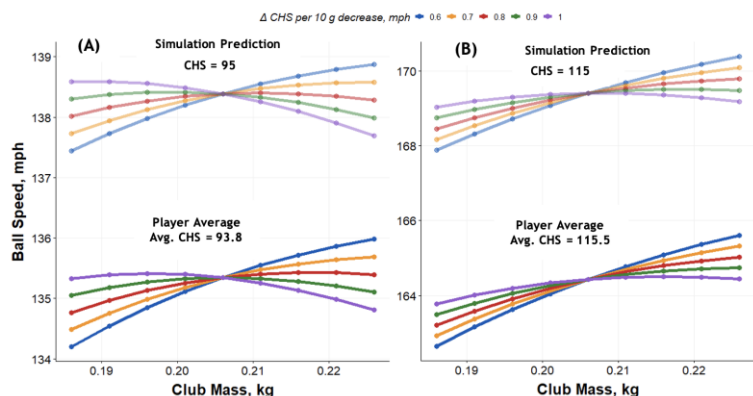


Figure 1: Club mass vs ball speed for two different club head speeds (A vs B), a range of club head speed sensitivities (colors), and center hits (translucent) vs realistic impact distributions (opaque)