R22-07 The effect of impact position on driving distance

R&A Rules Ltd., United States Golf Association

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1 Summary

The objective of these experiments was to investigate the effects of impact position, tee position, club loft and club type on the launch conditions and carry distance of a control ball when struck using the mechanical golfer.

2 Experimental Methods

The mechanical golfer and driver as described in the Overall Distance Standard (R&A Rules, Ltd.; USGA, 2019) was set up with a clubhead speed of approximately 115 mph to hit a two-piece control ball with a ball speed of 167 MPH, a launch angle of 10.5 degrees and spin of approximately 3,000 rpm as measured by a TrackMan launch monitor.

The ball position for this initial 'forward' setting was with the tee position 22.5 cm in front of the 'neutral' position at the bottom of the arc of the golf swing such that the ball was struck with a 1° upward angle of attack. The tee was positioned so that the ball was struck with the centre of the club face.

In addition to the Aeson driver, a 13-degree loft commercially available '3 wood' (3W) was utilized for this test. Both clubs were set up such that the ball flight was (near) straight for a centre impact as indicated by the launch monitor.

The tee height was changed such that the ball was struck from the centre of the face and then at 2-3 mm increments (depending on face depth) up (+ve) and down (-ve) the face until the edge of the face was reached. This testing was repeated for three tee positions: the neutral and forward positions as previously described, along with an intermediate position which bisected these two. Six shots were struck for each position at each tee height for each club.

In all tests, the power curve used by the robot was consistent.

3 Results

Figure 1. shows how ball speed varied with impact position up and down the face of the two clubs for each of the fore/aft tee positions. For ease of comparison, the data is plotted using the bottom of the face of each golf club as a common reference point. The driver has a deeper face at 53 mm, compared to the 3W that is only 35 mm deep.

Ball speed is shown to be dependent on impact position for both clubs in all three tee positions, with the lowest ball speeds observed towards the extremes of the club. The maximum speed observed for the driver was approximately 2 mm above the geometric centre of the face. At this impact location, the 'forward' tee position, produced approximately 1 mph lower maximum ball speed than

the other two tee positions. For the 3W, the maximum speeds for the intermediate and neutral tee positions were slightly above the centre of the face by 2 and 4 mm respectively whilst the maximum speed from the neutral position was observed when the ball was striking 2 mm below the centre of the face. The maximum ball speeds were higher for the driver than those for the 3W by approximately 3 mph comparing similar tee positions. The ball speeds from the 3W were higher than those from the driver for impact positions below approximately 16-18 mm from the bottom of the face of the club irrespective of tee position.

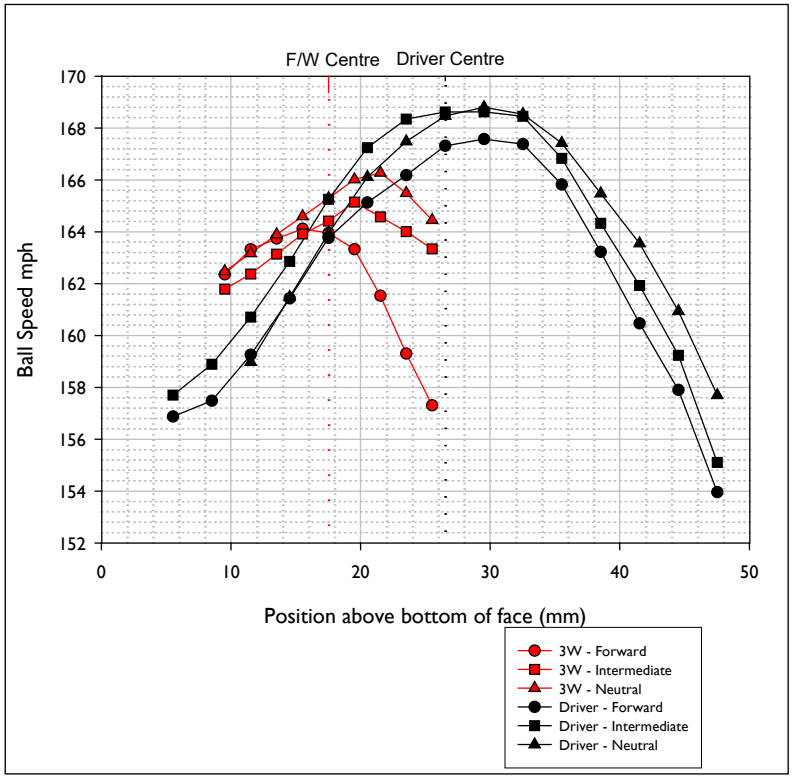

Figure 1. Ball Speed vs. impact position on the face for driver and 3W for forward, intermediate, and neutral tee positions. The respective centres of the two faces are denoted on the chart.

The launch characteristics of spin and launch angle attained for these tests are shown in Figures 2 and 3.

When considering spin (Figure 2), away from the edges of the face, the spin generated by both clubs for all three tee positions decreased as the impact point moves. There was an increase in spin on approaching the highest points on the driver face near the crown. There was also a decrease in spin for both clubs towards the bottom of the face. For the driver, the forward tee position produced highest spins for all impact positions and the neutral tee position generally the lowest (although near the centre of the face the differences are insignificant). For the 3W, the forward position generally produced the lowest spins and the intermediate the highest.

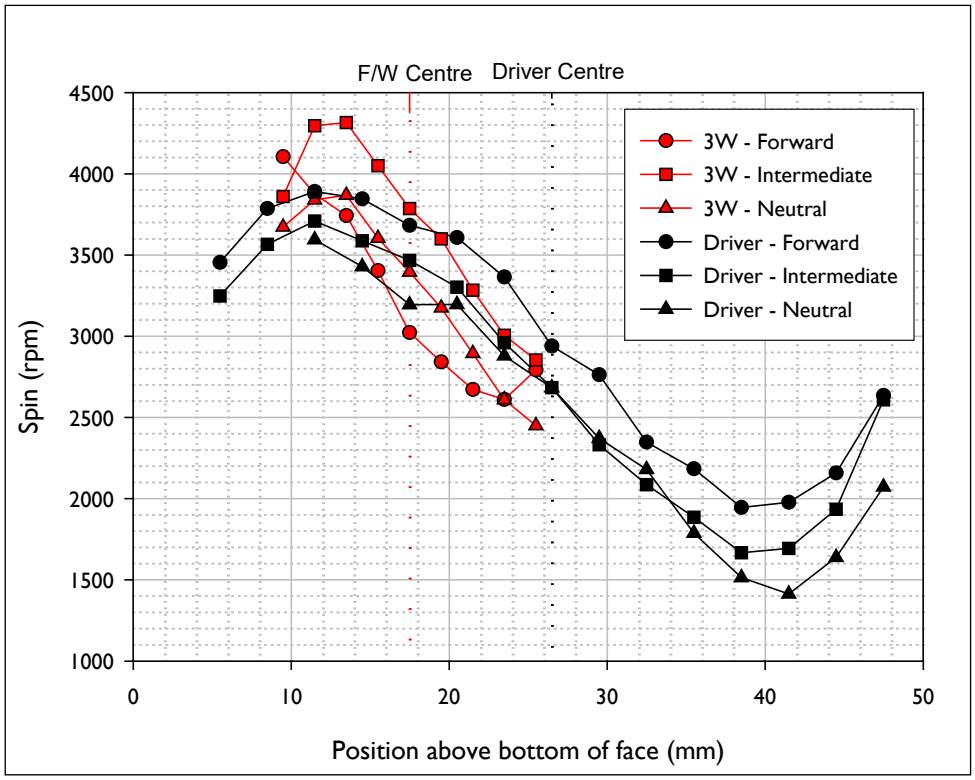

Figure 2. Spin vs. impact position on the face for driver and 3W for forward, intermediate and neutral tee positions.

Consideration of launch angle, Figure 3, shows that as impact position on the face became higher, so did launch angle, with forward tee positions also yielding higher launch angles.

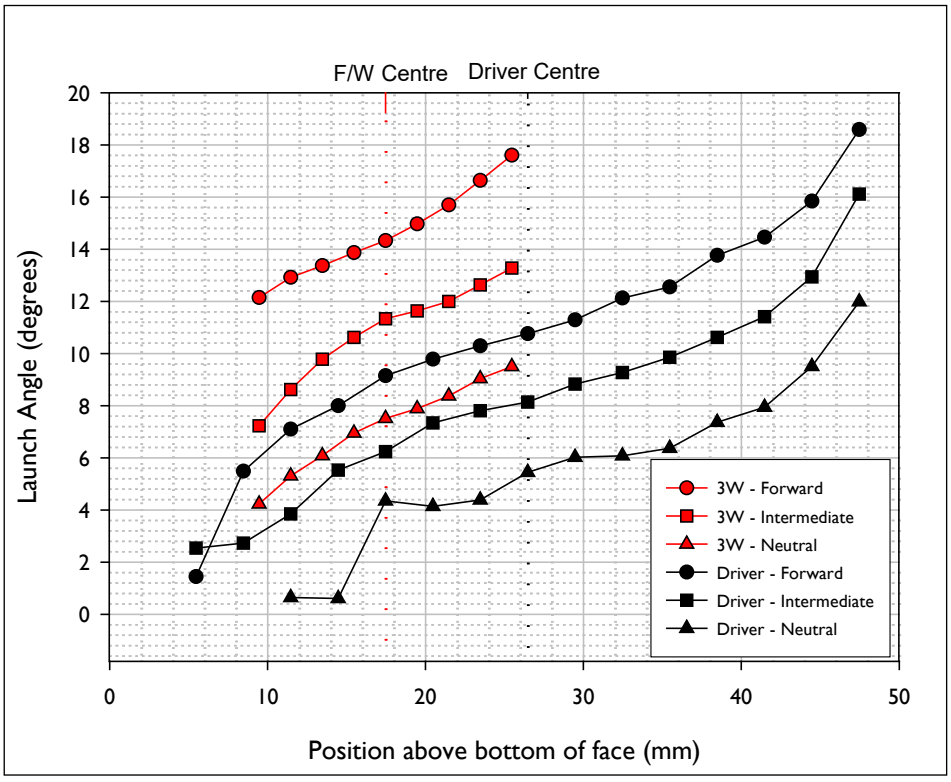

Figure 3. Launch Angle vs. impact position on the face for driver and 3W for forward, intermediate and neutral tee positions.

Launch angle is plotted against backspin for each tee position, Figure 3. Launch angle increases as the tee moves forward and with the increase in loft from driver to 3W. For a given club/tee position, there was a general decrease in backspin as launch angle increases. Both quantities do increase towards the top of the faces, but this may be attributed to interaction between the edge joining the face to the crown and the ball. For both clubs, the forward tee positions produced the highest launch angles for the same spin whilst the neutral positions produced the lowest.

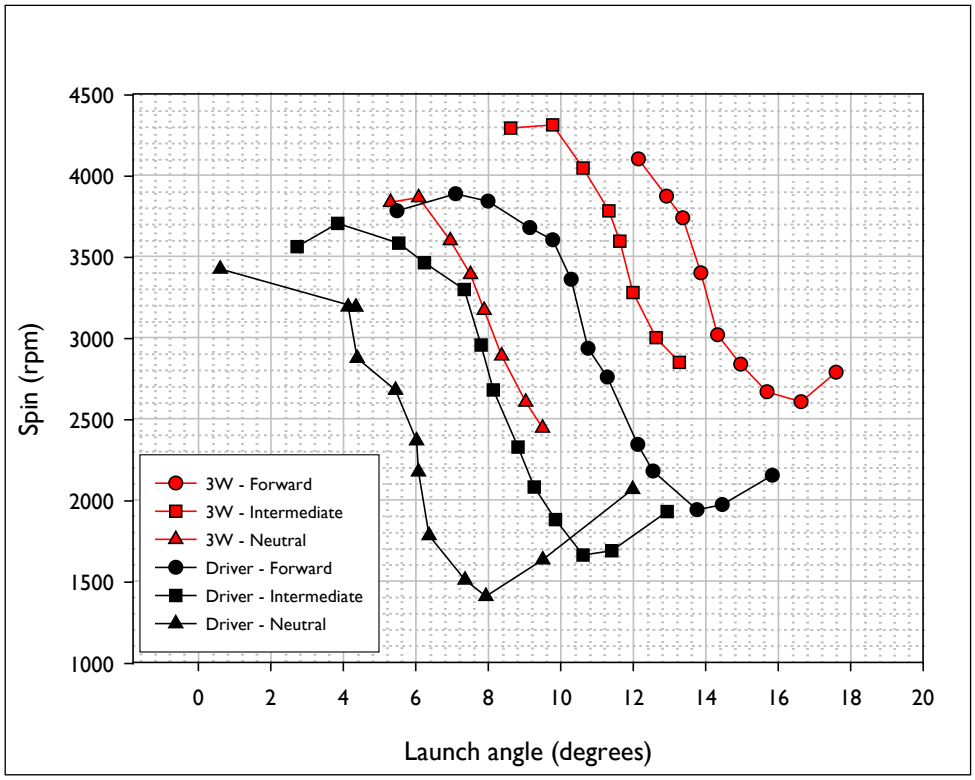

Figure 4. Spin vs. Launch Angle for the driver and 3W for forward, intermediate and neutral tee positions when struck from different positions on the face.

The carry distances measured by the TrackMan launch monitor during these tests are presented in Figure 5.

The carry distances were shortest when struck lowest on the face irrespective of tee position or club selection. These increased to a maximum generally just above the centre of the face before decreasing again. The driver tended to have a 'plateau' of carry distances above the centre of the face whereby there appears to be near similar carry distance for any impact above the centre of the face for the forward and intermediate tee positions. The forward tee positions typically yielded the longest carry distances and the neutral position the shortest. The maximum carry attained by 3W and driver were similar at just over 270 yards and at lower face positions, the 3W in the forward position was longest. It should be noted however that whilst this range of impact locations

and club paths can be investigated under laboratory conditions, they may not be achievable on the golf course due to the interaction between clubhead and turf.

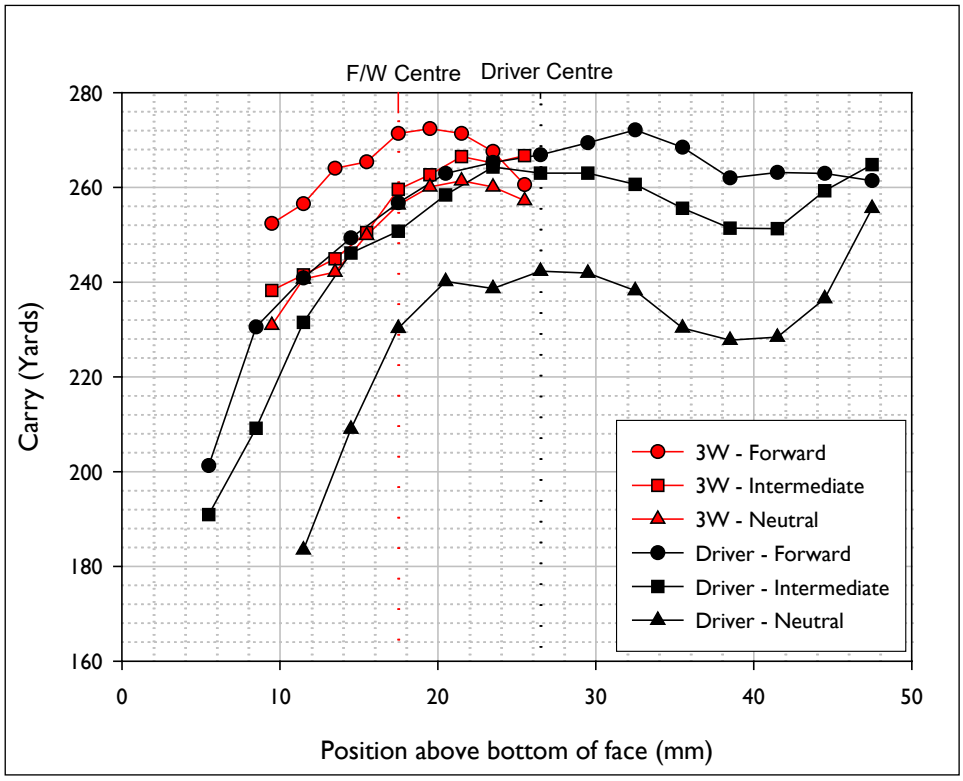

Figure 5. Carry distance vs. impact position on the face for driver and 3W for forward, intermediate and neutral tee positions.

4 Conclusions

In these tests, launch angle increased with impact position up the face for all setup variables investigated. Launch angle also increased for a forward impact position where the ball is struck on the 'upswing'.

Ball speed increased with impact position from the bottom of the face to a maximum point near the centre of the face (depending on setup) before decreasing as the top of the face is approached. Ball speed also decreased as the tee position is moved forward.

Away from the edges of the club, the spin generally decreased as impact location was moved higher on the face. Trends were inconsistent for the two clubs tested (the forward position produced most spin for the driver but the intermediate position produced most spin for the 3W).

Carry distance increased with impact position (from the bottom of the face) until a maximum was reached just above the centre of the face.