Official Response to questions posed on Tendulkar LBW.

2011 ICC Cricket World Cup Semi Final

**Introduction:**

In the 2011 ICC Cricket World Cup semi-final between India and Pakistan, Sachin Tendulkar was given out LBW off the bowling off Saeed Ajmal. He reviewed the decision and based on Hawk-Eye’s track the decision was overturned. This document will show that the path Hawk-Eye showed was accurate, and the Decision Review System was used correctly to overturn the Umpire’s original decision.

There are two main areas which have been questioned in the Hawk-Eye analysis of the Tendulkar lbw decision:

1. **The difference in position between the final real ball as seen on TV and the virtual impact position.**

2. **The apparent curvature of the Hawk-Eye trajectory post bounce as seen in the TV angle.**

To answer these points in turn:

**Why does the position of the virtual impact ball differ from the final “real” ball in the sequence?**

TV cameras take a picture of the action 50 times per second. As such there is NO frame of video that shows the impact point on the pad. The interception point is in between REAL balls, so to show this we insert a VIRTUAL ball.
Figure 1 – showing the last real ball before impact.

Figure 2 – showing virtual ball at impact.
The commentators said on air that Tendulkar had been “caught on the crease”. From the front-on angle it does look like Tendulkar has been hit when batting in his crease. However the Hawk-Eye system also captures the run-out angle (shown in Figure 3) allowing us to show how far down the wicket Tendulkar was out when struck (almost two metres).

**Why does the track appear to curve to the right?**

The trajectory of a ball is under the influence of gravity. In Figure 4 if you compare the path of the balls and the Hawk-Eye projection relative to a straight Red line, you can see the ball is on a flattening trajectory that will eventually bring it back to Earth. If the ball continued on the path in Red then it would end up on the moon!
Figure 5 is a grab of how the Hawk-Eye projection looks with the ball played through past the stumps, which shows the ball falling to Earth:

![Figure 5 – Hawk-Eye ball trajectory projection.](image1)

Figure 6 is a grab of how the track looks from side-on:

![Figure 6 – Hawk-Eye’s ball trajectory projection from side-on](image2)

Figure 7 shows the real balls lining up with the **BLUE** track, and the point at which the track goes from **BLUE** to **ORANGE** is the ACTUAL impact point.

You can see from the **ORANGE** track how the ball continually moves further away from the **GREEN** straight line with the REAL balls as they dip due to the force of gravity.
Figure 7 – Point of impact where BLUE track turns to ORANGE.

Whilst the ball arcs due to gravity as shown in figure 7, figure 8 and 9 show the track from above and directly behind including the ball interception point with the batsman. By drawing a straight line down the edge of the track we can see that the Hawk-Eye prediction does not deviate in any way after Tendulkar is hit.
Figure 8 – The ball track from above with a straight RED line to show the ball direction.

Figure 9 – Hawk-Eye’s virtual world showing the straight line of the balls track between bounce and impact.

For each ball bowled the Hawk-Eye system outputs a screen-shot showing our raw data. For reviewed LBWs this is sent to the ICC so that there is an independent check verifying the integrity of what is seen on TV for any DRS LBW decision. The ICC were happy with the outcome of this review.