by DR. GEORGE ONODA

Faster Than A Speeding Bullet?

How fast does the cue ball really travel on a typical break shot?

"HE'S GOING TO knock this ball in at 100 miles per hour...," whispered an ESPN announcer during a televised 9-ball match.

No, the announcer wasn't Joe Isuzu. But, the inference that the cue ball can travel 100 MPH made me curious. Just how fast *does* a professional pool player propel the cue ball on a 9-ball break shot?

I asked some of my pool playing friends, and their guesses ranged from speeds of 50 to 150 miles per hour. Since I had never seen this actual speed reported, I set off lo make such measurements.

Video tapes are a rich resource of top professional players in action. With modern technology, it is now possible to analyze these tapes in great detail, using slow motion and frame-by-frame stop action. The time between each frame is one-thirtieth seconds.

The average speed of a ball between two points can be measured from a video tape by knowing the distance traveled and measuring the time taken to travel this distance. Since the dimensions of a table are fairly standardized, the distance between the starting cue ball position and the loot spot where the one ball lies can be easily determined. For example, if the cue ball is placed on the head string, one diamond to the right of the head spot, the distance to the foot spot is typically 53 inches.

The time of travel is obtained from the number of video frames taken from beginning to end. The position of the cue ball in each frame is marked as a dot directly on the video screen. The result is a series of dots along the path. The spacing of the dots in the middle of (he path are measured. From this we can determine the total number of frames from the beginning to the end. The time from start to finish is equal to the number of frames times one-thirtieth second. Dividing this into the total distance gives the average speed of the ball in inches per second. This is converted to miles per hour. The measurements are accurate to around plus or minus one-quarter miles per hour.

To be certain that the frame counting method gives the right answer, spot checks were made using an entirely different technique. Here I used the sounds made when the cue hits the cue ball and when the cue ball hits the rack. With a special oscilloscope, which plots the sound intensity versus time, the time of travel (from one sound impulse to the next) could be accurately measured. It was found that this sound method and the frame counting method gave the same results.

These methods measure the average speed of the cue ball. Because the cue ball actually slows down gradually, the initial speed is slightly higher and the final speed is slightly lower than the average speed. But since the speed only diminishes by a few percent, the average speed serves adequately as a measure of the cue ball speed in a break shot.

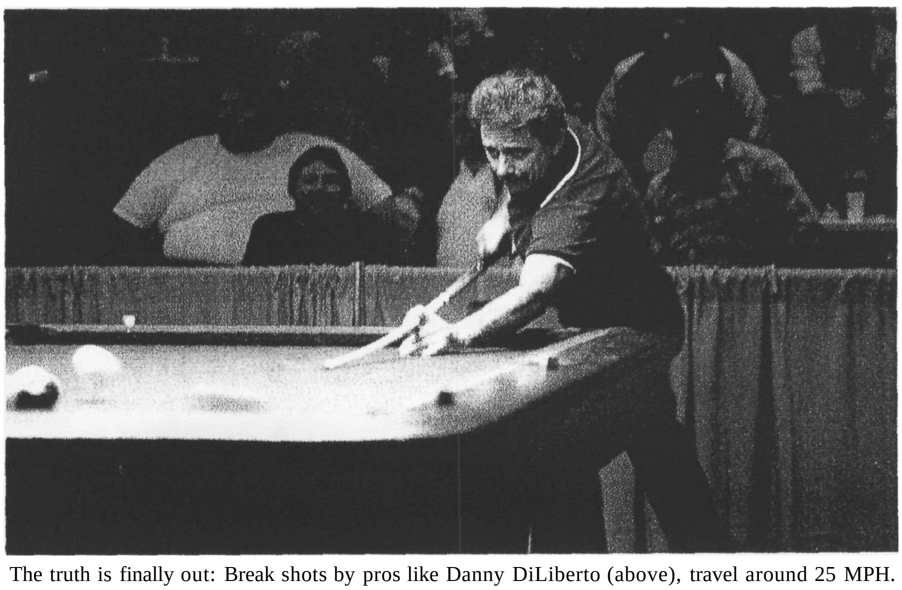
1 analyzed video tapes of some of the matches in the 1986 Resorts International tournament, and the 1987 Brunswick 9-Ball Team Challenge. (Players involved in the tapes included Mike Sigel, Jim Rempe, Allen Hopkins, Steve Mizerak, Nick Varner and Jose Garcia.) The speed of break shots ranged from 22 to 26 MPH, the average being 24 MPH. The top speed of 26 MPH was recorded for several break shots by Mike Sigel. At this speed, the cue ball reached the one ball in 0.12 seconds.

The speeds of break shots in several women professionals were also measured, using a tape of the Brunswick Team Challenge. In one break shot Jean Balukas propelled the ball at 22 MPH. Ewa Mataya, Belinda Bearden and Loree Jon Jones typically had speeds between 18 and 21 MPH. From this small sampling, the women's speed were on the average around 20 MPH, which is about 83 percent of the average for the men.

The three or four MPH variations in break shot speeds within players of the same sex might account in part for why some players have better break shots than others. But the tapes reveal that success, where a ball is made, was not strongly correlated with speed. Accuracy was equally important, which meant hitting the one ball in the right place and with the proper English. Often in successful break shots, the cue ball was observed to move about less after hitting the rack than with the unsuccessful shots, indicating that more of its energy has been transferred to the object balls.

In any event, the surprising truth is now revealed. The top speed that a professional propels a cue ball is around 26 miles per hour. Sorry to say that it is not 100 miles per hour, which is the top speed for throwing a baseball. While this may damage egos, take comfort in the fact that the cue ball weighs twice that of a baseball.

Dr. George Onoda is a research scientist al IBM's Research Division, as well as an avid pool and billiard player.



The truth is finally out: Break shots by pros like Danny DiLiberto (above), travel around 25 MPH.

Perfect Draw?

Test your draw shot against the best.

by DR. GEORGE Y. ONODA

STROKING THE BALL as low as possible is like sliding a coin to the edge of a table. The best and the worst differ by a gnat's eyelash. In pool, you either get a great draw or you miscue. Few players chance cutting it too close. But the closer you approach the brink, the better is the quality of your draw shot.

How low do you strike the cue ball? This cannot be determined from the usual draw test, where you measure how far a ball is drawn back in a head-on shot with an object ball. The draw distance depends not only on how low you hit the ball, but also on the force you apply and on the speed of the cloth. To reveal how low the cue ball is being struck, I have developed a method that you can easily carry out on a pool table.

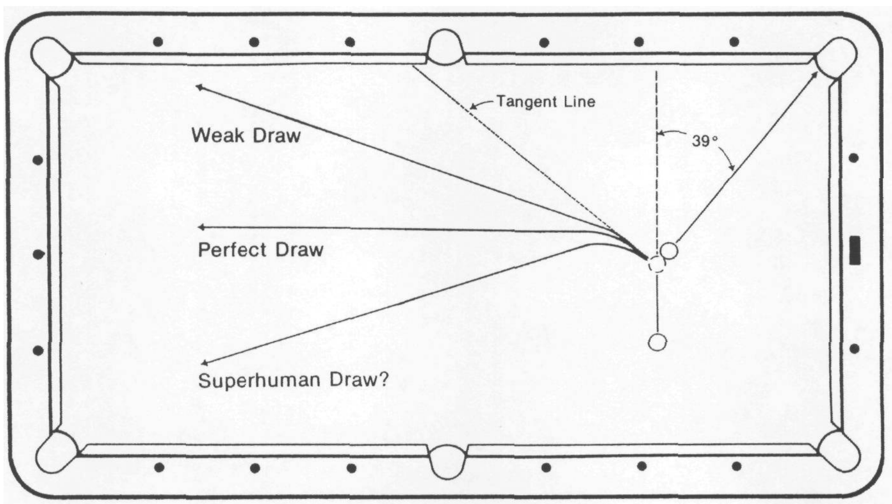
The setup for the method is illustrated in Fig. 1 (a regulation pool table is assumed). An object ball is placed 4% inches from the foot spot in the direction of the foot rail. Applying draw to the cue ball, the object ball is shot into the upper-right corner pocket. The cue ball is placed where the aiming direction is across the table, parallel to the foot rail. The cue ball must be as close as possible to the object ball, without interfering with the stroke, so that the least amount of back spin is lost when the object ball is reached.

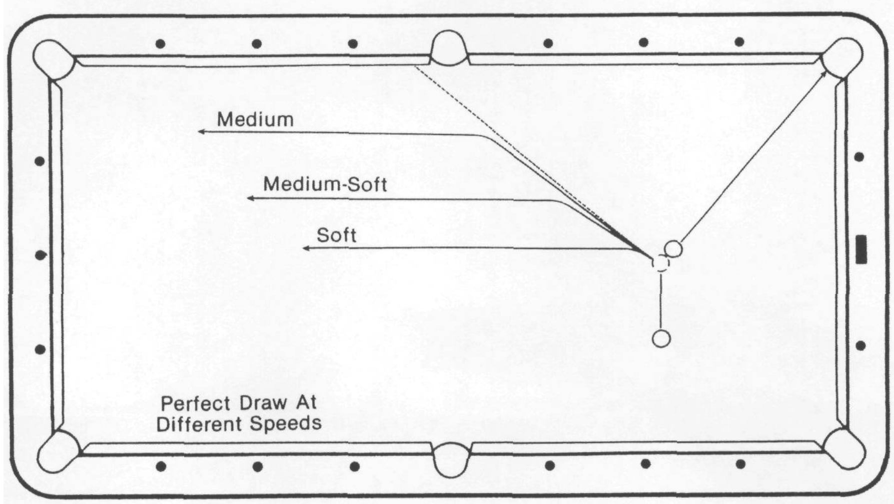
When the cue ball caroms off the object ball (Fig. 1), it initially travels along the tangent line (a line perpendicular to the direction that the object ball travels). Then the back spin curves the ball to the left, toward the head rail. After curving, the ball rolls along a straight path, or track.

The direction of this final track determines the quality of the draw. The closer this direction is to being parallel to the long rail, the lower the cue ball has been hit below center during the stroke. Altering the speed of the shot causes the length of the curve to change and the final track to shift. However, if the cue ball is struck the same distance below center, the direction of the final track remains the same irrespective of speed (see Fig. 2). The speed of the cloth also shifts the track but does not change its direction. This method works well with soft and medium strokes. If the ball is hit too hard, it will strike the long rail while it is still curving, and the final direction is not achieved.

This method is based on theory (the physics of pool). Let us suppose for sake of argument that the lowest a cue ball can be struck safely is around two-fifths the distance from the ball's center to the table surface. For the present, we will call this the perfect draw. Theory predicts that when the object ball is cut 39 degrees from the forward direction, the final track of the cue ball stroked with perfect draw and a horizontal cue will be perpendicular to the forward direction. In our setup, the object ball goes off at 39 degrees if sunk in the corner pocket. Since the cue ball is aimed parallel to the short rail, its final track ends up parallel to the long rail when a perfect draw shot is achieved.

Thanks to friends at the Jack and Jill Cue Lounge (Brewster, N.Y.), this method has been tested with players of varying abilities. The best players could sometimes, but not always, bring the ball parallel to the long direction. Less-skilled players had inclined tracks where the cue ball hit the long rail





before reaching the head rail. Interestingly, one player with an exceptional stroke seemed to be able to exceed the parallel limit by a few degrees. This might mean that the ball was struck lower than what we assumed for perfect draw. However, there is a little slop in our test, because the width of the pocket is more than twice the diameter of the ball. It is possible to cheat the pocket by about two degrees, which could explain how the parallel limit was exceeded slightly.

With this method, it is possible to test the truth about several assertions. One is that the cue ball can be hit significantly below the two-fifths point. If the ball could be struck half the distance from the center to the bottom, then the final track would exceed the "parallel limit" by around 12 degrees. This would be a shift sideways of almost one diamond for a forward travel of four diamonds, which would be very noticeable. There is also the question as to whether a partially inclined cue aids in increasing draw. In our setup, the cue must be inclined (slightly elevated) by at least five degrees because of the interference of the rail. If this causes an increase in the amount of draw compared with a horizontal cue, then increasing it even more (e.g. 20 degrees) should have a pronounced effect and cause the track course to exceed the parallel limit significantly. (A masse shot with a near-vertical cue is another matter, which we do not include in this discussion.)

So the question is, can the parallel limit of the track be exceeded significantly by any means other than a strong masse shot? Is it possible to cause the track to point toward the bottom-left corner in Fig. 1, for example? If any reader can achieve this seemingly superhuman draw, let me know, as it will give us new insights on the physics of draw. Please be reminded that the test is valid only if: 1. The balls are in the right position; 2. Your aim is parallel to the short rail; and 3. The object ball is sunk in the corner pocket. It is helpful to have someone watch to be certain that you are aiming parallel to the short rail as you shoot.

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