David Alciatore ("Dr. Dave") **ILLUSTRATED PRINCIPLES**

"Draw Shot Primer – *Part III: using the trisect system*"

***Note**: Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP) can be accessed and viewed online at **billiards.colostate.edu**. The reference numbers used in the article (e.g., **NV 3.8**) help you locate the resources on the website. If you have a slow or inconvenient Internet connection, you might want to view the resources offline using a CD-ROM. See the website for details.*

This is the third article in a series dealing with draw shot principles. In the last two months, we explored some of the basic physics of draw shots and compared various aiming systems for predicting the path of the cue ball. This month, we'll look at the *trisect aiming system* in more detail. In particular, we'll look at an easy way to implement the system using your hand for visualization.

Diagram 1 illustrates the *trisect system*. The cut angle (A) is defined as the angle between the aiming line and the impact line. As summarized in **Principle 29**, for a "typical" draw shot, with good action, the angle between the final cue ball direction and the impact line (2A) is twice the cut angle (A). Therefore, the total angle between the aiming line and the final cue ball direction is three-times the cut angle (3A = A + 2A). The impact line trisects (divides by one third) the total angle (i.e., A is 1/3 of 3A). That's why I call the method the trisect system. It could also be called the *double-angle* or *twice-the-angle* system since 2A is twice A. (**NOTE** - In last month's article, Principal 29 and the right side of Diagram 4 had a slight error. The angle "A" wasn't measured from the correct line. The angles are measured from the aiming line direction, not from the initial line through the cue ball and object ball as shown last month for the other aiming systems. I've repeated Principle 29 here with the correction made. Sorry for any confusion this might have caused.)

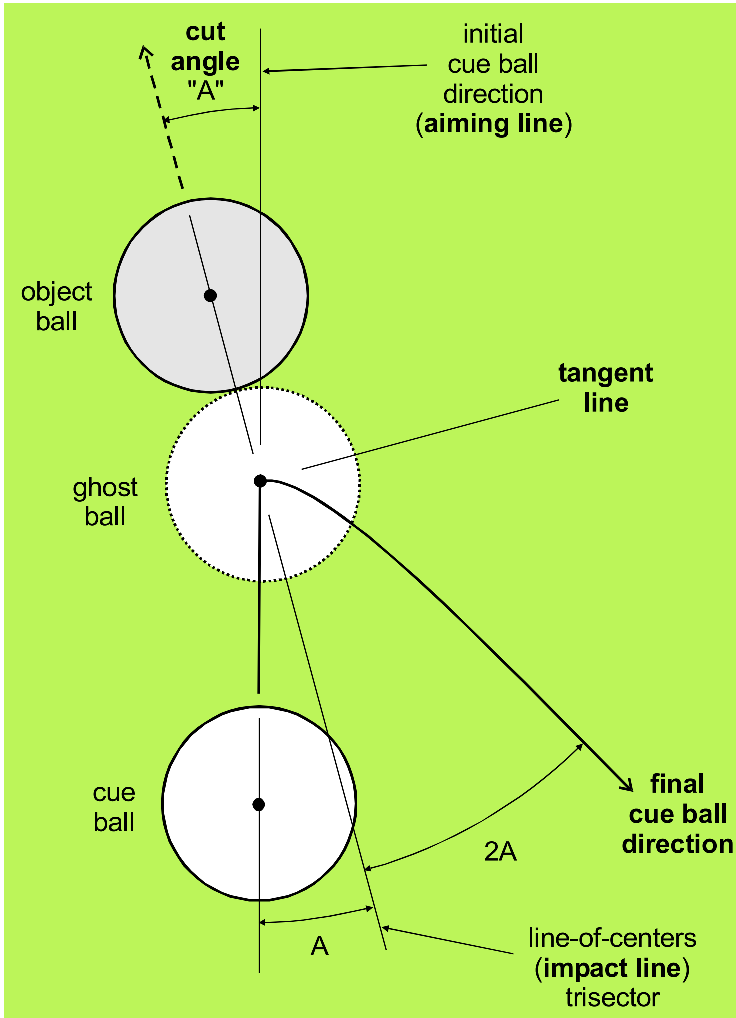


Diagram 1 Draw shot trisect system

> **Principle 29 Trisect draw aiming system**
>
> For a typical amount of draw, the angle between the final and initial cue ball directions is three-times the cut angle, and the impact line trisects the angle.

It is important to remember from last month that the trisect draw system applies only to draw shots with a "typical" amount of draw. You might remember from previous months that a "typical" amount of draw is defined as the amount of draw required to change the cue ball's direction by 90° for a half-ball hit, where the cue ball center is aimed at the edge of the object ball. For a draw shot with less action than "typical," the angle labeled 2A in Diagram 1 will be larger than 2A; and for a draw shot with lots of action, the angle will be smaller than 2A. A good way to get a feel for "typical" draw is to hit half-ball hit shots at various speeds, distances, and cue tip offsets and observe when the resulting cue ball path angle is typical, less than typical, or more than typical (see Diagram 4 below).

Diagram 2 shows an example shot where the goal is to pocket the stripe in the bottom-left corner pocket. But you also need to know (or be able to control) where the cue ball will go. We might need to detect a possible scratch, avoid traffic created by surrounding balls, break out clusters, or just plan accurate position for the next shot. The most important skill in pool is being able to pocket a ball (actually, for some people, it might just be to have fun), but the second most important skill is to be able to visualize the direction and path the cue ball will take to set up good position for the next shot.

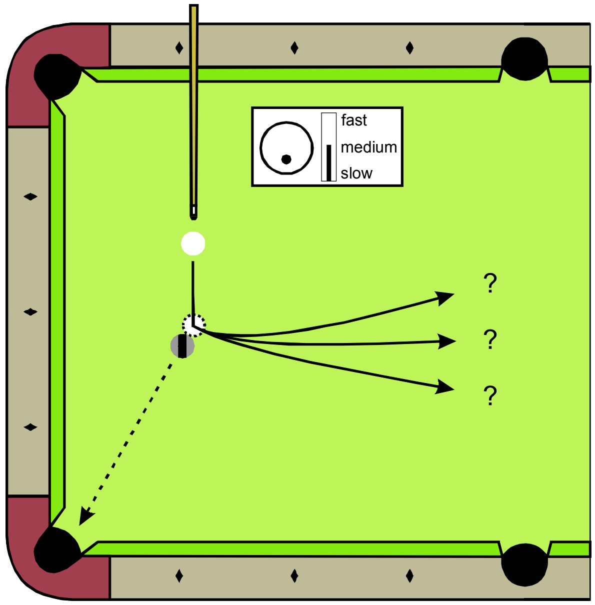


Diagram 2 Example shot

As with the peace-sign implementation of the 30° rule (see **NV 3.8** and my past articles dealing with the 30° rule), you can use your hand to help measure the cut angle and visualize the final cue ball direction for the trisect system. **Diagram 3** shows how it's done. The first step (see hand position **1** in the diagram) is to align you index and middle fingers with the aiming line and the desired object ball direction (the impact line). This defines angle "A" (the cut angle). The angle vertex point shown in the top right of the diagram is defined by the intersection of the lines through the two fingers. Your hand should be positioned so the vertex point is above the center of the ghost ball target. The next step (step 2) is to pivot your hand in the direction of the cut, while keeping the angle between the fingers fixed, so the aiming line finger (in this case the index finger) is now aligned with the impact line (i.e., pivot your hand so the index finger points in the original middle finger direction). If you have trouble visualizing where to stop the first finger, use the cue stick (or your other hand) to mark the second finger direction before pivoting your hand to the new position. Diagram 3 shows the second hand position offset from the first hand position (to prevent clutter in the illustration), but in practice it is better to just pivot the hand in place. The final step (step 3) is to repeat step 2 from the current hand position. Steps 2 and 3 rotate the hand the total angle of 2A and the final second-finger (in this case, the middle finger) will now be parallel to the final cue ball path (see the diagram). If the hand had been pivoted in place, the middle finger, in the final position, would be aligned more closely with the final cue ball path. I know all of this might sound a little complicated, but give it a try (using this paragraph and the example in Diagram 3 for guidance). It's actually quite easy once you get the hang of it.

normal video

NV 3.8 – Using your hand to visualize the 30° rule

One thing you might notice about Diagram 3 is that the final cue ball direction for this shot is perpendicular to (i.e., 90° away from) the original (aiming line) direction. This is because the shot happens to be a half-ball hit, which corresponds to a 30º cut angle. Remember that if a "typical" amount of draw is used for a half-ball hit, the cue ball changes direction by 90º. So in this case, the angle formed by the fingers is 30º. So if you have tried the peace-sign aiming method for the 30º rule (see **NV 3.8**) before, this shot will be an easy example to try out first. For smaller cut angle shots the fingers will be closer together, and for larger cut angle shots the fingers will be farther apart. (The angle vertex point, per Diagram 3, will also be in different positions for different cut angles, but it should always be located above the center of the ghost ball.) If you have trouble comfortably using your index and middle fingers for larger cut angles, you can use your thumb and index fingers instead. The procedure will still be the same.

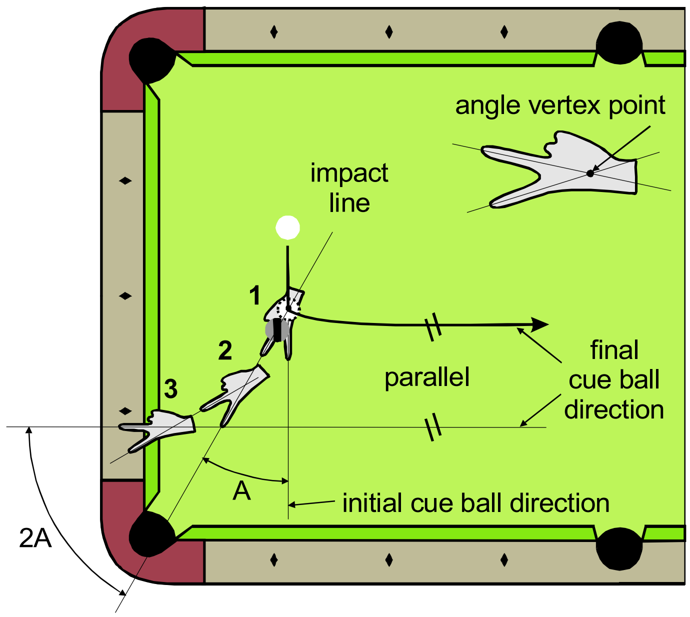


Diagram 3 Using your hand to visualize the final cue ball direction

As an alternative to trying to visualize angles, one can use distances instead. In Bob Jewett's October '04 article, he illustrated the *X/2X system* that uses distances instead of angles to predict the cue ball direction. This method is easy to apply and works well for small cut angles, but it becomes more difficult and less accurate as the cut angle increases. However, if you have trouble visualizing angles, the X/2X system might be a better alternative for you. As with all of my articles, Bob also has his past articles posted online for reference. My articles can be found at ***billiards.colostate.edu*** (under "Instructional Articles"), and Bob's can be found at **www.sfbilliards.com/articles/BD_articles.html**.

Well, by now you might be (or, at least, I hope you are) thinking: "It can't be that easy. What's the catch?" Well, the catch is that the amount of draw action and the shot speed also affect the path of the cue ball. Also, it can be difficult (and takes lots of practice) to accurately control the amount of draw action. Diagrams 4 and 5 show the effects of spin and speed for the shot in Diagram 3. **Diagram 4** shows what happens if you have less or more draw action than "typical." With excellent draw action, the cue ball will draw back more than expected (e.g., see the blue curve). And with less draw action than "typical" (which will be more common with beginner and intermediate players), the cue ball will come up short (e.g., see the red curve). With no draw action (bottom spin) at all at object ball impact (i.e., for a stun shot), the cue ball would travel straight down the tangent line. If the cue ball loses all draw action and starts to develop roll on the way to the object ball, the cue ball will follow past the tangent line. The amount of draw action depends on the cue ball distance to the object ball and the shot speed. The cue ball loses backspin with distance, especially at lower speeds (e.g., see **HSV 3.1**). Therefore, to achieve the same amount of draw for a lower speed shot, you need to strike the cue ball lower than with a faster speed shot.

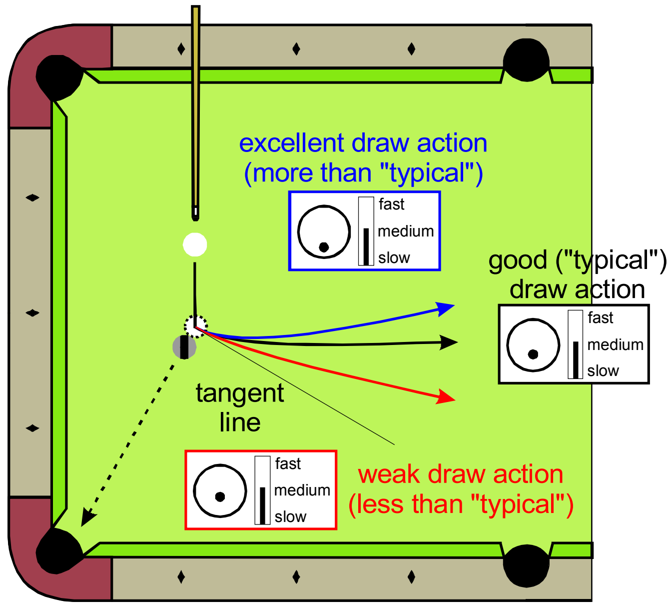
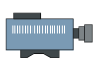


Diagram 4 Draw action effects


high-speed video

HSV 3.1 – Stop shot showing loss of bottom spin over distance

As shown in **Diagram 5**, shot speed also affects the shape of the cue ball path. With more speed, the cue ball travels farther down the tangent line before turning to the final direction. The diagram shows three different speed shots, all with the same amount of draw action. Note that for all three shots, the final cue ball paths are all still in the same direction (i.e., the same angle away from the aiming line), but the higher speed paths are offset farther down the tangent line. With higher speed, it takes longer for the cue ball to curve to the final direction (e.g., see **NV 4.21**). To adjust for this in your aim, you can shift your hand along the tangent line (more with more speed) to get a better prediction of the final cue ball path. The shifting is identical to the method illustrated in my June '05 article dealing with speed effects for the 30º rule.


normal video

NV 4.21 – Delay of draw curve with higher speed

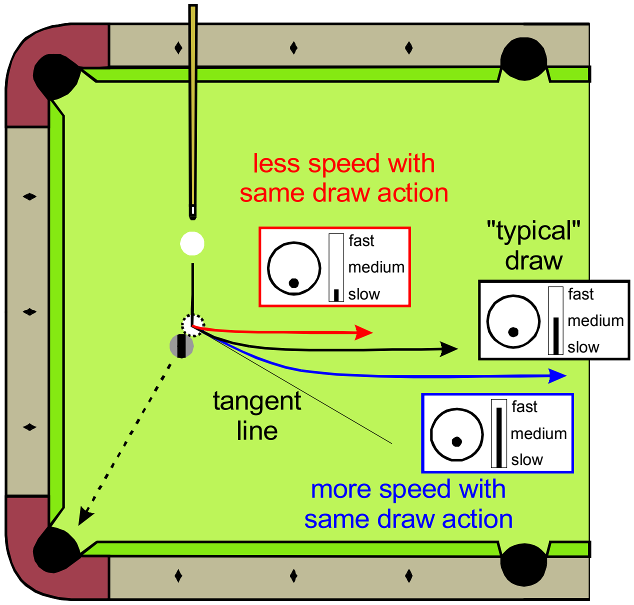


Diagram 5 Speed effects

Another thing to notice in Diagram 5 is the differences among the cue tip offsets shown in the spin/speed boxes for the three shots. The cue ball is assumed to have the same amount of backspin (as a percentage of the shot speed) for all three shots (see **TP A.20** for the technical details). But since the draw action wears off faster for a slower speed shot, a larger tip offset is required (i.e., you must hit the cue ball lower) when using less speed.


technical proof

TP A.20 – The effect of spin, speed, and cut angle on draw shots

I hope you are enjoying my series of articles on draw shot physics and aiming. Next month, we'll look at some example shots you might come across in game situations where some of this knowledge can be put to good use.

Good luck with your game,
Dr. Dave

PS:

- If you want to refer back to any of my previous articles and resources, you can access them online at ***billiards.colostate.edu***.

Dr. Dave is a mechanical engineering professor at Colorado State University in Fort Collins, CO. He is also author of the book: "The Illustrated Principles of Pool and Billiards."