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

# The 90° rule
## Part III – Carom and Billiards Shots

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***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 3.4**) help you locate the resources on the website.*

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In my previous two articles, I introduced the 90° rule. It states that when the cue ball strikes an object ball with no topspin or bottom spin, the two balls will separate at 90°, regardless of the cut angle. The cue ball leaves along the tangent line, which is perpendicular to the impact line (see **Diagram 1**). **Principle 1** and **NV 3.4** summarize and illustrate the important points of the rule. The 90° rule is very useful for helping to prevent scratches (see Part I in the January, 2004 issue) and to plan break-up and avoidance shots (see Part II in the February, 2004 issue). In this article (Part III) we will look at how the 90° rule can also be used to plan carom and billiards shots. We will also see how the 90° rule is important in position play.

**Principle 1 90° rule**

***With a stun shot where there is no topspin or bottom spin, after impact the cue ball will depart along the tangent line, which is perpendicular (at a right angle) to the impact line. In other words the cue ball and object ball paths, after impact, will be 90° apart (see Diagram 1, NV 3.4 and TP 3.1).***

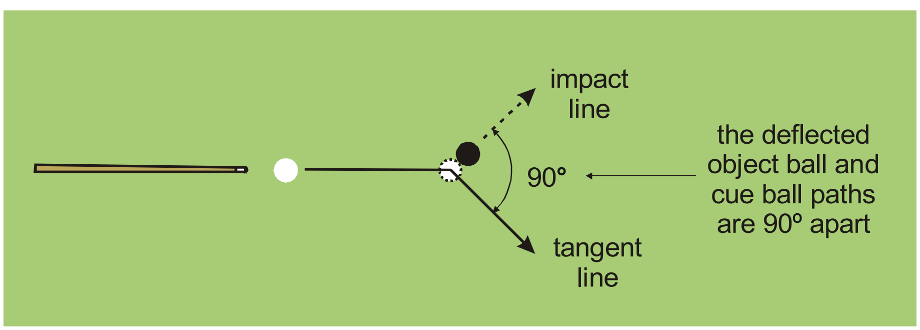


**Diagram 1 The 90° rule impact and tangent lines**


normal video

**NV 3.4** – 90° rule with various entering angles


technical proof

**TP 3.1** – 90° rule

With a **billiard shot**, you deflect ("kiss") the cue ball off one object ball into another to pocket the second object ball (see **Diagram 2**). In a **carom shot**, you deflect ("kiss") an object ball off a second object ball to send the first object ball into a pocket or into another target (see **Diagram 3**). Billiard and carom shots can be difficult and intimidating at first, but if you are comfortable with the 90° rule, these shots can be extremely useful weapons in your arsenal.

In **Diagram 2**, a billiard shot is used to deflect the cue ball off the 1-ball to pocket the 2-ball. Slight bottom English is used to achieve cue ball stun at contact with the 1-ball. If no bottom spin were used with the slow to medium speed shown, the cue ball would start rolling before reaching the 1-ball and the 90° rule would no longer apply (the cue ball would not deflect as much). The stun results in the cue ball deflecting off the 1-ball perpendicular to (i.e., exactly 90° away from) the impact line with the 1-ball. After deflecting off the 1-ball, the cue ball travels along the tangent line to pocket the 2-ball (see **NV 7.2**). Given the ball layout in **Diagram 2**, this shot is the only one with a reasonable chance of pocketing a ball. Fortunately, if you can visualize the impact line and cue ball ghost ball position (see **NV 3.1**) required to create the cue ball tangent line path, the billiard shot is easy to execute. The easiest way to aim the shot is to first visualize the post-impact cue ball tangent line to the target ball (e.g., using your cue stick), then visualize the required impact line perpendicular to that line (see **NV 7.2**). Then aim at the first object ball to drive the cue ball along this line.

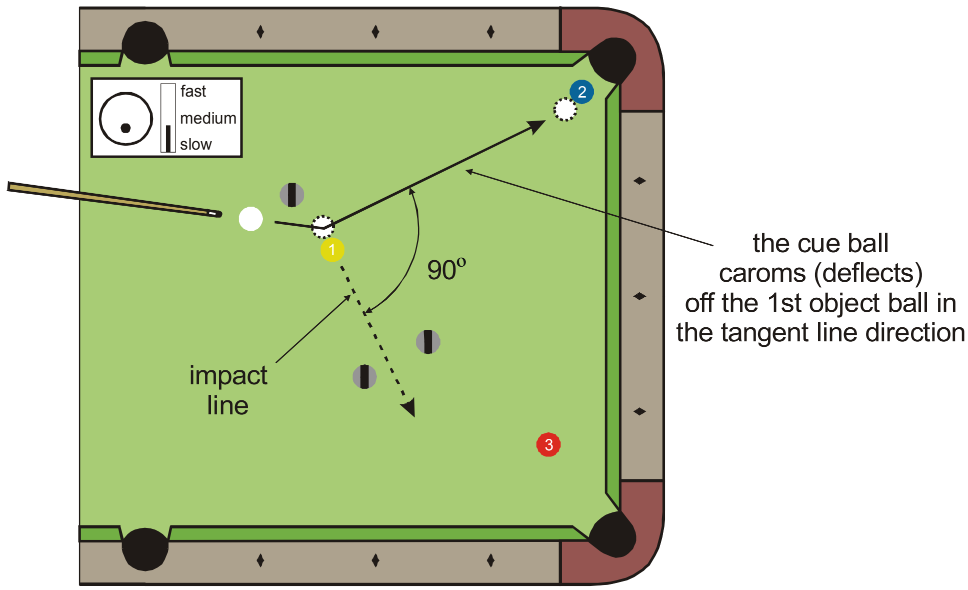


**Diagram 2 Cue ball billiard shot**


normal video

NV 7.2 – Cue ball billiard shot


normal video

NV 3.1 – Practicing contact point and ghost ball visualization

The 90° degree rule, in addition to applying to a cue ball striking an object ball, also applies to one object ball striking another. However, the requirement of stun still applies. In other words, the first object ball must be sliding and not rolling when it strikes the second object ball. For this to be the case, the first object ball must be either struck hard (by the cue ball) or be close to the second object ball so it doesn't have enough time to develop much roll (i.e., it will be mostly sliding across the felt). If the first object ball is rolling when it strikes the second, the two balls will separate at less than 90° as with a follow shot. **Diagram 3** shows a carom shot where the 1-ball is deflected off the 5-ball to pocket the 3-ball. This shot sounds complicated, but it really is not much more difficult than the cue ball billiard shot shown in **Diagram 2**. It would be much more difficult if the cue ball were farther away from the 1-ball and if a larger cut angle were required on the 1-ball. The aiming procedure is the same as above. First visualize the 1-ball tangent line path, then visualize the perpendicular impact line for the 5-ball, and then aim the 1-ball at the 5-ball to send the 1-ball along the tangent line (see **NV 7.3**). One major difference with object ball carom shots versus cue ball billiard shots is that you do not have as much control over the spin of the carom ball (e.g., the 1-ball in **Diagram 3**). With a billiard shot, you have total control over the cue ball English. But with an object ball carom the only way to ensure stun for the carom ball impact is to hit the shot hard, especially if there is significant separation distance between the carom object ball (the 1-ball) and the first impact ball (the 5-ball). In **Diagram 3**, because the 1-ball is fairly close to the 5-ball, the speed does not need to be excessive, but it still needs to be fairly fast. If the shot were hit much softer, the 1-ball would be rolling by the time it gets to the 5-ball and the 1-ball would deflect away from the tangent line.

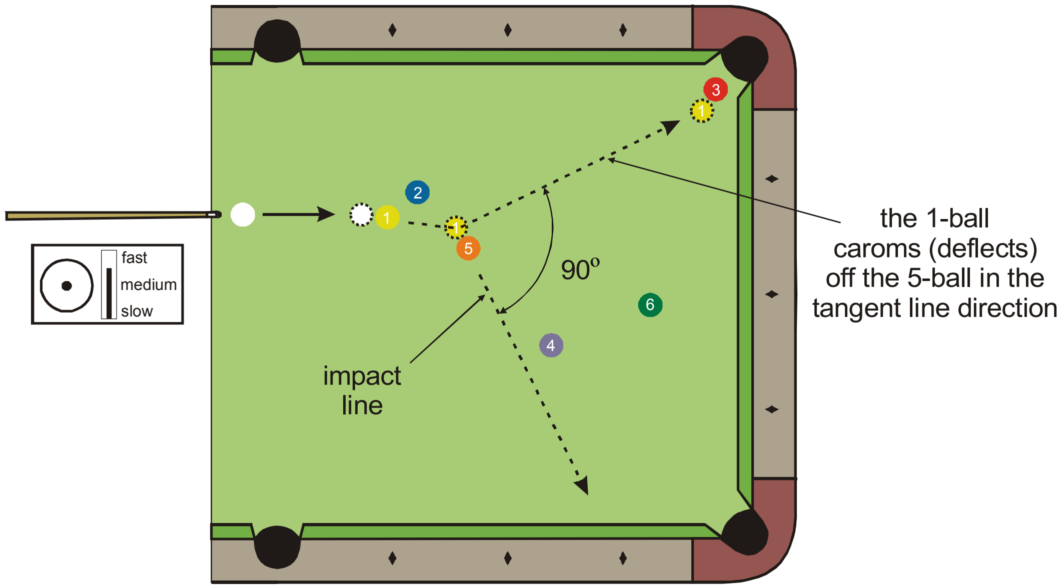


**Diagram 3 Object ball carom shot**


NV 7.3 – Object ball carom shot

In Parts I, II, and III of this article series, we have seen how the 90° rule can be used to help prevent scratches, plan break-up and avoidance shots, and plan carom and billiard shots. I want to close the series by showing how the 90° rule is also an invaluable tool for good position control, where you need to predict where the cue ball will go in planning a subsequent shot. **Diagram 4** shows an example of how the 90° rule is used along with good speed control to achieve good cue ball control. In the diagram, the 90° rule is used to help determine the path the cue ball will take after pocketing the 1-ball. The only thing that remains is to judge the speed necessary to have the cue ball travel the correct distance along the path. The diagram shows how different speeds are used to achieve position for three different follow-on shots. If your goal is to achieve position for the 2-ball shot after the 1-ball shot, a soft draw (bottom English) shot is appropriate. The draw is required to ensure the cue ball will be sliding (i.e., be in stun) by the time it impacts the 1-ball. If the cue ball were hit with a center stroke, it would be rolling (with topspin) when it hits the 1-ball. In that case, the cue ball and 1-ball would not separate at 90° (the angle would be less than 90°). If your goal is to achieve position for the 3-ball shot instead, you would use more speed, and less draw is required. For the 4-ball position shot, because the shot is hit fairly hard, the cue ball can be hit with a center stroke. For a higher speed, the cue ball does not have time to develop roll before hitting the 1-ball.

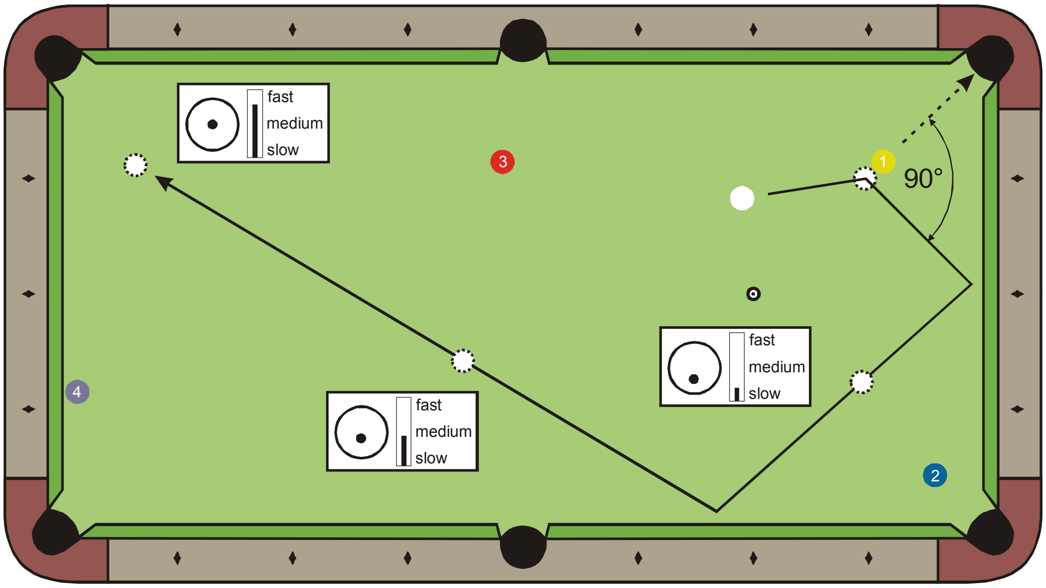


**Diagram 4 The 90° rule as an integral part of position play**

With all three shots in **Diagram 4**, knowledge of the 90° rule allows you to predict the path of the cue ball after impact with the object ball (the 1-ball). This reduces position play to a simple matter of speed control. If you can predict the direction of the cue ball path and have a good feel for speed, you will be a good position player. The only way to gain good speed control skills is to practice a lot. As with all articles in my series and with the other article series in the magazine, you should always try to practice all of the shots shown to help you develop the skills and intuition necessary to be able to apply the techniques in games that count.

Hopefully, after this series of articles, you will appreciate the importance of the 90° rule and be able to use it in your game. In the next series of articles, we will look at the lesser-known 30° rule, which is also very useful for predicting the path of the cue ball after hitting an object ball.

Good luck with your game,
Dr. Dave

*Dr. Dave is a mechanical engineering professor at Colorado State University in Fort Collins, CO. His book, "The Illustrated Principles of Pool and Billiards," is coming out this August.*