*Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, technical proofs (TP), and all past articles are available online at **billiards.colostate.edu**. Reference numbers used in the articles help you locate the resources on the website.*

I recently posted online video **NV J.76** that demonstrates several ways to accurately predict carom direction for rolling-CB shots. As shown in **Diagram 1**, the carom angle is the amount the cue ball (CB) changes direction after colliding with the object ball (OB). Being able to predict this is useful to detect a possible scratch, plan break-out and carom shots, and visualize position-play paths through "traffic." Below, I summarize all important highlights from the video.

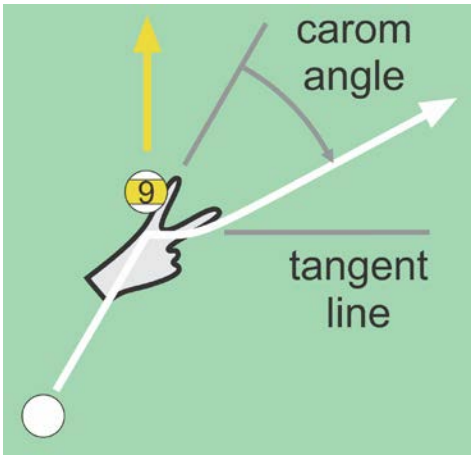

Diagram 1 Carom angle

1. 30˚ Rule Peace Sign

If you have followed my articles over the years, you have read a lot about my 30˚ rule peace sign technique (see **Diagram 1**) used to predict CB carom direction for rolling-CB shots between ¼-ball and ¾-ball hits. If your peace sign is well calibrated, and if you know how to adjust it for different shots, you can very accurately predict where the CB will head with a follow shot. For more information and video demonstrations, see the 30˚ rule FAQ resource page at ***billiards.colostate.edu***.

2. Full and Thin Hits

For cuts fuller than a ¾-ball hit, the 3-times-the-angle system gives good results. As demonstrated in **NV J.76**, you can use your cue to visualize the cut angle and copy it three times to find the predicted carom direction. You can also approximate CB carom direction for cuts thinner than a ¼-ball hit using the 70% rule. As also demonstrated in the video, for a thin hit, the CB heads in a direction 70% (or about ¾) of the way from the aiming line to the tangent line.

3. Rolling Carom Angle (RCA) System

Wouldn't it be nice if there were a single system that could accurately predict rolling-CB carom direction for any cut angle? Well, there is such a system. It was originally discovered in the early 1800s by the great mathematician and physicist Coriolis. For those interested (I know most of you won't be), online analysis **TP A.4** shows the math and physics of the system. The theoretical carom direction for a rolling CB is always

along a line 2/7 of the way from the tangent line to the CB aiming line. I call it the Rolling Carom Angle (RCA) system.

Since 2/7 is close to 1/4, fellow columnist Bob Jewett suggested you can use your cue or any known length to help visualize this direction. As shown in **Diagram 2**, starting with the tip at the ghost ball (GB) position, with the cue pointing to the pocket, parallel shift the cue along the tangent line until the butt of the cue is aligned with the aiming line through the CB and GB position. The quarter point on the cue, which is easy to visualize by taking half of half, will then point to the CB carom direction. In **NV J.76**, I show how you can also use just the shaft length instead of the full cue to apply the system.

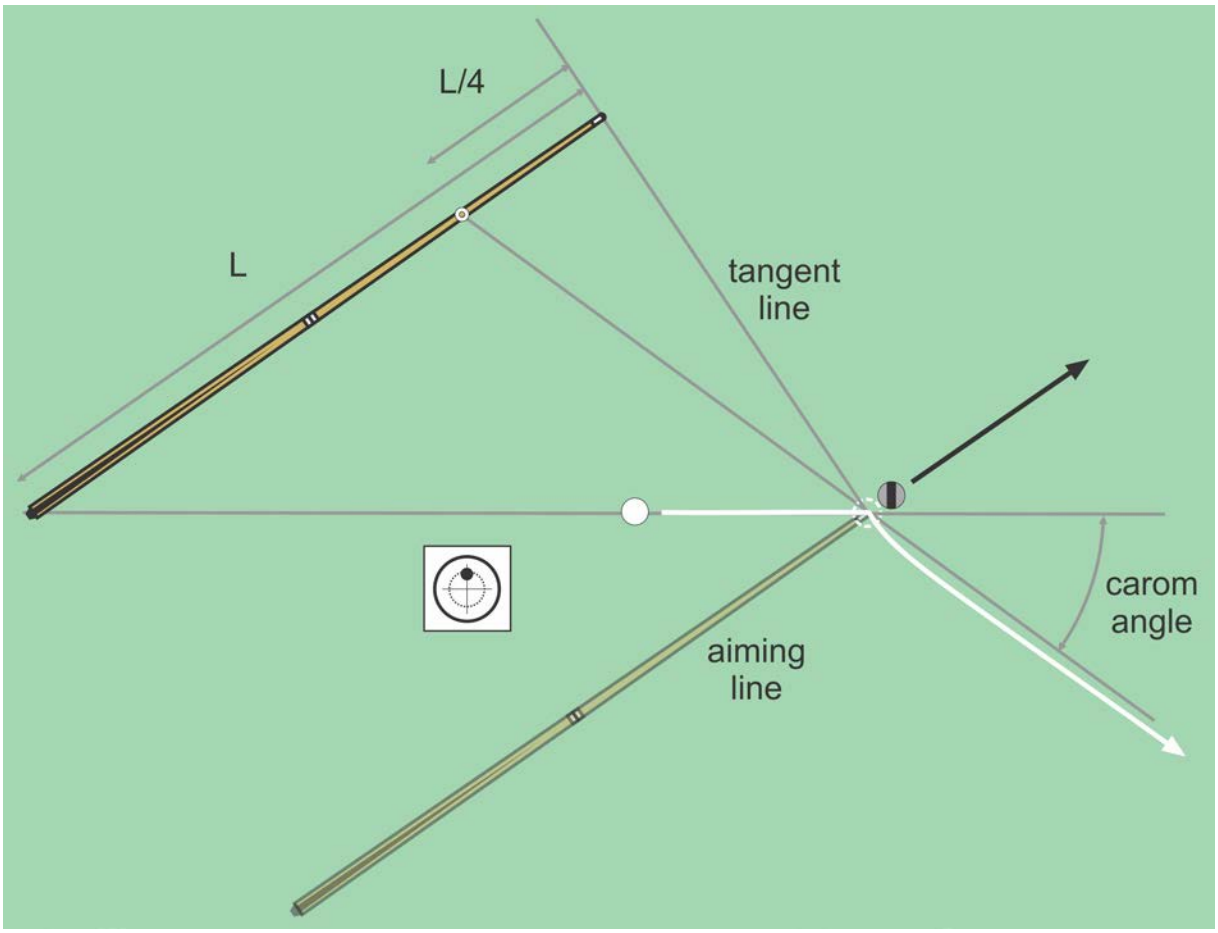

Diagram 2 RCA System

4. CB Line RCA

Patrick Johnson on the AZB online forum recently suggested that instead of using the cue which can sometimes be awkward, you can just visualize a line between the CB and tangent line and find the 1/4 point of that (see **Diagram 3**). I recently did an analysis (**TP B.24**) to determine the length proportion (instead or 2/7 or 1/4) that would yield perfect results. 2/7 is a theoretical value assuming a perfect CB-OB collision with no energy loss or friction effects. And 1/4 is just an easy-to-visualize approximation of the theoretical value. Based on my new analysis, the optimal length fraction is 0.281. 0.281 is between 1/4 (.25) and 1/3 (0.33) so an improved technique is to visualize between a quarter and third of the length, which is fairly easy for most people to do. You can also just estimate: “a little more than a quarter.”

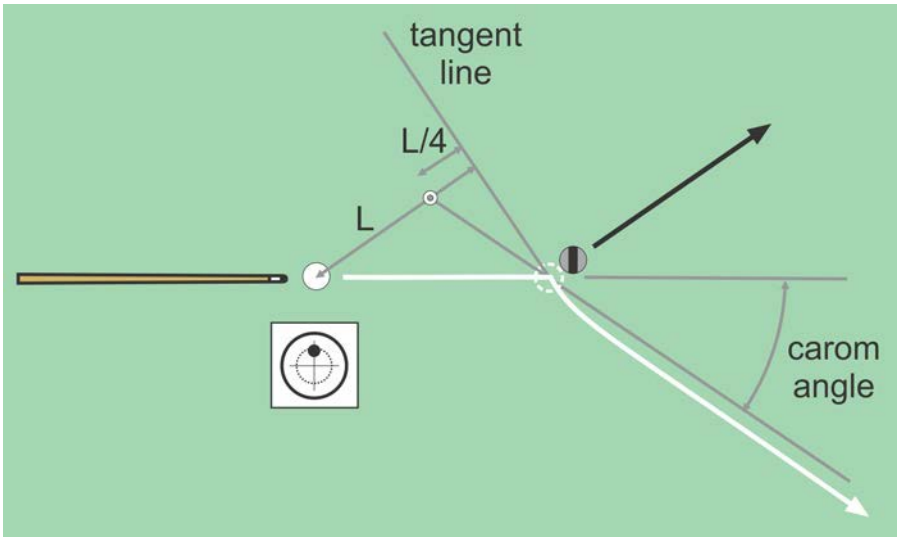

Diagram 3 CB line RCA

5. Marked-Cue RCA

An easier and more accurate approach is to mark the 0.281 point on your cue. Then you won't need to visualize or estimate anything. If using the full length of a standard 58″ (147 cm) cue, the 0.281 point is at 16.3″ (41 cm). This is too close to the bridging and visible part of the shaft, so it is better to mark the butt instead. In **NV J.76**, I use only the butt as the reference length. If the butt is the standard 29" length, the point should be at 8.2″ (20.7 cm). Luckily, this is right in the middle of my wrap, so I don't really need to mark it. As demonstrated in the video, start with the butt end at the GB and parallel shift until the other end is in line with the CB and GB. Then a line through the point and GB gives the carom direction. The 0.281 point works well for every cut angle from very full to very thin.

6. Perpendicular RCA

With any of the RCA approaches, instead starting with the cue along the aiming line and shifting down the tangent line, you can instead start with the cue along the tangent-line and shift along the line to the pocket (see **Diagram 4**). This technique is also demonstrated in the video. The approach you choose is a matter of preference, and one approach might be easier to reach and visualize than the other in different shot situations.

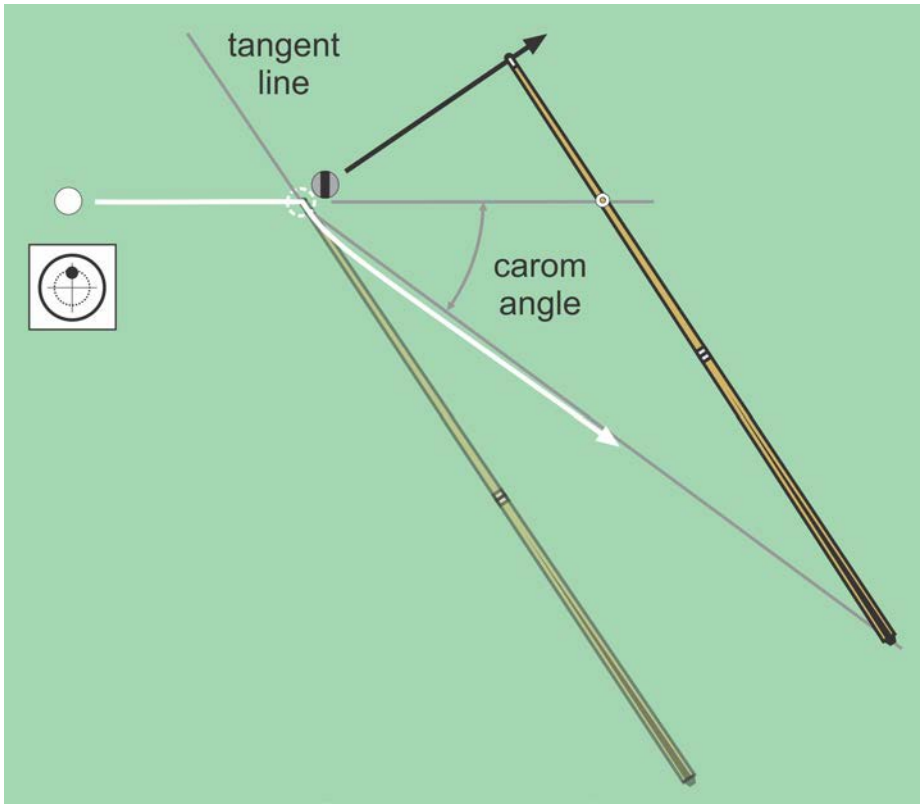

Diagram 4 Perpendicular RCA

7. Speed Effects

With all carom systems, it is important to account for shot speed. With faster speed, the CB persists on the tangent line longer before curving to the predicted CB carom angle. With a slow shot, the CB curves almost immediately and no correction is required. However, at fast speed, you need to parallel-shift the carom angle down the tangent line more with more speed. You need to practice to develop a feel for how much to shift at different angles and speeds, and this will vary some with cloth conditions. It is good to start with a fast-speed ½-ball hit to see the most the carom angle will shift. Then you can use proportionally less shifts at slower speeds. Again, at slow speed, no shift is required.

With the cue-based RCA approaches, it can be difficult to shift the cue along the proper directions and keep it parallel during the shifts. If you are not very careful with each step of the process, your carom direction predictions will not be very good. That's why I like the peace sign approach better. It is fast, easy, and accurate (assuming your peace-sign is well calibrated, which is easy to do), and it doesn't require any thought, estimation, or difficult visualization. Even when the balls are far away and tough to reach, you can still be fairly accurate using the "air peace sign" technique demonstrated in **NV J.76**. The other methods are interesting theoretically, they also apply to cuts very full or very thin, and they give accurate results if used very carefully, but I suspect most people will have trouble with them. But give all the systems a try and see what works best for you.

Good luck with your game,
Dr. Dave


normal video

NV J.76 – Rolling-Cue-Ball CAROM ANGLE Systems


technical proof

TP A.4 – Post-impact cue ball trajectory for any cut angle, speed, and spin
TP B.24 – Estimating Rolling CB Carom Angle with 1/4 Cue Point

PS:

- I know other authors and I tend to use lots of terminology, and I know not all readers are totally familiar with these terms. If you ever come across a word or phrase you do not fully understand, please refer to the online glossary at ***billiards.colostate.edu***.

Dr. Dave is a PBIA Advanced Instructor, Dean of the Billiard University, and author of the book: The Illustrated Principles of Pool and Billiards and numerous instructional DVD series, all available at: ***DrDaveBilliards.com****.*