"Rolling Cue Ball Deflection Angle Approximations" ILLUSTRATED PRINCIPLES

David Alciatore, PhD ("Dr. Dave")

*Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP), and all of my past articles, can be accessed and viewed online at **billiards.colostate.edu**. The reference numbers used in my articles will help you locate the resources on the website. If you have a slow or inconvenient Internet connection, you might want to view the resources from a CD-ROM or DVD. Details can be found online at: **dr-dave-billiards.com**.*

This article summarizes some useful techniques for approximating the path a rolling cue ball (CB) will take after striking an object ball (OB) when the hit is fairly thin or fairly thick.

I have covered the topic of CB control in many past articles, all of which are available at **billiards.colostate.edu**. In my April '04 article, I presented the 30º degree rule, which predicts that a rolling CB will deflect by about 30º degrees (the "natural angle") for the wide range of cut shots between a ¼-ball and ¾-ball hit. The rule is illustrated in **Diagram 1**. The clear message of the diagram is that even though the OB is being cut by very different amounts in the three shots, the CB still heads in nearly the same direction after impact. This "natural angle" can be easily visualized at the table using your hand, as demonstrated in **NV B.66** and **NV B.75**. For more information, see "Dr. Dave peace-sign technique" under "30º rule" in the FAQ section of my website.

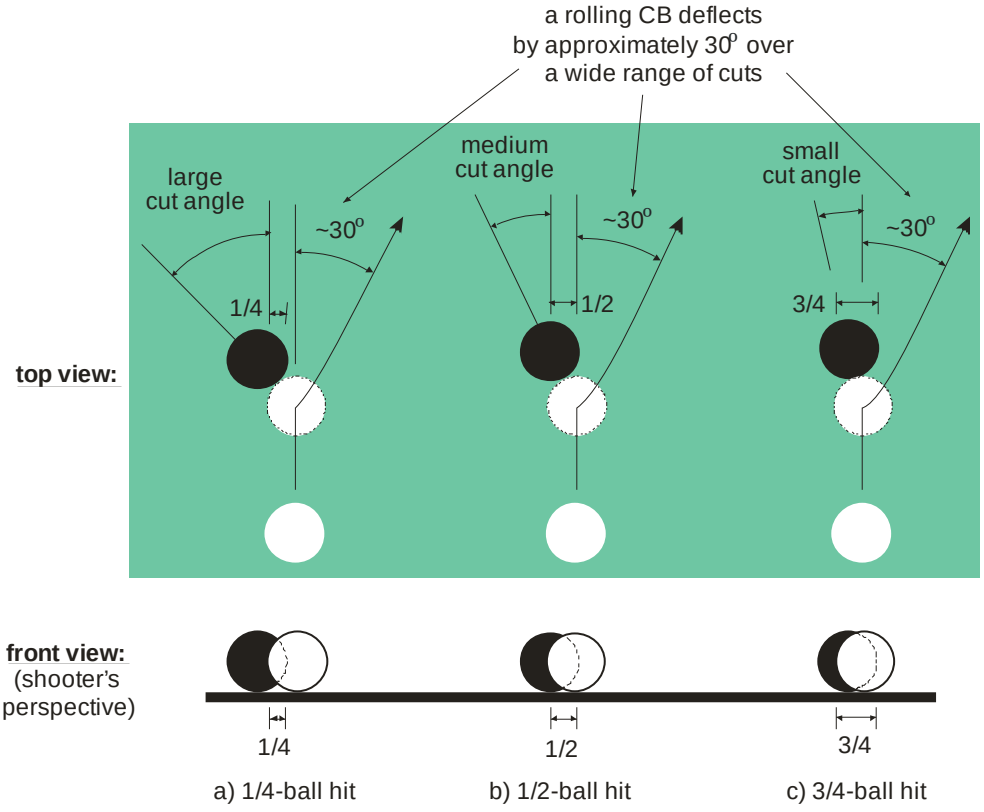

Diagram 1 30º rule

Being able to predict CB direction is critical for avoiding scratches, playing position for the next shot, avoiding obstacle balls, breaking up clusters, and aiming carom and kiss shots. For examples, see **NV B.46**,

NV B.68, **NV B.69**, and **NV B.75**. In addition, all CB control topics are covered and demonstrated in detail on Disc I of the Video Encyclopedia of Pool Shots (VEPS), which I created recently with past BD columnist Tom Ross.

The 30º rule begs an obvious question: How do you predict CB direction for shots thinner than a ¼-ball hit or thicker than a ¾-ball hit, where the rule doesn't apply? Well, as indicated earlier, that's the topic of this article. In 1989, George Onoda wrote a technical article in the *American Journal of Physics* offering suggestions for how to approximate CB deflection angles for different amounts of cut. His analysis assumed perfectly elastic balls with no friction. Recently, I did an analysis to take into account the non-ideal properties of real pool balls. If you have a math and physics background, you might be interested in checking out Onoda's article (which is available in the Physics Resources section of my website under "technical articles") and the new analysis (**TP B.13**). Even if you don't want to see a bunch of math and physics, you still might find the results interesting and useful.

Diagram 2 illustrates one result of the analysis. For a fairly thin hit (less than a 1/4-ball hit), the angle a rolling CB will deflect is about 70% of the angle from the original CB direction to the tangent line. The right side of the diagram shows how the approximation is applied. You first visualize the line of the shot and the tangent line, which is perpendicular to the desired OB direction. You then picture 70% of this total angle. The left side of the diagram shows an easy way to visualize this 70%. Because 70% is close to ¾, bisecting the angle twice (see the red and blue lines) provides a reasonably close approximation.

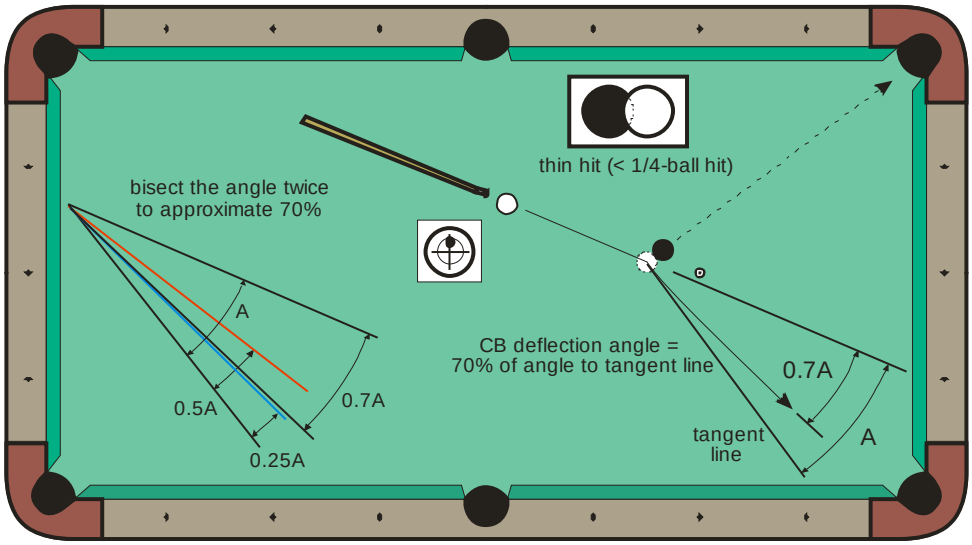

Diagram 2 Thin hit 70% approximation

Diagram 3 illustrates another result from **TP B.13**. For a fairly full hit (more than a ¾-ball hit), the angle a rolling CB will deflect is about 3-times the cut angle of the shot. To apply this rule, note the cut angle of the shot ("A" in the diagram) and then visualize three-times this angle ("3A") on the opposite side of the aiming line. As with the trisect system, which applies to draw shots (see **NV B.67**), you can use your cue or fingers to construct this angle.

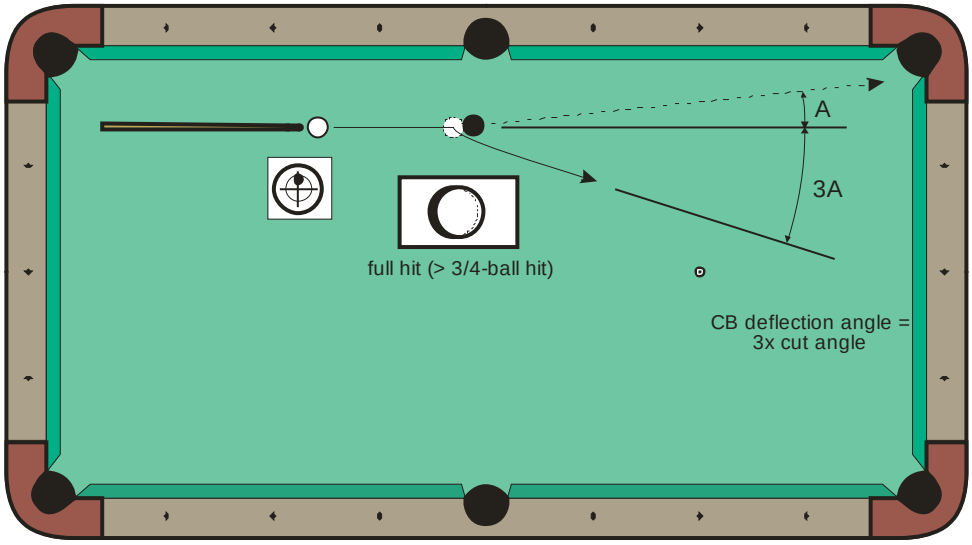

Diagram 3 Full hit 3x approximation

Another conclusion from the analysis in **TP B.13** is that the "30º rule" should probably be called the "35º rule" instead, because the average natural deflection angle with typical equipment is closer to 35º than 30º. However, I still think "30º rule" sounds better, so I won't be changing the name. The actual number isn't important anyway. What really matters is being able to judge the "natural angle" (e.g., by using the Dr. Dave peace sign technique) and knowing how to adjust this angle at the extremes of the rule. As demonstrated in **NV B.66**, for cuts closer to a ¼-ball hit and a ¾-ball hit, the angle will be slightly less than the average "natural angle;" and for cuts closer to a ½-ball hit, the angle will be slightly more. And, if you want to be precise with CB control, it is also important to know how to make adjustments for speed. With both follow and draw shots, the CB persists along the tangent line longer at higher speeds before curving to the final direction, as demonstrated in **NV B.45** and **HSV B.23**. For more information, see "speed effects" under "30º rule" in the FAQ section of my website.

normal video

NV B.45 – Cue ball path speed effects
NV.B.46 – Cue ball path scratch avoid, cluster break-out, and carom example
NV B.66 – The 30-degree rule, from VEPS I
NV B.67 – The trisect system for draw shots, from VEPS I
NV B.68 – Tweener cluster breaks, from VEPS I
NV B.69 – NV B.69 - Carom shots, from VEPS I
NV B.75 – 30-degree-rule natural-angle examples, from VEPS III

high-speed video

HSV B.23 – Cue ball path speed, spin, and cue elevation effects

technical proof

TP B.13 – Cue ball deflection angle approximations

I hope you find the methods in this article useful in your game. Be sure to try them out the next time you play. Next month, we'll look at some approximations that can help in estimating CB direction for draw shots of various amounts of cut.

Good luck with your game,
Dr. Dave

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 don't fully understand, please refer to the online glossary on my website.
- I want to thank Jim Valasina. He graciously proof-reads my articles every month to help find errors and make suggestions. My article quality is better as a result of his efforts. Thanks again Jim!

Dr. Dave is author of the book, DVD, and CD-ROM: "The Illustrated Principles of Pool and Billiards," the DVD Series: "The Video Encyclopedia of Pool Shots," and the DVD: "High-speed Video Magic."