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

"90° and 30° Rule Follow-up – *Part II: speed effects*"

***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. You might also want to view the resources from a CD-ROM. See the website for more details.*

In last month's article, I answered a few basic questions that have come up concerning my series of articles on the 90° and 30° rules (see my January through June, 2004 articles at ***billiards.colostate.edu***). In the next few articles, I'll look at the important effects of English, speed, and other factors on the 90° and 30° rules. If you don't remember what the 90° and 30° rules are and when they apply, see **NV 3.4-3.5** and **NV 3.7-3.10**. Readers with engineering or physics backgrounds might also find **TP 3.1** and **3.3** interesting. Remember, the 90° rule states that for a stun shot, where the cue ball is sliding at object ball impact, the cue ball and object ball paths separate at 90° (i.e., the separating paths are perpendicular). The 30° rule states that when the cue ball is rolling at object ball impact, and when the cut angle is between a 1/4-ball and 3/4-ball hit fraction, the cue ball's path will be deflected by approximately 30°. If these previous two sentences are not clear, you might want to look at the online videos and articles mentioned above.

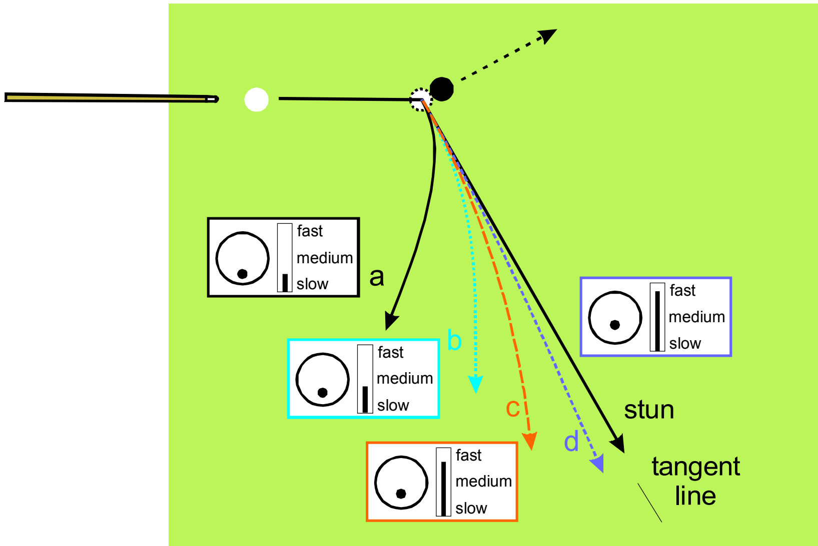

normal video

NV 3.4 – 90° rule with various cut angles
NV 3.5 – Using your hand to visualize the 90° rule impact and tangent lines
NV 3.7 – Using the 90° rule to check for and prevent a scratch
NV 3.8 – Using your hand to visualize the 30° rule
NV 3.9 – 30° rule example
NV 3.10 – Using the 30° rule to check for and prevent a scratch

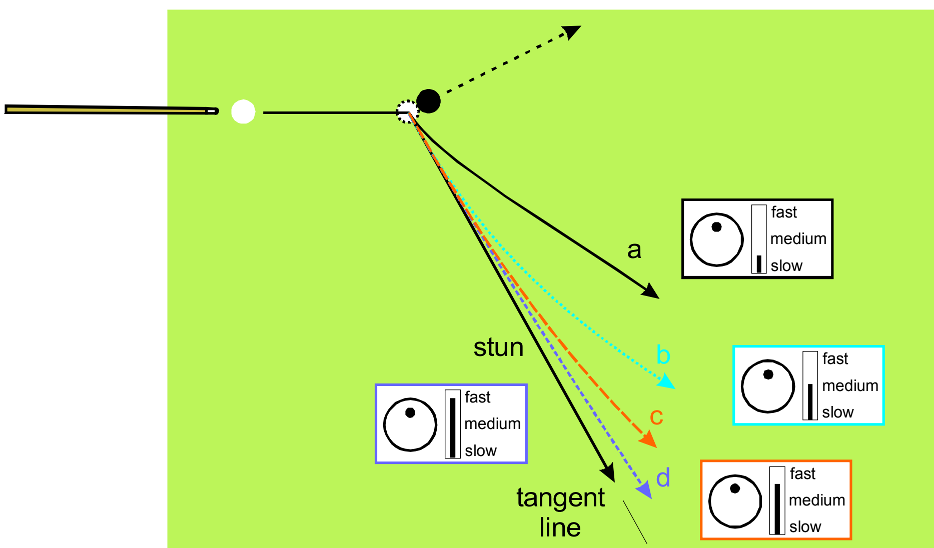

technical proof

TP 3.1 – 90° rule
TP 3.3 – 30° rule

Diagrams 1 and **2** show the effects of speed and vertical-plane spin (draw, follow, or stun) on the 90° rule. **Diagram 1** shows the speed effect for draw shots. The cue ball is assumed to have the same amount of bottom spin at impact with all four shots. That's why a lower draw stroke is required at the slower speeds. The speed is slowest for shot "a" and fastest for shot "d." Note how the cue ball travels farther down the tangent line direction with increased speed. **Diagram 2** shows the effect of speed on follow shots. The cue ball has normal roll in each shot. **Principle 17** summarizes the main conclusions that can be drawn from the diagrams. The harder a shot is hit, the longer the cue ball stays on the tangent-line path before curving due to follow or draw (see **NV 4.20** and **NV 4.21**). Only with a stun shot (no follow or draw) does the cue ball travel exactly along the tangent line, regardless of the speed. For a draw shot, the final angle between the cue ball and object ball paths is greater than 90°, and for a follow shot the angle is less than 90°.



<u>Diagram 1</u> Effect of speed on draw shots

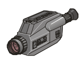


<u>Diagram 2</u> Effect of speed on follow shots

Principle 17 **Cue-ball curve delay**

Even if a cue ball has draw or follow when striking an object ball, it will still leave initially along the tangent line path before curving due to the spin.

- With higher speed, the path of the cue ball takes longer to curve away from the tangent-line path (see **Diagram 1**, **Diagram 2**, and **TP A.4**).
- Be careful when using draw or follow to help avoid an obstacle ball or a scratch if the cue ball is close to the obstacle ball or pocket in the tangent-line path (see **Diagram 3**).

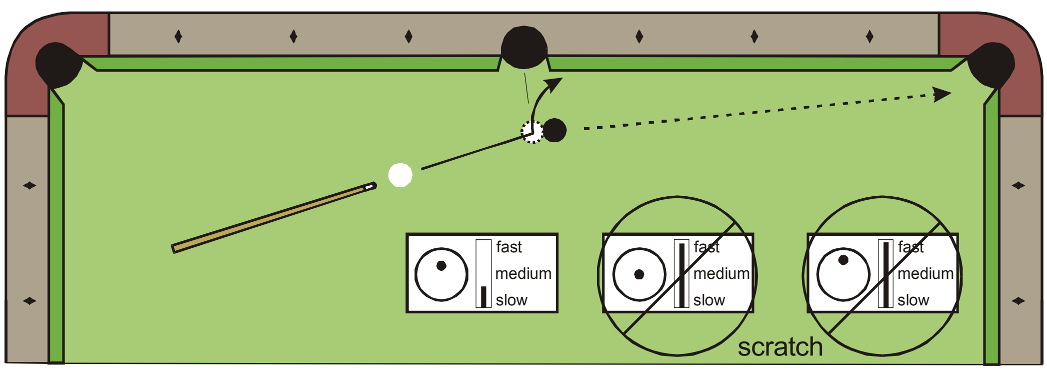

normal video

NV 4.20 – Delay of follow curve with higher speed
NV 4.21 – Delay of draw curve with higher speed


technical proof

TP A.4 - Cue ball trajectory for any cut angle, speed, and vertical spin

Diagram 3 illustrates an example shot where knowledge of the speed effect described above is important. A very inexperienced player might think: “hit it hard with follow to avoid the scratch in the side pocket.” This is terribly flawed thinking. The right thing to do is to hit the cue ball soft enough (optionally, with slight follow) to result in cue-ball roll. With soft roll, the cue ball starts curving away from the tangent line as soon as possible (see **NV 4.22**). If you hit the shot hard, you will scratch in the side pocket, regardless of what type of English (top, bottom, or side) you put on the cue ball!



the speed must be
slow enough to avoid the scratch

Diagram 3 **Avoiding a tangent line scratch using slow speed**


normal video

NV 4.22 – Avoiding a tangent line scratch using slow speed roll

As with the 90° rule, the exact path of the cue ball predicted by the 30° rule also depends on the speed of the shot. **Diagram 4** illustrates this effect. Again, the harder you hit the shot, the longer the cue ball persists along the tangent line before curving to the 30° heading (see **NV 4.24**). Therefore, if you are using the 30° rule to plan the path of the cue ball (e.g., for position play, carom shots, break-up shots, etc.), you need to offset the 30° direction as the speed of the shot is increased. If you are using the “V” or peace-sign hand aiming method (see **NV 3.8**), you just need to offset your hand down the tangent line direction a little (based on shot speed) to visualize the final cue ball path. For slow to medium speed shots, the cue ball deflects away from the tangent line, in the 30° direction, almost immediately (see **NV 3.8**, **NV 3.9**, and **TP A.4**).

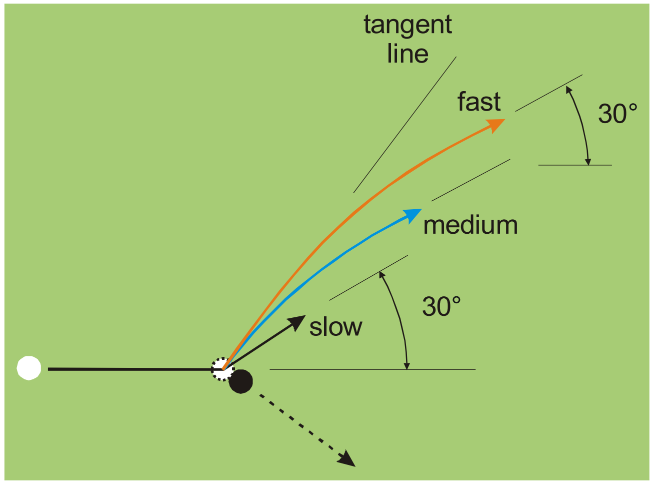


Diagram 4 Effect of speed on 30° rule


normal video

NV 4.24 – 30° rule speed effects

In the next few months, we will look at the effects of cut angle, side English, and other factors that influence the 90° rule. We will also look at some more examples.

Good luck with your game, and practice hard,
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***.
- I recently completed a thorough physics analysis to calculate exact cue ball trajectories. If you are a nerdy engineer or physicist, you might enjoy the calculations in **TP A.4.** I show exact trajectory results for various follow and draw shots at different speeds.
- FYI, over the next three years I will be presenting a multimedia seminar across the country, sponsored by the *American Society of Mechanical Engineers*. The title is "The Illustrated Principles of Pool and Billiards." The talks are usually open to the public, so periodically check out the dates and locations on my website. It would be fun to have some BD readers (and not just engineers) in the audience. The seminar is geared toward a general audience (even non pool players), but it is usually well received by both engineers and seasoned pool players.

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” (2004, Sterling Publishing).