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

"Squirt – Part VIII: squerve effects"

__Note__: 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 the article 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. See the website for details.

This is the eighth and final article in my series dealing with "squirt." So far, we have looked at basic terminology, the physics behind squirt, some experimental results, the effects of follow and draw on squirt and swerve, techniques for compensating one's aim for squirt, low-squirt cues, tip shape effects, and cue-test machine results. To refresh your memory, **squirt**, also called **deflection**, refers to the angular change in the initial cue ball (CB) direction due to an off-center hit. In other words, when you use English, the CB doesn't go where you are aiming because of squirt. For more background information, see my August '07 article and refer to **NV 4.13** and **NV A.17**. When using English, it is also important to be aware of the effects of **swerve** (see **NV 4.14** and **NV 7.12**) and **throw** (see **NV 4.15**, **NV 4.16**, **NV A.21**, and my August '06 through July '07 articles). Sometimes, the phrase "**effective squirt**" or the term "**squerve**" is used to refer to the net effect of both squirt and swerve on the shift in the CB position at object ball (OB) impact (see my August '07 article for more information). If you want to refer back to any of my past articles, they are all available on my website (***billiards.colostate.edu***).


normal video

NV 4.13 – Squirt due to high speed English
NV 4.14 – English curve due to an elevated cue
NV 4.15 – Using throw to make a partially blocked shot
NV 4.16 – Over-cutting a cut shot to compensate for throw
NV 7.12 – Small-curve massé shot
NV A.17 – Effective squirt vs. speed
NV A.21 – Bank shot using throw and spin transfer

This month, we'll look in detail at the interactions of squirt and swerve. Let's start with a summary of all of the important effects concerning squirt and swerve:

- squirt increases with the amount of English.
- squirt does not depend on shot speed.
- squirt increases with the amount of shaft end-mass (e.g., a low-squirt cue has less end-mass and results in less squirt).
- squirt is less with a heavier CB.
- squerve can be zero with certain speeds and cue elevations for a given shot distance, amount of English, and cue.
- squirt or squerve can be canceled using back-hand English (BHE) or front-hand English (FHE) aim-and-pivot methods.
- swerve increases with cue elevation.
- swerve occurs with practically all English shots because the cue must be elevated to clear the rails.
- swerve is delayed with faster shot speed.

- swerve occurs only while the CB is sliding; once rolling begins, the CB heads in a straight line.
- swerve occurs earlier with sticky cloth and later on slick cloth.
- swerve occurs earlier with a follow shot than with a draw shot.
- swerve angle is larger with a draw shot than with a follow shot.
- swerve angle can be predicted and visualized using the Coriolis masse-shot aiming method presented in my November '05 article.

Refer to my past articles in this series for detailed explanations and illustrations of most of these effects.

Now let's look at a collection of examples to show how knowledge of all of these effects can help you understand what will happen with various speeds and cue elevations for follow and draw shots with English. **Diagram 1** shows fast follow and draw shots, with English, over a short distance, with a typical cue elevation (enough to clear the rails). Be aware that the diagram isn't drawn to scale. The squirt angle is exaggerated to help illustrate the effects. Both shots in Diagram 1 end up to the left of the aiming line. With the fast speed and short distance, squirt is still the dominant effect (especially with a cue with larger squirt). The fast speed delays the swerve action, and it takes more distance for the CB to develop complete roll.

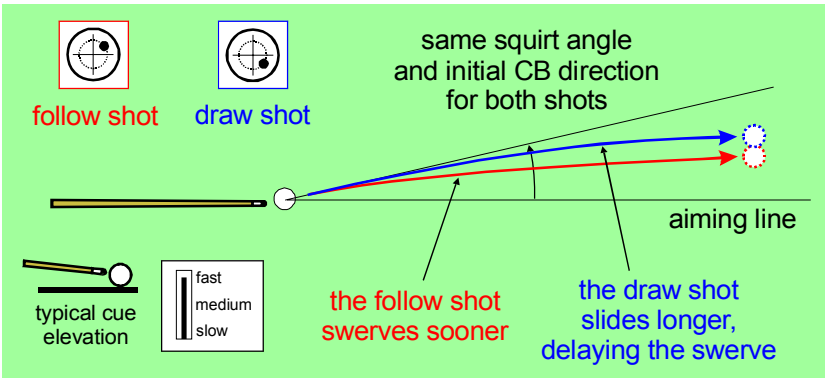

Diagram 1 Short, fast shots with typical (very little) cue elevation

Diagram 2 shows what happens with slower speed over a longer distance. The ball stops sliding and the swerve occurs sooner. Then the CB heads in a straight line. The draw shot takes a little longer for the swerve to complete, but the final swerve angle is a little larger (see my October '07 article for more information). With the follow shot, the swerve effect is smaller than the squirt effect, so the CB ends up to the left of the aiming line. With the draw shot, the final swerve angle is slightly larger than the squirt angle, so the CB ends up to the right of the aiming line.

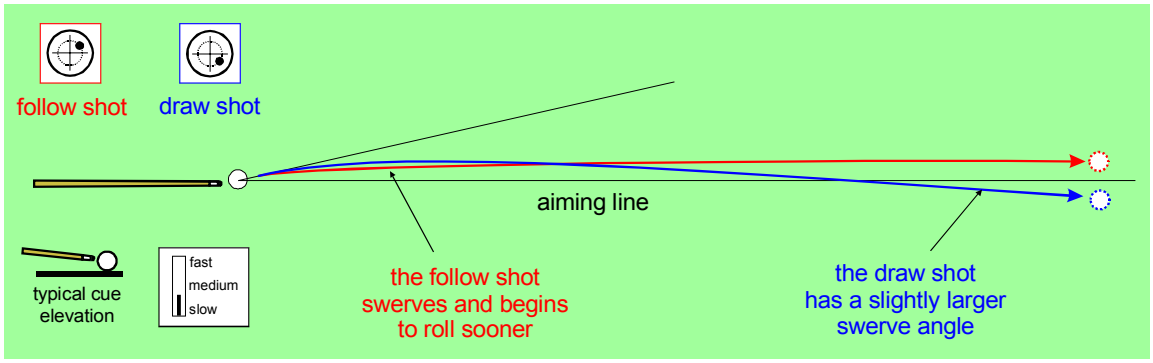

Diagram 2 Long, slow shots with typical cue elevation

Diagram 3 shows what happens to fast, short shots with slightly more cue elevation than normal. Comparing Diagram 3 to Diagram 1, you can see that the extra elevation creates more swerve. Also, the CB slides and swerves over a longer distance. With the large swerve angle, the CB would eventually cross to the right of the aiming line; but for a fast shot, the squirt effect can still dominate, keeping the CB left of the aiming line over the short distance.

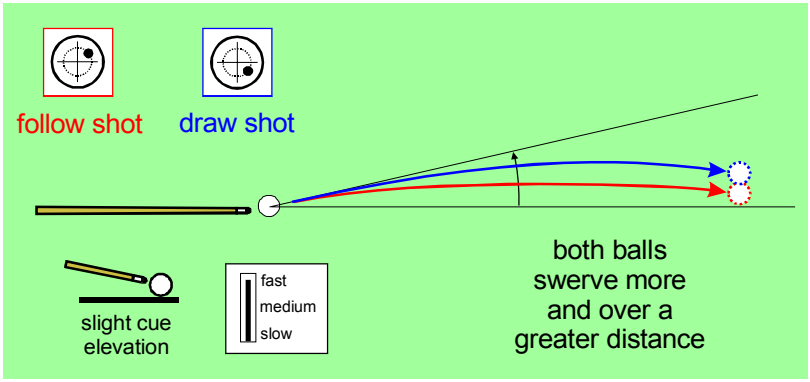

Diagram 3 Short, fast shots with a slightly elevated cue

Diagram 4 shows what happens for a slower speed and longer distance. With this cue elevation, the CB can end up quite a bit to the right of the aiming line.

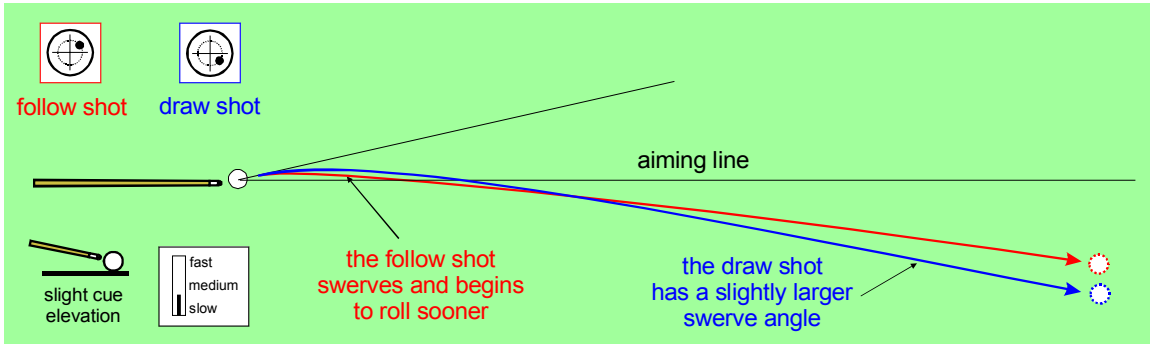

Diagram 4 Long, slow shots with a slightly elevated cue

If you want more discussion, examples, and demonstrations of squirt and swerve and the effects of speed and cue elevation, refer to **NV B.1**. Mike Page does a good job at describing and illustrating some of the effects. Also, if you want to learn more about masse shot effects and aiming, see my November '05 article. A masse shot is just an elevated-cue shot with a lot more swerve than normal (due to the larger cue elevation).


normal video

NV B.1 – Mike Page's squirt and swerve video

I hope you have enjoyed and learned from my series on squirt. I also hope you look forward to a new topic next month ... I certainly do.

Good luck with your game,
Dr. Dave

PS: I know other authors and I tend to use lots of terminology (e.g., squirt, throw, cling, stun, tangent line, 30º rule, etc.), 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 in the "Instructor and Student Resources" section of my website.

PS: I just released a new DVD called "*High-speed Video Magic*." It features billiards, but it also includes stupid human and animal tricks, balloons popping and bouncing, things breaking, engineering stuff, toy physics, and fluids and foods in motion. For more information and video excerpts, see my website (*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, DVD, and CD-ROM: "The Illustrated Principles of Pool and Billiards," and the DVD: "High-speed Video Magic."