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

"Squirt – Part VI: tip shape"

__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 sixth 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, and low-squirt cues. 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 at how tip shape affects English and squirt. Many people in pool halls will tell you: If you want to get more English, use a rounder tip. People usually recommend the tip shape should be somewhere between the curvature of a nickel and a dime; and if you use a lot of English, a dime shape is probably best. I think most people think this is sound advice. Now, what many people don't know is how tip shape affects the amount of English applied and the amount of resulting squirt.

Two months ago, we looked at back-hand English (BHE) and front-hand English (FHE) squirt-compensation techniques and cue pivot-length calibration. BHE and FHE are also known as aim-and-pivot techniques. For these methods to be effective, the amount of squirt must increase as the cue pivot-angle increases. As shown in **Diagram 1**, when you pivot the cue, the tip contact-point offset increases. This is what creates sidespin (English). The location of the point (and the amount of English) also depends on the shape of the tip (see "tip radius" in the diagram). Fortunately, squirt angle increases nearly linearly with tip offset, and tip offset increases nearly linearly with cue pivot angle. So if you pivot the cue twice as much, you create roughly twice as much tip offset (and English) and you create roughly twice as much squirt. Because of this, the pivot angle can roughly cancel squirt angle for any amount of English, and the CB still heads in the original aiming line direction (see my November '07 article for more information). The math and physics behind all of this, with some useful graphs and conclusions, can be found in **TP B.1**.

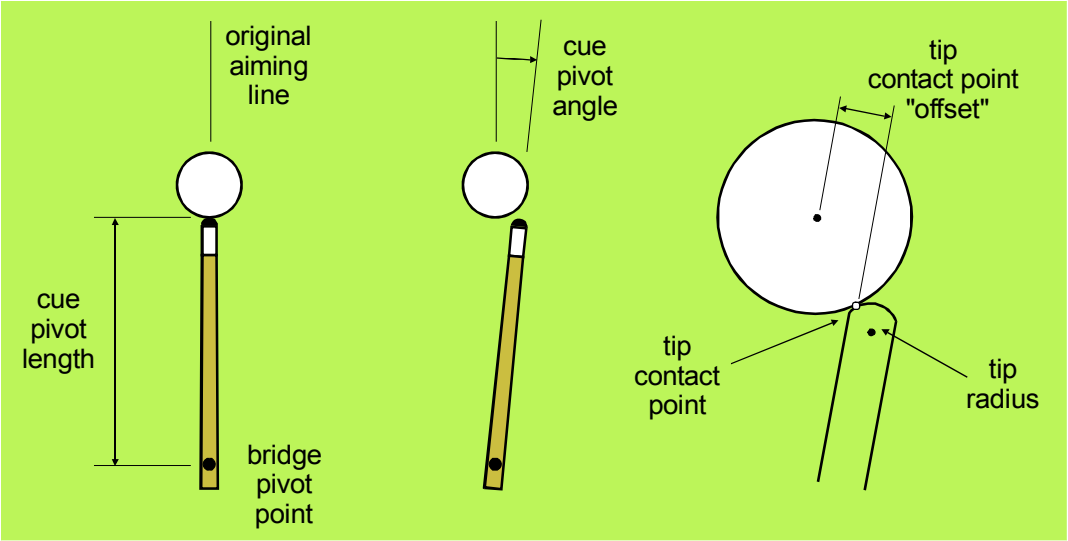

Diagram 1 Cue pivot length, pivot angle, and tip offset

technical proof

TP B.1 – Squirt angle, pivot length, and tip size

TP B.1 also investigates the effects of tip shape and CB weight on the natural pivot length of a cue. It turns out that the required cue pivot length (see Diagram 1) does vary a little with both tip offset and tip radius. TP B.1 shows that the natural pivot length of a cue is about 5% longer for a cue with a tip of nickel radius vs. the same cue with a tip of dime radius. So if you ever change or reshape your tip, and you use an aim-and-pivot aim compensation method, you might need to recalibrate your pivot point a little for the new tip shape. Also, when comparing different cues, it is important to use the same tip shape and the same amount of tip offset (English) for each cue; otherwise, the results can be misleading.

The "natural pivot length" for a cue also depends on the CB weight. (I want to thank "Spiderman" on the BD CCB online discussion forum for bringing this to my attention. We all hope his recovery from his recent motorcycle accident is speedy and complete.) TP B.1 shows that a 10% heavier CB increases the pivot length by about 9%, and a 10% lighter CB shortens the pivot length by about 9%. So if you are playing on a bar box with a heavier CB, and if you use an aim-and-pivot technique, you might need to adjust your pivot length. See my November '07 article for a simple experiment you can use to determine the pivot point for whatever cue, tip shape, and CB weight you might be using.

Diagram 2 illustrates another effect related to tip size. Both cases show a tip of the same size located at the same "tip" position (i.e., the centerlines of the tips are aligned). As you can see, the rounder tip (left) creates more offset, and therefore more English, than the flatter tip. This is probably one reason people report better "action" with a rounder tip. Another benefit of the rounder tip is that the tip contact point is closer to the centerline of the cue. This allows the large impact forces between the tip and ball to transfer more solidly, which might result in less vibration and a better "feel."

Another tip-shape issue also illustrated by Diagram 2 is that a flatter tip keeps the contact point closer to the center of the ball for a given tip offset. This is important in understanding accuracy with a center-ball hit. If you are aiming for a center-ball hit and you have a slight stroking error, unintentional English will be imparted to the CB. This will cause squirt, swerve,

and spin-induced-throw (see my August ‘06 article), which can make you miss the shot. As shown in TP B.1, a flatter tip helps reduce the effect of center-ball-hit stroking error, because the amount of English will be less than with a rounder tip.

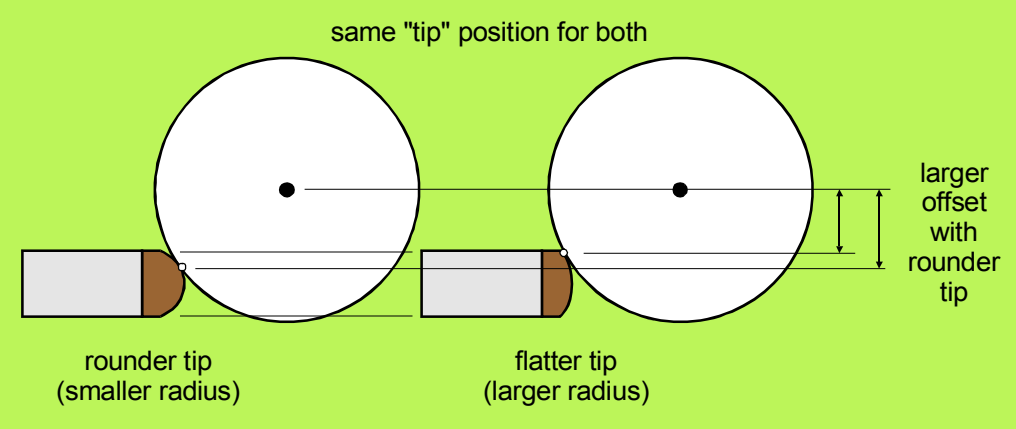

Diagram 2 Effect of tip shape on tip contact point offset

A shorter bridge also helps minimize the effects of stroking error with a center-ball hit. With a shorter bridge, cue pivot-angle errors don’t result in as much tip motion (see TP B.1 and TP A.10). However, a shorter bridge can cause other stroke problems (e.g., not enough length for smooth acceleration), and a shorter bridge might fail to take advantage of the squirt-canceling natural-pivot-length effect of the cue (see my November '07 article).

Many people use “tips of English” to specify and visually see how much English is applied to the CB. **Diagram 3** shows how “tips of English” varies for shots with different amounts of offset for an average size cue tip. The amount of English (sidespin) imparted to the CB depends on the distance the cue-tip contact point is offset from the center of the CB. It is important to distinguish contact-point offset from cue centerline offset. “Tips of English” is measured relative to the center of the cue. For example, in Diagram 2, the “tips of English” is the same for both cases, but the tip contact-point offset (and amount of English) is different. In my July ’06 article, I suggested using “percentage English” instead of “tips of English” to specify and visualize the amount of English. 0% English corresponds to a center-ball hit, which imparts no English to the CB. 100% English corresponds to the maximum amount of English that can be applied. Any additional offset would result in a miscue. Diagram 3 shows the miscue limit (half the ball’s radius) with the large dashed circle. At 100% English, the center of the cue is offset a little less than 1 1/2 tip widths, which explains the “1.4 tips of English.” 50% English corresponds to the tip position that results in a contact point halfway to the miscue limit, which corresponds to “3/4 tips of English”. The diagram also shows 25% English.

The tip size used in Diagram 3 (relative to the scaled 2.25” ball) is 12.5 mm. However, as I showed in my July ‘06 article, both the size and shape of the tip can create a significant discrepancy between “tips of English” for different cues. “1.4 tips of English” for one cue can be radically different than “1.4 tips of English” for another. That’s why I prefer the percentage English terminology. 50% (or 1/2 maximum) English is always half the maximum, regardless of what cue you are using. You just need to be able to understand and visualize the tip contact point and judge how close it is to the miscue limit. That intuition is easy to gain with practice.

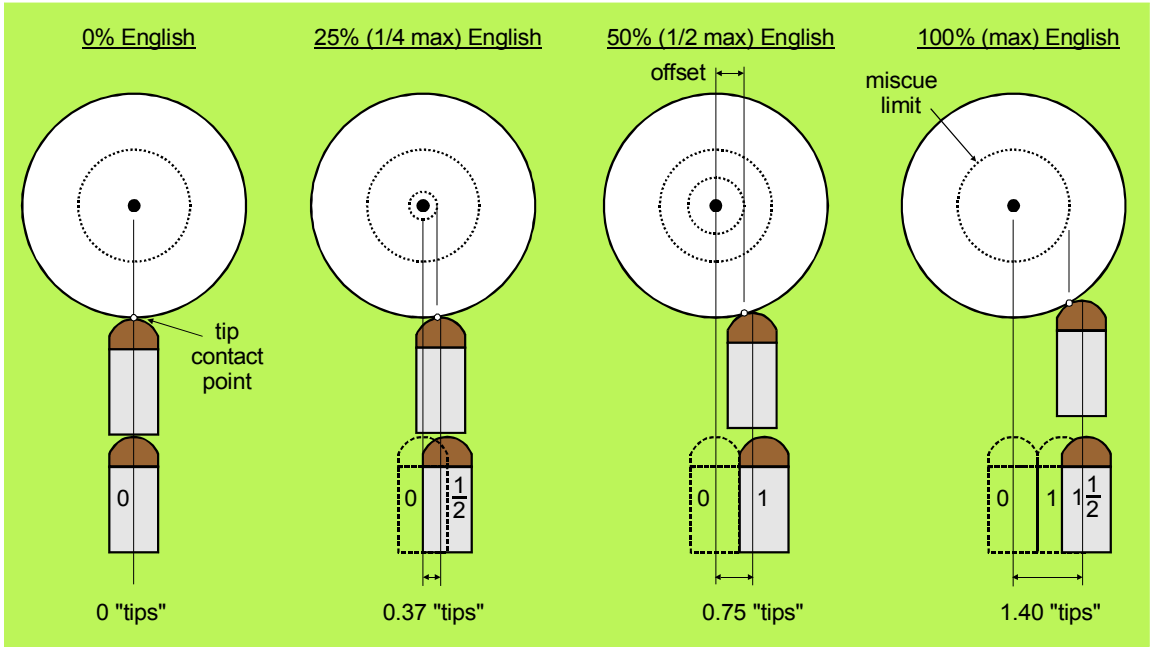

Diagram 3 Percent English (offset) and "Tips" of English

I hope you are enjoying and learning from my series on squirt. Over the next two months, I'll complete the series by looking at some experimental results from a cue-testing machine and the combined effects of squirt and swerve.

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 the 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."