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

"Squirt – Part IV: BHE, FHE, and pivot-length calibration"

__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 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 fourth article in my series dealing with "squirt." So far, we have looked at basic terminology, the physics behind squirt, some experimental results, and the effects of follow and draw on squirt, swerve, and effective squirt. 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 methods for adjusting your aim to compensate for squirt. Before I start, I want to be clear that the methods presented here compensate only for squirt, and don't directly take into account swerve and throw. It is assumed that you are already adjusting your aim for swerve and throw, if they are significant for a given shot. If you are using fast speed and/or if the CB is close to the OB, and if the cue is near level, swerve will not be much of a factor. Also, if the balls are clean, smooth, and polished, throw effects will be much smaller than normal. But just remember that the techniques presented here for squirt compensation assume swerve and throw are either small or already considered in one's aim. Good players have solid intuition built from years of successful practice and experience that helps them adjust their aim (consciously or subconsciously) to account for squirt, swerve, and throw. If your intuition is not as good as that of a top player, the techniques in this article might be useful.

Diagram 1 illustrates a fairly well known method for squirt compensation called **back-hand English (BHE)**, also known as the "aim and pivot" method. **Diagram 1a** shows what happens if you don't compensate for squirt ... the CB doesn't go where the cue is aiming. To correct for this, you can first aim the shot by lining up the tip at the center of the CB (see **Diagram 1b**). Then you pivot the cue on your bridge the amount necessary to achieve the desired amount of English. If the bridge pivot point is in the right place for the given cue, the amount of pivot can exactly cancel the amount of squirt, and the CB will head in the desired direction (see **Diagram 1c**). That's the good news. The bad news is that every cue has a different natural pivot point. Also, the required pivot-point location might not be at a comfortable bridge length for you. A method to find the pivot length for your cue is presented below. For more information on BHE, see my May '07 article.

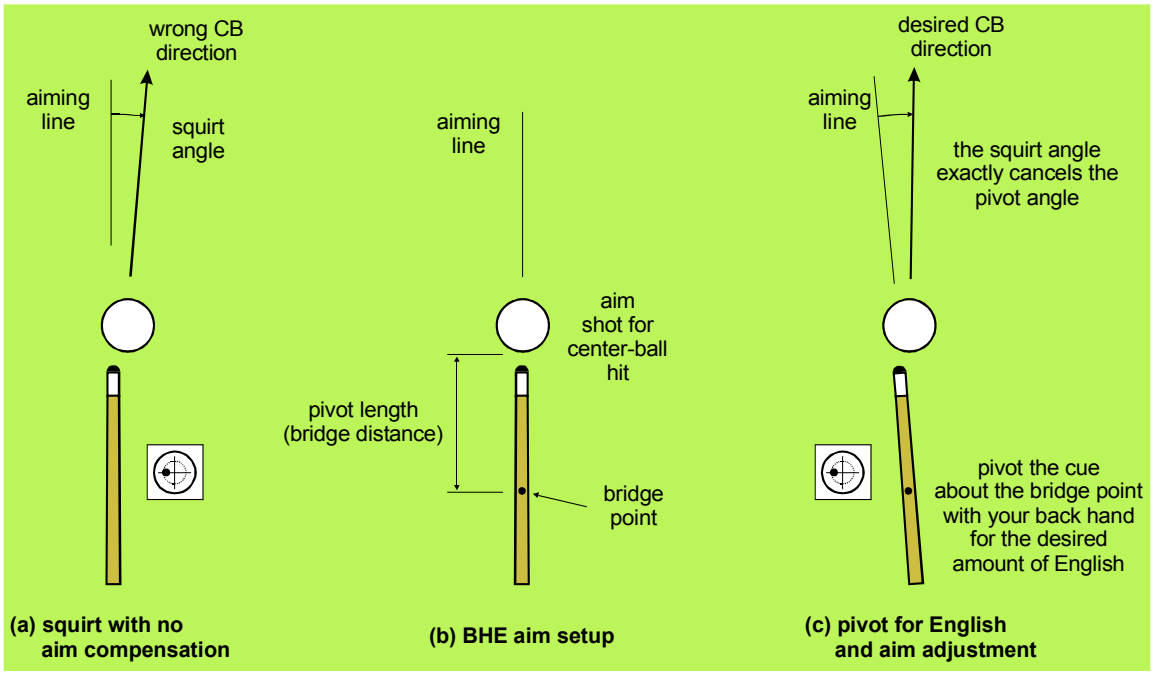

Diagram 1 Back-hand English (BHE) squirt compensation

Low-squirt (AKA "low deflection") cues can require a bridge length larger than what might be comfortable for use with BHE. For these cues, a different squirt-compensation aiming method called **front-hand English (FHE)** might be more suitable. **Diagram 2** illustrates how it works. Parts "a" and "b" of Diagram 1 still apply; but with FHE, you keep the grip hand stationary while you move your bridge left or right. If the distance from your grip hand to the CB happens to match the natural pivot length for the cue, the amount of pivot will exactly cancel the squirt, and the CB with head in the initial aiming-line direction.

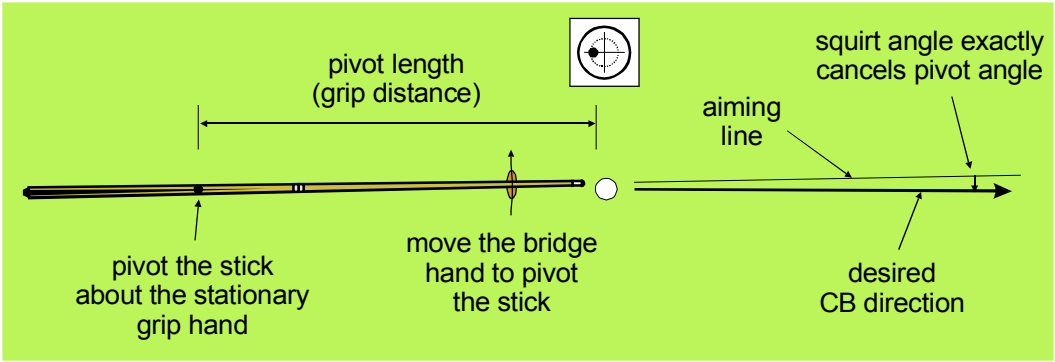

Diagram 2 Front-hand English (FHE) squirt compensation

To use BHE or FHE, you first need to know the **natural pivot length** for your cue. This is the distance you need to place the pivot point (bridge for BHE, grip for FHE) to have the pivot angle cancel the squirt. **Diagram 3** illustrates an experiment you can do yourself to determine your cue's natural pivot length. First lay a tape measure or string down the center of the table. Carefully mark the CB and OB locations about 6-8 inches apart between the head spot and the center of the table. Use self-adhesive hole-reinforcement labels ("donuts") to mark the ball

locations, and “set” the balls in place by tapping down on them with a spare ball. This will help ensure accurate and consistent ball placement for each trial of the experiment. Place a target chalk on the center diamond of the foot rail to help with aiming and to help you clearly see where the OB hits the rail (right or left of the chalk).

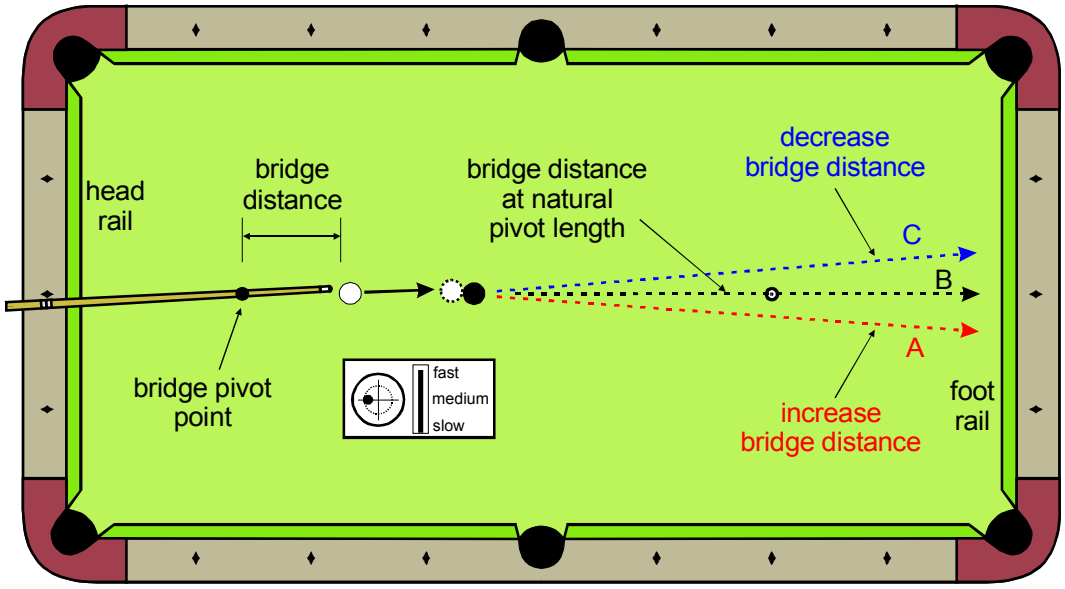

Diagram 3 Pivot point calibration

For the first shot, use your normal bridge distance. Line up the shot for a center-ball hit, using the center diamond on the head rail and the chalk on the foot rail to help you align your cue. Then pivot your aim to apply at least 50% of maximum left English. As we will see next month, the amount of English has little effect on the results. Regardless, you should use a CB with markings (e.g., a Jim Rempe CB) or replace the CB with a striped ball so you can apply the same amount of English on each shot. If using a striped ball, maybe aim the center of the cue between the edge of the stripe and the edge of the number circle. Use a firm stroke and observe where the OB hits the foot rail. The short distance between the CB and OB, and the fast shot speed, help limit the effect of swerve. Also keep your cue as level as possible (i.e., don’t elevate the back end) to also limit swerve. The fast speed and a larger amount of English help reduce the effects of throw (see my December ’06 article).

In Diagram 3, three cases are shown: “A, “B,” and “C.” Case “A” corresponds to a bridge distance shorter than the natural pivot length. The pivot angle of the cue is too large, as compared to the squirt angle, and the CB goes left of the centerline as shown in the diagram, causing the OB to go right of the centerline. In this case you need to move your bridge farther away from the CB and try again. Each time you move your bridge, mark the new location on top of the shaft with a small piece of tape or Post-It note. Case “B” corresponds to the bridge distance being exactly equal to the natural pivot length of the cue. In this case, the pivot angle exactly cancels the squirt angle, and the CB and OB both head along the centerline, ignoring throw for now (see the next paragraph). So if the OB heads straight, then the bridge distance (or grip distance) is what you want to use when applying the BHE (or FHE) method. Case “C” corresponds to a bridge distance longer than the natural pivot length. The pivot angle of the cue is too small, as compared to the squirt angle, and the CB goes right of the centerline, causing the OB to go left of the centerline. In this case you need to move your bridge closer the CB and try again. If you keep adjusting your bridge location, eventually you’ll see case “B” and you will have found the natural pivot length for your cue.

To get the best measurement, you need to make sure throw does not corrupt your results. With spin-induced throw (SIT), the OB would go off course a little when the CB heads straight up the centerline. To limit this effect, you can wet the contact area on the OB (e.g., with spit on your finger) to reduce friction. An even better solution is to spray and wipe the balls with silicone spray. This will dramatically reduce friction between the balls and between the CB and the cloth to mostly eliminate the effects of both throw and swerve. If you plan to use silicone spray, consider using spare balls (i.e., not balls from your normal playing set). You wouldn't want one or two slicked-up balls in your set that will play differently from the rest. Faster speed also reduces the effects of both throw and swerve. Referring to case "B" in Diagram 3, using fast speed and silicone-sprayed balls with the bridge at the natural pivot distance, the CB should stop in place spinning and the OB should head perfectly straight up table and rebound straight back to the CB (assuming the table is level).

I used the experiment described above to measure the pivot lengths for several of my cues. Here are the results: Players XIX (12.75 mm shaft): 12.7 inches; Predator Z (11.85 mm shaft): 20.2 inches; Stinger break/jump cue (13.5 mm shaft): 9.2 inches. As you can see, the pivot length can vary quite a lot among different cues. The pivot length I measured for my Predator Z shaft falls outside the comfort zones for using BHE and FHE (for me anyway). Nonetheless, some people report success-using FHE with low-squirt cues. Maybe it is because throw is coming into play. FHE, with a grip distance longer than the natural pivot length, might not be adjusting for squirt enough, but throw might be helping to bring the OB back on line. However, the amount of throw depends a lot on conditions and the type of shot (see my August '06 through July '07 articles), so this method might not be reliable. I personally don't use BHE or FHE, but the techniques do seem to be helpful to some people. I adjust my aim mostly intuitively (backed up by knowledge and understanding of various effects) based on the amount of squirt, swerve, and throw I expect for a given shot. The other thing I do is try to avoid English for shots where CB accuracy is critical (e.g., long and/or thin-cut shots). Squirt, swerve, and throw are too difficult to predict and manage when extreme accuracy is required.

One shot where the natural pivot length can be very important is the break shot. Not all of us have a perfect stroke and we don't always deliver the cue perfectly straight, especially at break speeds. But if your break bridge-distance happens to match the natural pivot length for your break cue, errors in stroking direction will not affect your break accuracy, provided your initial aim is good. **Diagram 4** shows how this works. (Note that swerve really isn't a factor at break speeds.) In Diagram 4a, the stroke and hit are perfect. In Diagram 4b, the shooter unintentionally pivots the cue during the stroke, applying unintentional left English to the CB. But because the bridge is at the natural pivot length of the cue, the pivot angle cancels out the squirt angle, and the CB still heads in the initial aiming line direction. So we still get a direct hit, despite the stroke error. Isn't that amazing? This is a great example where a little knowledge about your equipment and squirt compensation techniques can help improve your game ... immediately! So the next time you buy a break cue, try to get one that has a natural pivot length that matches your most comfortable break bridge-distance.

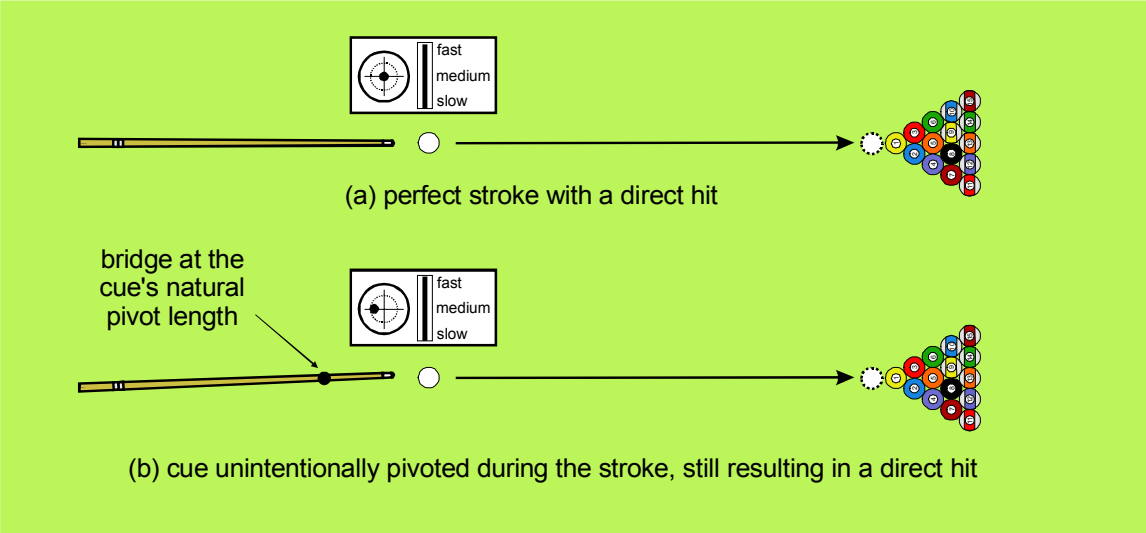

Diagram 4 Break with bridge at natural pivot point

I hope you are enjoying and learning from my series on squirt. Next month, we'll look at the effects of tip size and shape on squirt and aim compensation. I hope you look forward to the remainder of the series.

Good luck with your game,
Dr. Dave

PS: I know other authors and I tend to use a lot 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 glossary in my book. For convenience, an expanded version is posted online 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."