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

"Throw – Part XII: calibration, and hold shots"

***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 twelfth and final article in my series dealing with throw and English effects. Over the past year, I've looked at examples of where throw can help you or hurt you in game situations, the effects of cut angle and speed, the effects of follow and draw, spin-induced throw, the difference between inside and outside English, the combination of spin- and cut-induced throw effects, spin transfer, and the big picture of squirt, swerve and throw. If you want to refer back to any of my past articles, they are all available on my website (billiards.colostate.edu).

To refresh your memory, **throw** is change in **object ball** direction due to sideways forces between the **cue ball** and object ball during impact. **NV 4.15, 4.16, 7.5, 7.6, and A.21** show examples of both **cut-induced throw** (**CIT**) and **spin-induced throw** (**SIT**). When using English, in addition to understanding throw, it is also important to understand the effects of squirt (see **NV 4.13** and **NV A.17**) and swerve (see **NV 4.14** and **NV 7.12**). See the video demos and my last two articles for definitions, illustrations, and more information.


normal video

NV 4.13 – Squirt due to high speed English
NV 4.14 – English swerve 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 7.5 – Frozen ball throw
NV 7.6 – Frozen cue-ball throw
NV 7.12 – Small-curve massé shot
NV A.17 – English deflection (squirt) vs. speed
NV A.21 – Bank shot using throw and spin transfer

In last month's article, I had intended to provide a concise summary of many of the important conclusions from my entire series of articles. However, due to space constraints, the list didn't make it into the magazine. Fortunately, the online version of my article is the original full-length version. Please refer to it if you want to see the complete summary. The most important basic conclusions are:

1. Maximum CIT occurs with slow, stun shots with cut angles of about 30 degrees and larger (e.g., about 1/2-ball hit or thinner). Therefore, you need to adjust your aim to compensate for throw more with these types of shots (see my August '06 and September '06 articles for more info). If you use faster speed and/or follow or draw, the amount of throw and required amount of adjustment is less (see my October '06 article).

2. Maximum SIT occurs with slow, stun shots with about 50% English. So if you are faced with a shot where you need maximum throw to create an angle that isn't there, hit the shot softly and don't use too much English (see my December '06 article for more information).

It is important to remember that throw can vary dramatically from one set of ball conditions to another. New, high quality, and clean balls (e.g., those typical in professional tournaments) will usually throw much less than old, beat-up, and dirty balls (e.g., those typical in "bar boxes"). Therefore, it is important to "calibrate" yourself for the conditions under which you will be playing. You need to know how much to adjust your aim for different types of shots for different ball conditions. Also, if you need throw to execute a shot, you need to know how much throw is possible. **Diagram 1** shows a test set-up you can use to calibrate yourself for given ball conditions. The 1-ball is on the foot spot and the 2-ball is frozen to the 1-ball, with the line between their centers heading straight up-table. The cue ball is about a foot away on a line going through the first diamond beyond the opposite side pocket. Hit the shot softly with just enough speed for the 2-ball to reach the head rail, and measure the throw distance "x." This shot set-up will produce the maximum throw possible for any cut angle (see my September '06 article for more information). Please try this shot out on various tables (e.g., pool hall, bar, home tables, show room, etc.) to see how significant throw can be, and to see how much the throw amount can vary from one set of balls to the next. This will help you appreciate how important it is to calibrate yourself to different conditions.

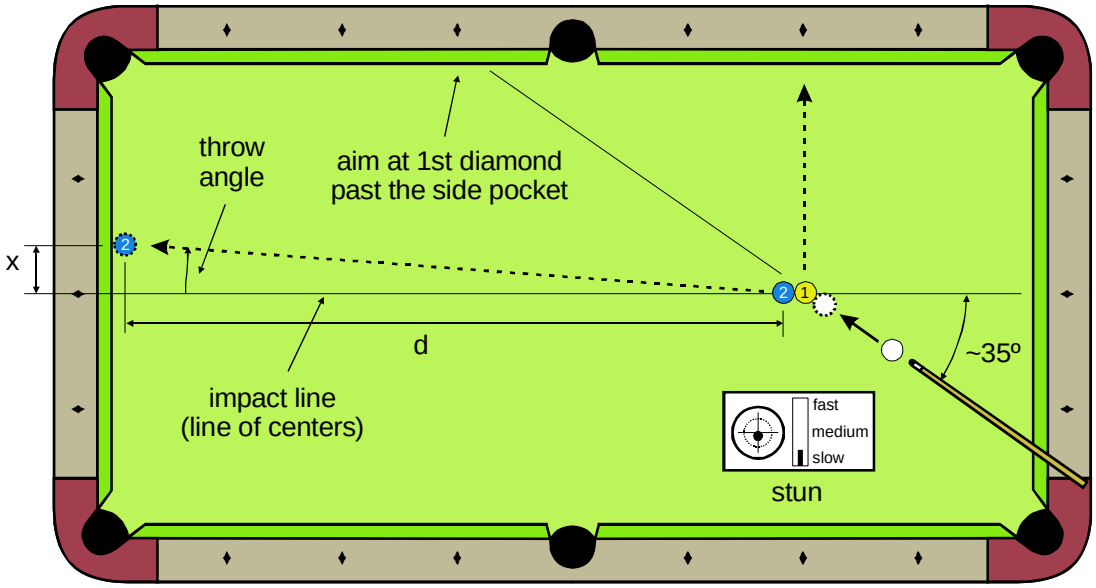

Diagram 1 Test shot for measuring maximum throw

Throw angles, like those that have appeared in all of the plots and examples in my previous articles, can be calculated from distance measurements using the trigonometry arctangent function. If you don't' have access to a scientific calculator, luckily Google (www.google.com) can do the calculation for you. For example, if you measure a rail throw distance (x) of 6 inches and the travel distance (d) is 65 inches, you just need to type in "atan(6/65) * 180/pi" in the Google search box and hit the Enter key. Google will magically report the answer in degrees (in this case 5.3º).

Small angles can be difficult to visualize and quantify for most people, so a better way to describe the amount of throw is in units of "inches per foot" (inches/foot). It is easy to visualize how far the object ball will travel in feet. And if you know the expected amount of throw in units of inches/foot, you can easily estimate how much you need to adjust your aim. For the example above, d = 65 inches = 65/12 feet = 5.4 feet. Therefore, the throw amount is about 1 inch per foot (6 inches / 5.4 feet = 1.1 inches/foot). This is a fairly common value under typical ball conditions. And since the diamonds are about 1 foot apart on larger tables, a good rule of thumb is: you get

about 1 inch of maximum throw per diamond of travel for typical ball conditions. But again, the amount of throw will vary significantly with ball conditions, so make sure you do the test shot in Diagram 1. The amount of throw for a given shot also depends on cut angle, speed, amount and type of English, and amount of spin (per my previous eleven articles for more information).

I want to close this series of articles by looking at how throw can be used to help limit cue ball motion for a small cut-angle shot. **Diagram 2** illustrates an example shot where we need to pocket the 1-ball while "holding" the cue ball for position on the 8-ball shot. The question is: Can you hold the cue ball more easily if you use English? The answer is: Yes ... most of the time. **Diagram 3** shows the effect of using English as compared to not using English. It is assumed that the object ball is heading in the same direction and with the same speed in both shots. It turns out throw can be used to reduce the amount of cue ball drift (see the bottom shot in Diagram 3). The spin-induced throw allows you to hit the object ball on the left side a little (creating a small cut angle to the right), and still have the object ball head to the left a little. Friction between the balls throws the object ball to the left and throws the cue ball to the right, but the cut angle reduces the net cue ball speed. **TP A.29** shows all of the math and physics behind the effect. Now, the reduction in cue ball drift might not be very large (e.g., an inch or less), but sometimes even a half cue-ball roll can mean the difference between a win and a loss (e.g., with the shot in Diagram 2).

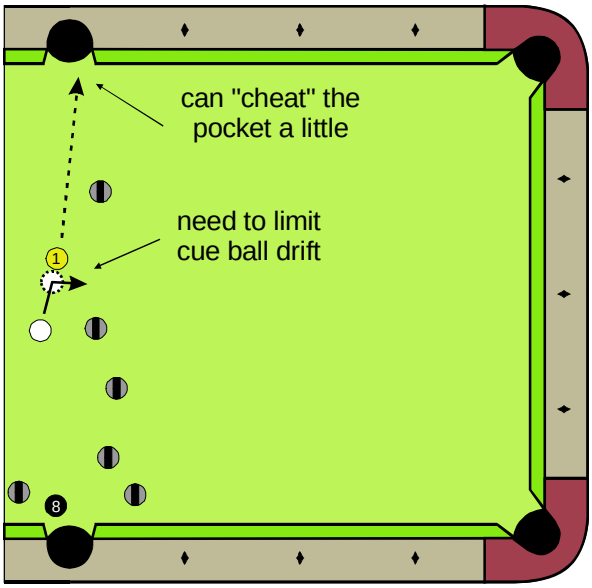

Diagram 2 Example shot requiring cue ball "hold"

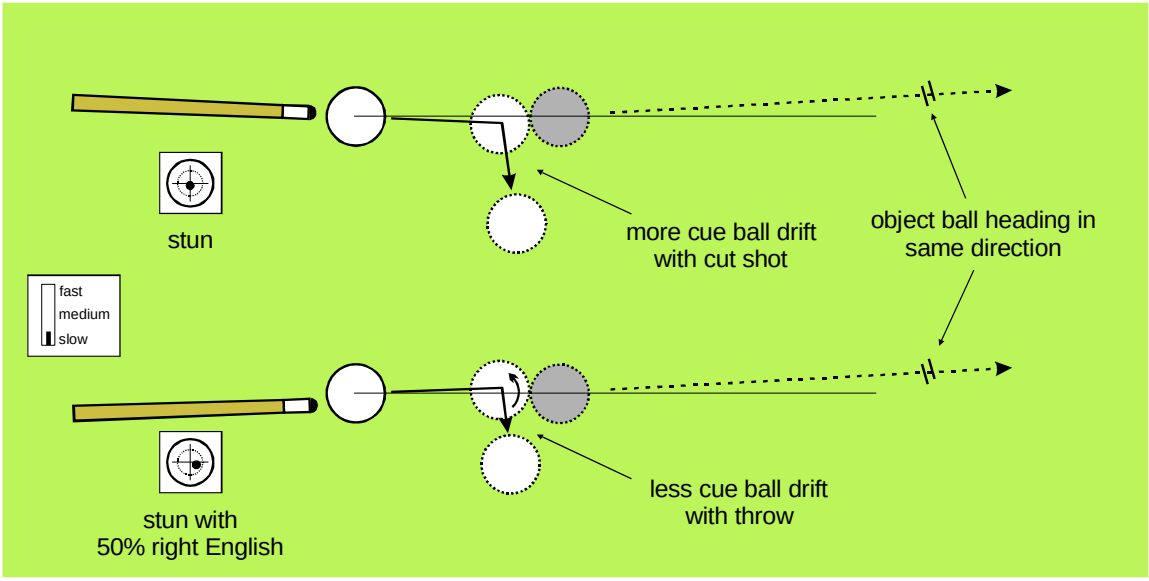

Diagram 3 Comparison of cue-ball hold with and without throw

technical proof

TP A.29 – Using throw to limit cue ball motion

The reason I wrote "most of the time" in my answer to the question in the previous paragraph is that a throw-assisted hold-shot becomes less effective for larger distances between the cue ball and object ball. When the balls are close, it is fairly easy to control. However, at larger distances, squirt and swerve become larger factors. It also becomes more difficult to achieve stun with a longer drag shot (i.e., it's tougher to judge how much bottom spin and speed to use). Remember, to achieve maximum throw, you want stun at object ball impact. Also, not only are squirt and swerve tougher to adjust for at greater distances, the swerve also hurts the shot angle a little, making it more difficult to hold the cue ball. Also, as shown in TP A.29, distance reduces the effectiveness of the cue ball angle vs. the cut angle. You might think that you can eliminate the effects of swerve by using faster speed, but the problem is that you get much less SIT at faster speeds. Bob Jewett proposed an experiment in his July '03 article (see his Diagram 3) that can help you see the results of some of these effects (a link to Bob's articles is available at the bottom of the "Instructional Articles" section of my website). Give the experiment a try if you're still not convinced.

I hope you have enjoyed and learned from my series of articles on throw and English effects. Have you been able to incorporate some of the knowledge into your game? I also hope you look forward to a totally new topic next month. Even I am getting a little tired of focusing on throw and spin transfer effects (even though I appreciate their importance).

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, impact line, 30 degree 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 electronic copy is posted online in the "Instructor and Student Resources" section of my website.

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."