"Throw Follow-up: Part I: Cling"

David Alciatore, PhD ("Dr. Dave")

*Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, 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 articles 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. Details can be found online at: **dr-dave-billiards.com**.*

This is the first article in a series dealing with throw, which is the change in object ball (OB) direction due to sideways forces between the cue ball (CB) and OB during impact. As illustrated in **NV B.86**, when the throw is due to cut angle, it is called cut-induced throw (CIT); and when it is due to sidespin, it is called spin-induced throw (SIT). The focus of this series is CIT. In the past, I actually wrote a series of twelve consecutive articles (August, 2006 through July, 2007) dealing with various aspects of both CIT and SIT. Back then, the editor told me "enough was enough," so I moved on to other topics; but now that it has been a while since my last throw article, I thought it was time for some more. If you want to refer to any of my past articles, they are all available at ***billiards.colostate.edu***.

This article deals with cling (AKA "skid" or "kick"), which refers to a "bad hit" resulting from an excessive amount of throw, well beyond what is expected for a given shot. When the CB hits an OB with a cut angle or non-gearing spin, there is friction between the CB and OB at the point of contact that resists the relative motion between the balls. This is what causes throw (CIT or SIT), which is normal. A "bad hit" occurs when the amount of friction is greater than normal (e.g., because there is a chalk mark at the point of contact). In this case, the amount of throw (or ball hop and topspin loss in the case of a nearly straight follow shot) is larger than the typical amount.

People sometimes mistake a naturally large amount of throw as cling, especially if they are unaware of how throw varies with the type of shot. (For more info, see throw effects and maximum throw in the throw FAQ section on my website.) Again, cling is an amount of throw much greater than should be expected for a given shot and conditions. People also sometimes think that a "bad hit" results from the CB and OB actually clinging together for a longer time than normal. This is not the case, even though it might seem this way based on the reaction of the balls.

Cling can occur more often with old, beat up (e.g., from phenolic tip damage), scuffed (e.g., from miscues), and dirty balls, where portions of the ball surfaces might create more friction than other portions (especially when the suspect portions collect and hold chalk easily). However, cling also occurs with new, clean, and smooth balls. The primary cause for cling is a chalk mark or smudge (or a significant amount of chalk dust) appearing at the contact point between the CB and OB. Anytime you see chalk smudges on the CB, you should wipe them off (or ask a referee to wipe them off if you are in the middle of a tournament game). Definitely wipe off the CB before each break or any time you have ball in hand. We have enough reasons to miss shots as it is without having to worry about excessive and unpredictable throw due to cling caused by chalk smudges.

Cling can also be created and used on purpose in certain proposition and trick shots. Examples can be found in **HSV A.142**, **NV B.91**, and **NV B.92**.

Recently, I performed a set of experiments, that are completely documented in online video **NV D.16**, to characterize the effects of different surface treatments on the amount pool balls throw. It also looks at what causes cling. The surface treatments tested include static electricity, chalk marks, dish-washing liquid, Aramith ball cleaner, Acetone, rubbing alcohol, Silicone Spray, and sand paper. **Diagram 1** shows the test shot used in the experiment. The 1 ball is frozen to the 2 ball, and the CB is hit squarely into the 1 ball with no sidespin to create an accurate and consistent center-to-edge ½-ball hit on the 2 ball. The frozen combination simulates a normal, non-frozen stun shot, where throw is largest. With a straight hit along the line of the balls, the 2-ball would not be thrown at all and would head straight up table along the "line of centers" direction. However, with a cut angle, the 2 ball gets pushed off line at an angle as shown in the diagram.

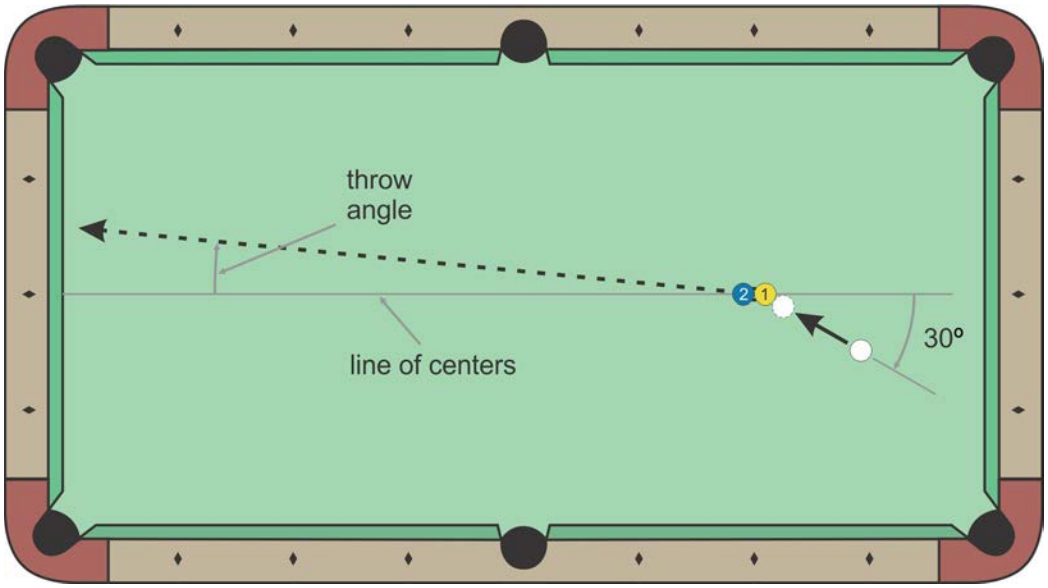


Diagram 1 **Test shot for throw experiments**

The first test I did was to see how throw angle varies with shot speed. **Diagram 2** shows the results. The smallest amount of throw (at the fastest speed) was about 3.5 degrees and the largest (at the slowest speed) was about 6 degrees. Throw is less at higher speeds because the coefficient of friction (COF) between the balls is less at faster relative surface sliding speeds. So on cut shots, if you want the OB to head in a more "true" direction closer to the "line of centers," use more speed. Notice in the diagram how, at the slowest speed, throw is about the same as at the next higher speed. This is because at the slow speeds sliding motion between the balls ceases during contact and the balls rotate together like gears before separating. This is called the gearing limit, where throw is maximum for a given cut angle. In this case, added friction (with slower speed) will not create more throw because there is already enough friction to create gearing.

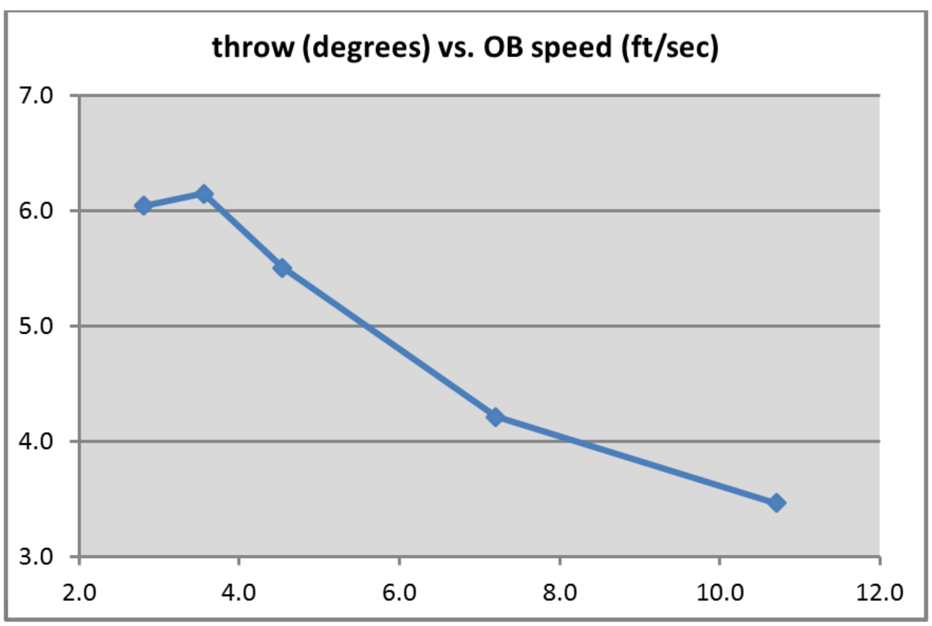


Diagram 2 **How throw varies with shot speed**

In the next set of tests, I decided to look at how throw varies with ball surface condition. First, I wanted to dispel a myth concerning cling. Some people have suggested that a major cause of cling is static electricity resulting from the CB sliding across the table cloth (e.g., during a stun or draw shots). In the experiment, to create as much static charge as possible, I held the ball with two pieces of rubber (to insulate the ball from my fingers), and then vigorously rubbed the ball on a fold of table cloth. I verified that there was charge on the ball by seeing if attracted small pieces of paper when held close to them. The rubbing was done before each shot. **Table 1** shows the results of the test. Static electricity alone definitely does not create cling, skid, or kick. The throw of the charged ball was actually less; although, the difference was not significant, and could represent experimental error. The reduced throw could have also been caused by the rubbing on the cloth, creating a slight polishing effect on the ball. Regardless, static electricity definitely did not cause an increase in throw, as some people have suggested.

Table 1 Results of static electricity test

test	throw		
	inch	**cm**	**degrees**
new	7	17.8	**5.8**
static	6 3/4	17.1	**5.6**

Cling, skid, or kick is often caused by a chalk smudge appearing at the contact point between the CB and OB. In the next set of tests, I applied chalk marks to each OB by striking each with a well-chalked tip. Then I placed the balls in position with the chalk marks touching at the contact point. **Table 2** shows the results of the experiment. In this case, the used balls had less throw (4.4 degrees) than the new out-of-the-box balls tested earlier (which threw about 5.8 degrees); although, they were different brands. A chalk smudge at the contact point created about 50% more throw than normal for this test. The cling effect due to a chalk smudge can be even greater at other cut angles and speeds, as we'll see next month.

Table 2 Results of chalk-at-contact-point test

test	throw		
	inch	**cm**	**degrees**
used/clean	5 3/8	13.7	**4.4**
chalk	7 3/4	19.7	**6.5**

Table 3 shows the throw experiment results for various surface treatments. Standard pool ball cleaners like the Aramith cleaner reduces throw some. Car wax can reduce throw significantly. Saliva and Silicone Spray can each practically eliminate throw. About 7° seems to be the maximum throw possible for a 30 degree cut. This probably corresponds to the gearing limit discussed earlier. Attempting to create additional friction with sand paper and chalk did not increase the amount of throw. It appears that the squeaky-clean surfaces dishwashing liquid and alcohol create result in the most throw. Again, online video **NV D.16** shows and describes the results of all of the experiments performed. Check it out when you get a chance.

Table 3 Results of surface treatment tests

test	throw		
	inch	cm	degrees
used	7 7/8	20.0	**6.6**
dishwash	8 3/8	21.3	**7.0**
Aramith	6 3/8	16.2	**5.3**
Turtle	3 3/8	8.6	**2.7**
Silicone	1/2	1.3	**0.2**
Acetone	8	20.3	**6.7**
spit	7/8	2.2	**0.5**
alcohol	8 1/2	21.6	**7.1**
light sand	7 7/8	20.0	**6.6**
with chalk	7 3/4	19.7	**6.5**

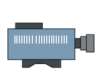
You may be asking yourself: “Why not always use a wax to reduce throw as much as possible?” If there were no throw, shot making would be easier because you could aim every shot, regardless of angle, speed, and spin, to hit at the ideal ghost-ball position along the "line of centers." Low friction on the CB would also make draw shots easier since less backspin would be lost on the way to the OB. However, with a very-low-friction wax, certain throw and spin-transfer shots would no longer be possible (see the throw FAQ page on my website for examples). Also, conditions being so different than what people expect would require adjustments. Also, as the wax wears off with use, the conditions could change significantly. Also, if everybody did not use the same wax, and clean and wax the balls frequently, conditions could be very different from one place to another, from one day to the next, and from one ball to the next.

I hope you enjoy my throw follow-up article series. If you want to learn more about throw, lots of information and video demonstrations can be found on the throw resources page in the FAQ section at ***billiards.colostate.edu***.

Good luck with your game,
Dr. Dave


normal video

NV B.86 –Cut-induced throw (CIT) and spin-induced throw (SIT), from VEPS IV
NV B.91 – Frozen-throw-down-rail proposition shot, from VEPS V
NV B.92 – "Impossible" cut shots, from VEPS V
NV D.16 – Pool ball cut-induced throw and cling/skid/kick experiment


high-speed video

HSV A.142 – Vernon Elliott cross-side bank with chalk on the OB to increase throw and spin transfer

PS:

- I know other authors and I tend to use lots of terminology, 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 on my website.

Dr. Dave is author of "The Illustrated Principles of Pool and Billiards" book and DVD, and co-author of the "Video Encyclopedia of Pool Shots (VEPS)," "Video Encyclopedia of Pool Practice (VEPP)," and "Billiard University (BU)" instructional DVD series.