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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 third article in a follow-up 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 (see **NV B.86** for more info and demonstrations). Over the last two months, I presented the results of experiments performed to characterize the effects of different surface treatments on the amount pool balls throw (see **NV D.16**). The experiments also looked at what causes cling (AKA "skid" or "kick"), which is an excessive amount of throw. In these experiments, the OB being thrown was frozen to the simulated CB doing the throwing. This begs the question: Do pool balls throw more when they are frozen? This article presents the results of an additional experiment designed to answer that question.

Diagram 1 shows the test shot used in the experiment. The 1 ball is either frozen to the 2 ball or placed very close with a small gap, with the line of centers pointing straight up table. A small gap between the 1 and 2 balls creates a non-frozen combination shot and simulates a normal stun shot where the CB has absolutely no top or bottom-spin at contact with the OB. Two different cut angles were tested: 30° and 45°. Two different conditions were tested for the 1-ball-2-ball contact point: clean and with a chalk smudge (to create cling). A spare CB is frozen to the 1 ball to help ensure a consistent and square hit on the 1 ball and to minimize any effects of unintentional sidespin on the struck CB.

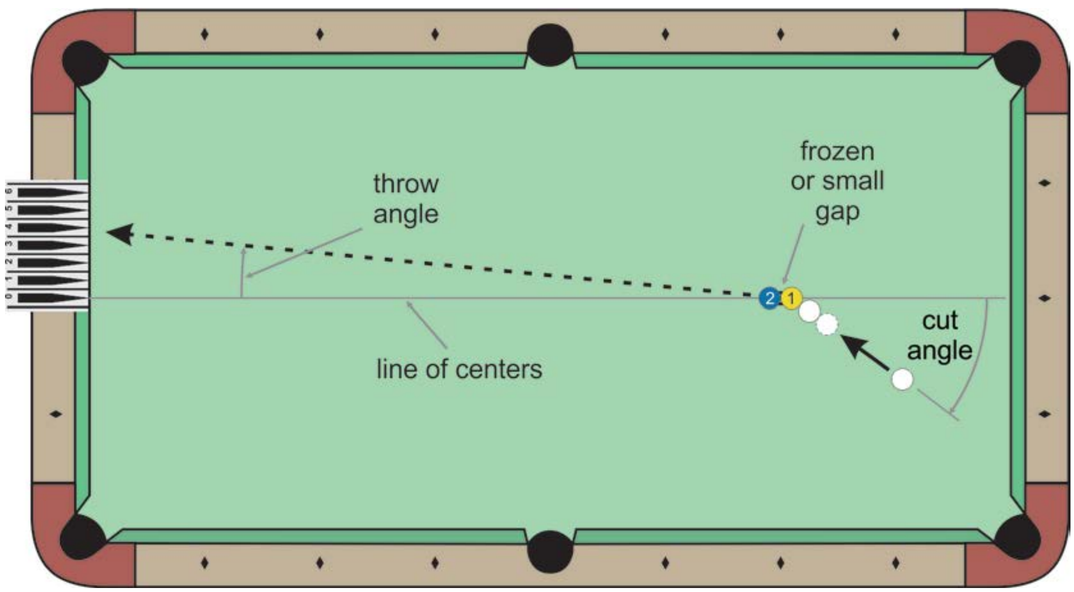

Diagram 1 Test shot for frozen throw experiments

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 thrown off line at an angle, as shown in the diagram. The rail ruler measurements allow the throw angle to be calculated.

Under each set of the conditions, 10-20 shots were taken and the three shots with the most consistent speeds were kept and averaged to give the final results.

Table 1 summarizes all of the results of the experiment. In the first column, "frz" indicates the 1 and 2 balls were frozen, "chk" indicates there was a chalk smudge on each ball at the contact point, and "gap" indicates there was a small gap (about 1 mm) between the 1 and 2 balls. Counter to conventional wisdom, the throw amount was actually a little larger with the non-chalked gap vs. the frozen cases. The 30° cut throw value increased from 4.5° to 5.3° (see the 1st and 5th rows), and the 45° cut throw value increased from 4.3° to 4.9° (see the 2nd and 6th rows). Throw was actually a little smaller with the chalked gap vs. frozen cases. The 30° throw value decreased from 7° to 6.8°, and the 45° cut throw value decreased from 13.4° to 13.2°; although, both sets of values are fairly close.

There are many possible causes for the apparent discrepancies. It is possible that any wax or residue left on the balls by the Aramith cleaner could have been wearing off a little during the tests, tending to increase throw. Also, there might have been slight speed differences from one set of shots to the next, but probably fairly small, because I carefully checked for this. Also, the cut angles with the small gap might have been slightly different than with the frozen balls. This is difficult to control perfectly; although the gap I used was very small, and it was consistent, so this was also probably not that large of an effect.

Regardless, based on the experiment, it is probably safe to say that for stun shots of the same speed, whether the balls are frozen or not probably doesn't matter much. Now, with a normal shot, it can difficult to create perfect stun, especially at slower speeds where throw is largest, and especially at larger distances between the CB and OB, so it might seem like frozen balls always throw more. But this is because the frozen ball has perfect stun during contact, as it hasn't started sliding or developing roll yet. Again, throw is largest with stun. Also, frozen combos might be hit softly more often, where the combination of stun and slow speed creates the largest possible throw. Again, **a normal non-frozen stun shot at the same speed as a frozen combination will throw very close to the same amount**.

Table 1 Results of frozen-throw experiments

test	throw		
	inch	cm	degrees
30 frz	5	12.7	**4.5**
45 frz	4 7/8	12.4	**4.3**
30 frz chk	7 7/8	20.0	**7.0**
45 frz chk	15 1/4	38.7	**13.4**
30 gap	6	15.2	**5.3**
45 gap	5 1/2	14.0	**4.9**
30 gap chk	7 5/8	19.4	**6.8**
45 gap chk	15	38.1	**13.2**

Again, online video **NV D.17** shows and describes the entire experiment along with the results. Check it out when you get a chance. It is a lot more interesting to actually see an effect rather than just read about it. Even better, try some of the experiments on your own. They aren't that difficult, and they don't take much time.

I hope you are enjoying my throw follow-up 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 D.16 – Pool ball cut-induced throw and cling/skid/kick experiment
NV D.17 – Does a pool and billiards frozen combination throw more than a small-gap stun shot?

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.