

Bob Jewett



Combinations and Throw

Some surprising insights into the world of "throw."

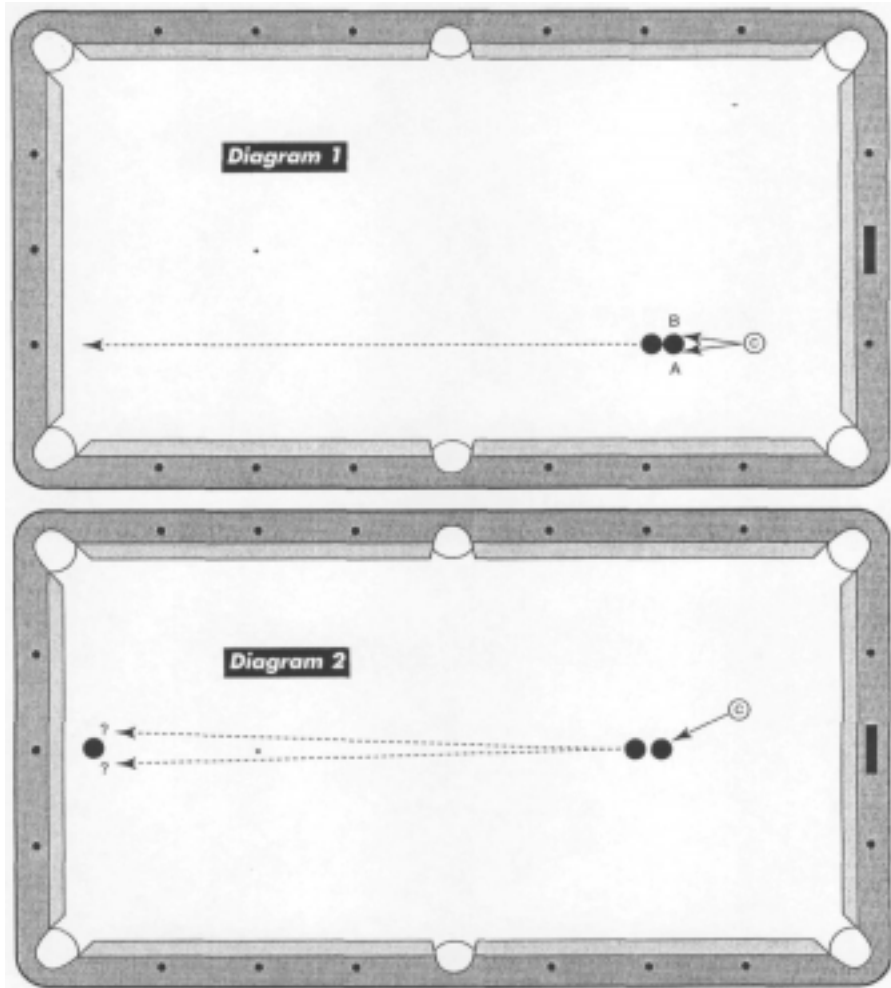
In my column last April, I covered some of the details of throw. Here are two related and surprising experiments for you to try. As a reminder, a ball is said to be "thrown" when its path is not directly away from the spot where another ball contacts it. This deviation can be due to spin on the cue ball, or simply from the motion of the striking ball across the struck ball on a cut shot.

Most beginners will shoot the shot in Diagram 1 wrong. The two object balls are frozen together and pointed about six inches away from the pocket. A novice will attempt to "cut" the second ball by playing to side A of the balls, perhaps expecting the first ball to move to the right before pushing the second ball towards the pocket. Of course, we all know that you have to hit the shot on side B, and let the friction between the balls drag the second ball towards the pocket. But how does the shot change if the balls aren't touching? With some separation, as in Diagram 2, there will be two effects, the throw from the surface friction, and the cut because the first ball does move to the side before it hits the second ball. Which effect will dominate?

If the balls are separated by a hair's breadth, the shot hasn't changed much and you would expect nearly the same result as for frozen balls. With an inch of separation, the cut effect will probably dominate. Our goal in the experiment is to find the separation at which the cut exactly cancels the throw, and the second ball goes straight up the table. In Diagram 2, a ball is placed on the far cushion along the line of the two balls, so we can easily see the amount of cut or throw.

For repeatability of ball placement, get some self-adhesive donut-shaped paper reinforcements. There is a new style available made of thin, tough plastic that can be lifted and moved several times for repositioning. A trick I use for minor tweaks is to place a fingernail as a marker at the edge, and then lift and replace the donut the required distance from the nail.

As a first guess, place die two balls one-quarter inch apart. That's probably close to half the diameter of your ferrule, in case you don't carry calipers. Place the rail ball on another donut, and shoot straight along the combination line to be sure that all three balls are in line. Once you have the target in



the right place, shoot the shot as an angle combo as shown, with full contact on the first ball, which in turn has a half-ball contact on the ball that's driven up the table.

Is there more throw or cut on the shot? That is, where does the ball land on the far cushion relative to the target ball? Is it the same from the other side? If it's not, something is screwy with your setup or table. Next, try a fuller hit; place the cue ball closer to the line of the shot, so the first ball is driven about 3/4 full into the second ball. What happens for a more extreme angle? Does speed change the shot? If you have the donuts on the table to replace the balls, you can try all of these changes in a few minutes.

Of course, the results will depend on how sticky the balls are. When I tried this shot at a local pool hall, I got cancellation for a half-ball hit when the separation was close to a quarter-inch. This is exactly the rule of thumb that I've used for over 30 years, but I had never measured it before. Common rule of thumb: "If the balls are a quarter-inch apart, there is no throw or cut, no matter how you hit them." Is it a quarter-inch with your equipment?

When I tried a fuller hit, I got a surprise. The throw dominated. With a thinner contact, such as 45 degrees or 1/4-ball full, the cut dominates. The result of this experiment is that the simple rule of thumb isn't accurate, and you need to do some testing

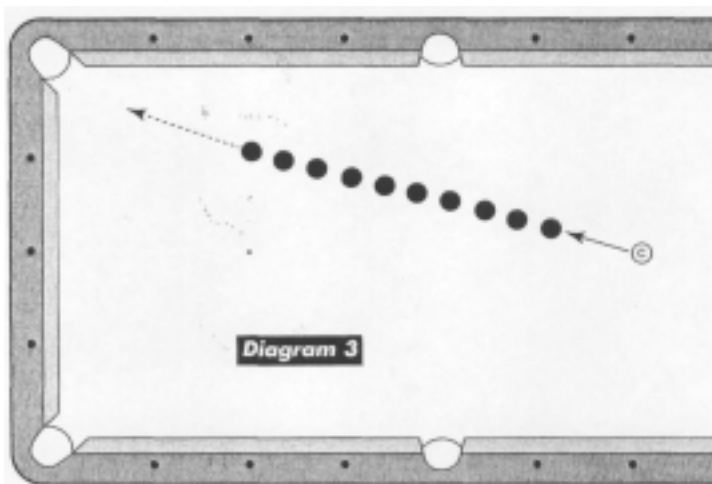
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under your own conditions. I've seen ball-to-ball friction vary by a factor of two, and this will surely change the "zero-throw" spacing. If you try the experiment, please send me your results in care of *Billiards Digest*.

The second experiment in throw was suggested by Hugh Hilden, who is a professor of mathematics at the University of Hawaii, and who sometimes uses pool problems in his calculus courses. The setup is shown in **Diagram 3**, and is similar to an ancient trick shot.

Ten balls are lined up straight to a pocket. The critical factor in the experiment is the separation of the balls. In theory, if the balls are separated by one-ball diameter, any small aiming error you have on the first pair — one degree — will be copied exactly to each subsequent collision.

Suppose you space the balls by two ball diameters instead. Geometry says that any initial error will be doubled in each collision, and with a one-degree error at the start, the sixth ball won't even hit the seventh. There is geometrical growth of the



error, and the shot is theoretically nearly impossible.

Where does throw enter? It turns out that throw between successive balls, which is caused by the cut angle of the error, tends to correct the error. This is partly due to the balls being thrown back in line, and partly due to spin that the thrown ball picks up, in the direction which tends to cancel the error.

Professor Hilden reports that when the balls are one ball and a half apart, the shot

could be made consistently even when the last ball was two diamonds from the pocket. For this case, the error multiplication factor without correcting throw is about 58, and the permitted error at the end is only five degrees, so the simple theory would require a tenth of a degree accuracy in the aiming. This is a sixth of an inch in the length of the table. With the balls set two balls apart, the percentage was down, but the shot was still possible. With a one-ball separation, the shot becomes unmissable, even with some

intentional aiming error. This shot is fun to try, and it sounds like a machine gun when you shoot it. Try it with all fifteen balls.

These experiments will improve your feel for combinations, and the next time you run **into** either multi-ball or not-quite-frozen combos, you'll be ready. And if you're a junior player deciding about college, consider math at the University of Hawaii. You may have already done the homework.

Bob Jewett is an Advanced-level BCA Certified Instructor.