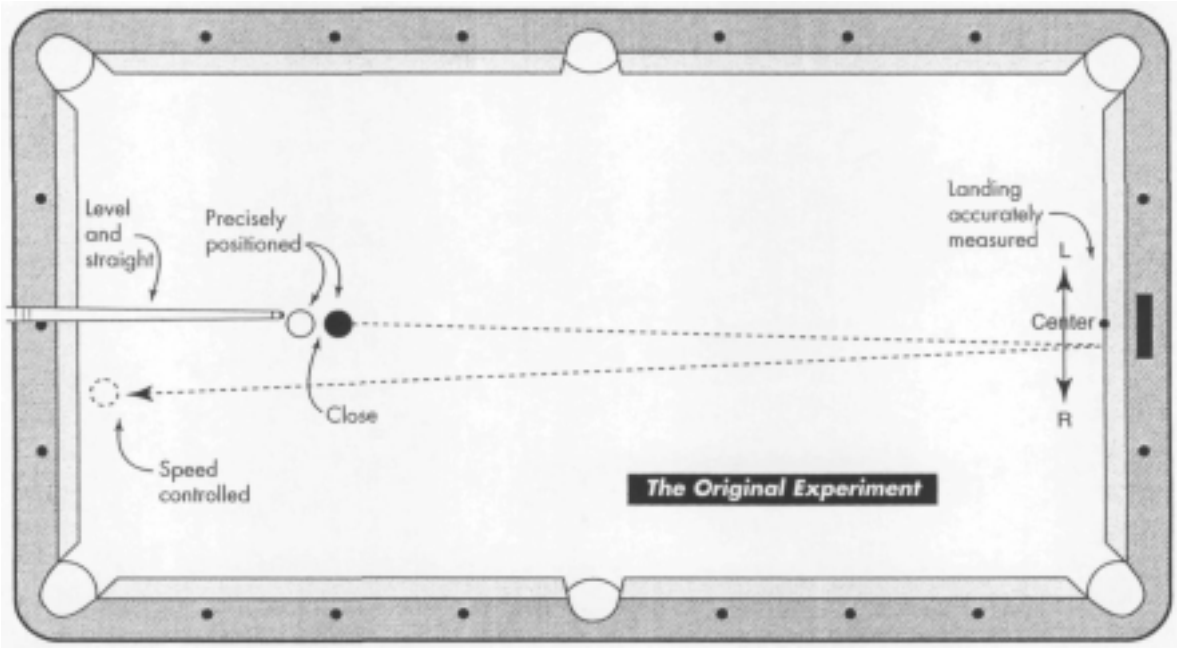
Bob Jewett

The Results Are In

Readers responding to the Jewett challenge find evidence of throw.

*When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, **but** you have scarcely, in your thoughts, advanced to the stage of science.* — Lord Kelvin



In last month's column on experiments in throw, I went over some results from readers that were mostly qualitative in nature — that is, there were usually no numbers involved, just observations. For example, there were no conclusions such as "With old balls and maximum side spin, it is possible to get up to six degrees of throw." Instead, the results were mostly of the nature, "I saw some throw in my setup."

Lord Kelvin, who gave us the Kelvin temperature scale of measurement, would not be satisfied with such results. To start to be real science, the experiment needs not only a number attached to the result, but an estimate of the confidence (or uncertainty) of the number. Even if the measured throw is close to zero, the result should include an "error bar" like: "We consistently measured less than +/- 0.5 degrees of throw for all cases."

The setup that I proposed to measure throw is shown in **Diagram 1.** The balls are pointed straight up the table. Trials are made using three different types of English: Center-ball, left and right. The English is applied while shooting straight at the object ball, and the landing location on the far cushion is noted. Care must be used in the setup to avoid known pitfalls. For example, the cue ball must be close to the object ball to avoid the well-known phenomena of squirt and swerve. The effects of these are in opposite directions, and are known to be plenty large enough to ruin the results if not well-controlled. Also, it is common for players to subconsciously apply a little correction angle on the cue stick when applying side spin, and the close positioning helps to reduce this effect as well.

Results were submitted for eleven different shooters following the above diagram. The most thorough and careful setup was by Dan White, who took the following steps to ensure accuracy. He positioned the balls on paper reinforcement donuts for position repeatability. He set the balls up so that the cue ball travelled only one inch before contacting the object ball. He controlled the speed to two table lengths to avoid any roll-off contamination. He used an object ball as the cue ball so that the amount of English could be easily seen on the ball. (Some experimenters used a training cue ball for this same reason.) He applied the English without any squirt-compensating pivot and with a level-as-possible stick. He cleaned the "cue ball" before each shot and positioned it with the same side "forward." To record where the object ball hit on the cushion, a camcorder with a macro lens was used and a ruler was positioned just above the cushion. The camcorder was repositioned for each case so that it was looking straight down on the landing location for that case. Ten trials were done for each case to allow a determination of consistency.

The best sets of measurements also included an estimate of the error, as described above. For some of these, all of the measurements were included.

In **Diagram** 2, I have combined the results and represented them graphically. The distance above center on the chart reflects the amount to the left the cue ball landed on the cushion for right English, and the distance below center is the how far to the right the cue ball landed for left English. The initials give the experimenter, and for each experimenter, an average for both left and right results is shown. All but one set of results demonstrated throw; John Cundiff (JC) observed no throw within his estimated margin of error. The entries that begin with "NM" are results for four shooters testing on the same table and with the same balls.

Some experimenters had multiple sets of results. Frank Zrinski tried multiple speeds, strokes, and offsets, and I chose a representative set. He also observed the landing point when the object ball came back to the second end cushion, and managed to pocket the ball under some conditions.

Some experimenters also tried extensions on the original experiment's set-up. For instance, Rick Malm, who recorded low throw under his conditions, also tried the same test after chalking the object ball, and found 9 inches of throw on some shots.

You may want to draw your own conclusions from the results, but here are mine. Cue-ball-to-object-ball throw exists and is significant. It seems to vary with conditions and shooter. It can be as large as six inches for a ball path six diamonds in length, which is clearly enough to affect a significant number of shots. Some players seem to have a bias towards left or right throw. (This could be due to an error in alignment, for example.)

Of course, as a fellow scientist, you may want to take these conclusions on a probationary basis until you can do your own tests.

When I first read the original hypothesis that throw does not exist, I was quite skeptical, but the scientific approach is not to simply ignore or deride ideas that don't seem to lit, but instead to establish tests to see if they have merit. Of course, it doesn't help the original hypothesis that it completely ignored the measurements that had been done in the past to demonstrate throw, such as those by Jack Koehler in his book "The Science of Pocket Billiards." Yet another set of measurements were made by the several experimenters who participated in a test I proposed in my first column for this magazine, back in April 1992. Scientific methodology demands that you include or at least consider those who have gone before, and those who ignore previous work lose credibility.

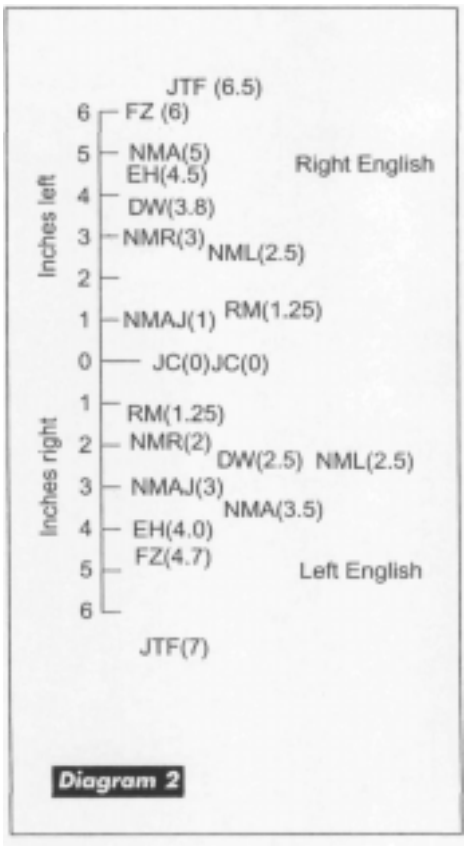


Diagram 2

Lastly, a hypothesis has to fit into generally accepted theories of physics. In the case of throw, the applicable theories are very basic ones, such as conservation of momentum and energy, and the way friction works. The original hypothesis — that there is no throw — does not fit into this framework at all. As Professor Hilden of the University of Hawaii math department said, "If a cue ball cannot throw an object ball, then much of classical physics can be thrown ... out the window."

Well, whether you're convinced or not of the existence of throw, I hope that you will check for yourself the next time you're playing how large it is on your equipment and for your stroke. Check also to see if you have a left/right bias, as some of the experimenters seem to. If so, you may want to recalibrate the way you look at the table, or at least realize that this bias can affect your play.