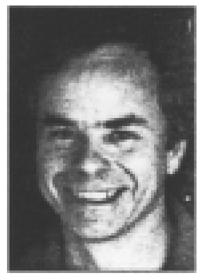
TECH TALK

Friction: Friend *And* Foe

by BOB JEWETT



JULY, 1980. MIKE Sigel and Ronnie Allen. One pocket.

It was the sort of after-hours match everyone at the San Francisco Open had been hoping to see. Or at least everyone interested in clever tactics, precision safety play and a change from the smash-'em-shoot-by-the-numbers 9-ball tournament. It was a night made memorable by two pool legends, head to head in a tough, expensive contest of wit and moves and traps.

About two hours into the match, a third participant arrived: the fog. San Francisco Bay relieves hot, summer days by generating cool fog at night. The damp descended on the table, destroyed stroke, and especially aggravated Allen, who lamented, "It's tough. You know what the ball's supposed to do but it just won't do it."

Friction was the problem, as Allen well knew, and studying it a little may reduce your own frustration when friction attacks.

There are three types of friction found on pool tables: static, sliding and rolling. The first two are usually explained with a situation like a box on a table. (This is not much like a pool ball, but stick with me.) When you push on the side of the box, you have to get up to a certain force to start the box moving, but then a smaller force can keep it moving. The first is due to "static" friction and the second is due to "sliding" friction.

Physicists have found that how hard you need to push sideways is some fraction of the weight of the box. For example, with a 10-pound box, you might need 6 pounds of push to start the box moving and 2 pounds to maintain motion. If you double the weight of the box (20 pounds), you also double the required forces (12 and 4 pounds). The ratios of push to weight, in this case 0.6 and 0.2, are constant.

These ratios are called the "coefficients" of friction. They depend on the two materials rubbing against each other. Rubber on concrete has high coefficients which makes it necessary to push very hard to slide a rubber object across pavement. Rubber on ice has low coefficients and little force is needed to slide.

"Rolling" is a third kind of friction that is a little more obvious on a pool table. It describes how quickly a rolling balls slows down. A convenient way to think of rolling friction is that a ball slows down continuously as if it were rolling up a hill. The steeper a hill, the higher the percentage of its grade, the quicker a ball rolling up it will slow down. A moderately fast cloth acts like a 1% grade. Obviously the metaphor is not perfect, because a ball stops on a pool table, while a ball rolling up a hill will start rolling back down after stopping. But a hill's grade still provides a useful terminology for the speed of cloth.

There is an easy way to measure the speeds of cloth and thereby compare the speeds of tables. Shoot a lag shot that barely doesn't touch the head rail (the one you start from). Measure the time between the contact on the foot rail and when the ball stops moving. Timing needs to be accurate to a tenth of a second and the cue ball must not quite touch the head rail. The time will usually be between six and eight seconds. Multiply the time by itself and then by two. For example, if the time was seven seconds, the result would be 7 x 7 x 2 = 98. This is the speed of the cloth.

The speed of cloth is the reciprocal of, or one over, the slope. A table with a speed of 100 would slow a rolling ball as if it were going up 1 % grade slope, a 50-speed table would perform like a 2% slope.

To summarize, a faster cloth will produce a higher number. A slow cloth will produce a lower number and balls will roll as if they were going up a steeper incline.

I've seen tables as slow as 60; the cloth must have been a rug. The fastest table I've clocked was on an Accu-stats tape of a three-cushion match at Sang Lee's room in New York. The cloth was a very fine, thin weave, and the table was heated as required by international rules. The 10-second measured lag time gives a speed of 180. (The arithmetic is a little different for 10-foot tables, after you multiply the time by itself, then multiply by 1.8). The lesson there is that if you want the cloth to be fast, keep it thin, clean and dry.

Here's an experiment that shows that draw is the victim of friction. Get two striped balls of average cleanliness. Wash one of them and wax it with a hard wax. Using the undoctored ball as the cue ball, place the stripe equatorially, and shoot with draw and medium speed. Note how far up the table the draw lasts by noting when the rotation of the stripe turns over. Now try the same with the waxed ball. It's not unusual to get twice the original distance before the draw evaporates.

That night in San Francisco at the Sigel-Allen match, the damp had the opposite effect of wax; it increased the friction between ball and cloth, and the draw rubbed off very quickly. This seems backward, since lots of water makes things slippery. However, small amounts of moisture can actually increase friction. Have you ever licked your finger to turn a slippery page?

The last kind of friction is one that all players seek out — friction between the tip and cue ball — static friction. If the tip slides on the cue ball, it's a miscue, so the goal is to prevent any sliding at all. Chalk increases the friction. Again, this seems somewhat backwards since you also see people using chalk as a substitute for talc to make their bridge hand slippery.

Measuring the coefficient of static friction between the tip and ball turns out to be fairly easy. Just note how far from the center you can hit the cue ball without miscuing. As mentioned in Robert Byrne's series of articles on fundamentals, George Onoda has found this to be half the way from the center to the edge of the cue ball. With a little geometry it can be shown that the coefficient of static friction is 0.58 for a chalked tip on a cue ball.

If you can't hit as far from center as Onoda, here are some suggestions:

• Roughen your tip. I press coarse sandpaper into the tip.
• Chalk thoroughly but do not leave caking. The only way to make sure you have done a good job is to look at your tip.
• Get good chalk. Opinions and batches vary. Find what works for you.
• Clean the cue ball. Most dirt increases miscues.

This is necessarily a brief overview of a very complicated subject. To discuss this further, drop me a note in care of this magazine or send me E-mail, via the Internet to jewett@hpl.hp.com