

Bob Jewett



# Bank Losses, Rolling Ratios

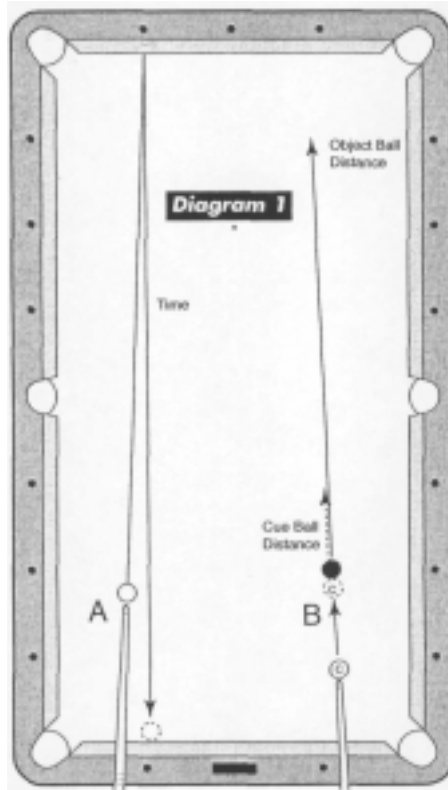
The numbers and formulas behind the results.

Two of the most important factors in how a table plays are the speed of both the cloth and cushions. If these two variables change, your position and banks will suffer horribly unless you compensate. I'm sure you have had the experience of playing on a new, fast cloth and watching helplessly while the cue ball rolls on and on at the end of the shot. Here is some analysis that can help you measure how fast the cloth is and how lively the cushions are.

In my April, 1995 column I offered the following way to measure the speed of cloth: shoot the cue ball as for a lag shot, and time from when it hits the far cushion until it stops. Only count those tries in which it almost hits the cushion you shoot from, as shown in **Diagram 1A**. Say it takes seven seconds to cover that distance. Square the seven (49) and then multiply by two to get 98, which is the "speed" of the cloth. The longer it takes the ball to cover that eight-diamond distance, the faster the cloth is. Take one over the speed number (about 1/100, or 1% in this case), and that gives the effective slope of the cloth. I've seen carom cloth as fast as 200, and some fuzzy, backed cloths that were down around 50.

This rule of thumb for cloth speed ignores a lot of the details in the physics, including the energy in the rotation of the ball, the possibility that the ball may decelerate faster at higher speeds, and that there may be some slide immediately after the far cushion is contacted. Fortunately for the physics fanatics among you, Wayland Marlow, the author of *The Physics of Pocket Billiards*, has written down all the details (contact me through this magazine for more information). One detail I will mention is that you need to correct for the distance traveled if it is not close to the length of a nine-foot table. For example, on a ten-foot carom table, the multiplying factor is about 1.8, rather than the rough two above.

The speed of the cushions is harder to measure. You might expect that when a ball hits the cushion, it loses a certain fraction of its energy, or equivalently, some fraction of its speed, no matter how much it started with. This problem is complicated by roll that the ball nearly always has when going into the cushion softly, as for the lag above. If we had a calibrated video camera, or a



radar gun that could plot speed versus time, we could measure ball speeds into and out of cushions with various spins. There is a simpler way to make the basic measurement with just a tape measure and a couple of balls.

The first basic idea is that we can measure the energy in a ball by how far it goes on the cloth — the farther it goes, the more energy, and in direct proportion. Here we are interested in the ratios, so we will only look at relative distances traveled by the cue ball and the object ball.

The second major idea is that when a cue ball hits an object ball full, and the cue ball is rolling smoothly on the cloth, the cue ball and object ball end up with a certain ratio of energies. What happens is that right after contact, the cue ball stops dead but still has top spin, while the object ball is sliding away with all of the speed of the cue ball without spin. Soon the object ball starts rolling smoothly while the cue ball expends its follow to start moving forward. Theory says that the speeds of the two balls after

they are both smoothly rolling should be in a ratio of 2:5, with the object ball moving two and a half times as fast as the cue ball. Because energy is proportional to the square of velocity, the object ball should end up rolling 6.25 times as far as the cue ball after the collision.

The ratio of about 6:1 is a useful rule of thumb when playing soft position. Suppose the object ball is six diamonds from a pocket, and you want the cue ball to follow straightforward not more than about one diamond after the collision. If you just get the object ball to the pocket — six diamonds of travel — the cue ball will roll forward about one diamond. Another way to state this is that on a full, soft follow shot, the cue ball will go forward one ball for each diamond the object ball travels.

The set up for the experiment is shown as **Diagram 1B**. The object ball is on the head string, and the cue ball is close to the head rail. (Placing it close to the cushion makes it more likely that you will start the cue ball with follow, which is essential for the test.) Simply shoot a lot of straight-on shots at various speeds and measure how far the object ball rolls and how far the cue ball rolls after contact. Be careful on those shots that include a cushion, as the ball can't get all the way to the nose — its center only goes to the rail groove.

Plotted in **Diagram 2** are my results from a 9-foot pool table. On the bottom axis is how far the cue ball traveled, and on the vertical axis is how far the object ball went. The major features are the various straight slopes and the break, or "knee," in the curve when the object ball has gone about 74 inches.

The first straight slope — to the left of the knee — is where neither ball contacts a cushion. The ratio of the distances traveled is estimated to be 7:1, which is close to the 6.25:1 mentioned above. This can be crudely explained by invoking the friction between the balls, which tends to retard the cue ball more than the object ball. At any rate, until the object ball hits the cushion, the ratio holds up pretty well. The next section of the curve is again nearly a straight line, but with a considerably different slope. This is the region where the object ball has hit the far cushion and bounced back. Remember to add up the total dis-

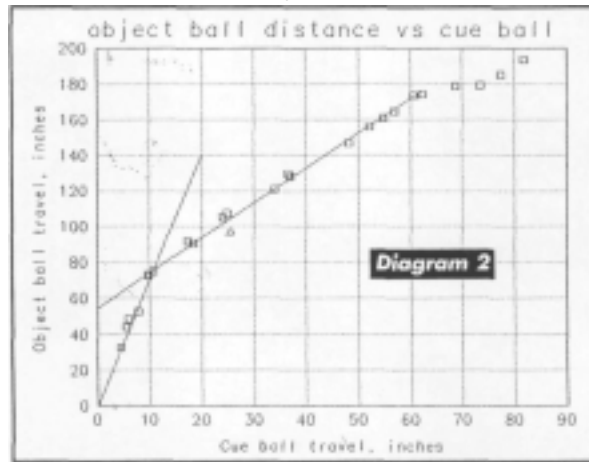
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tance traveled, and not the net distance. The change in slope is because the object ball lost a certain fraction of its energy when it contacted the cushion. The fact that the line is nearly straight until the next cushion is struck means that the cushion "efficiency" is nearly constant for this range of speeds.

By looking at the ratio of the slopes in the two regions, it is possible to calculate what fraction of energy is lost during cushion contact. This solid line fits the data well, with a slope of about 2:1. This means that the object ball only retains 2/7 of its energy in bouncing off the cushion. In terms of speed, the exit speed is 53% of the entrance speed. This is far from the perfect reflector that many people assume the cushion to be.

The wrinkles in the curve on the right side are due to both the cue ball and the object ball hitting more cushions. Starting from the setup as shown, the two balls will both reach cushions for about the same starting speed. This suggests an easy way to measure relative liveliness of cushions. Place an object ball about a diamond in front of the line, and shoot the bank shot with the idea

of leaving the cue ball frozen to the far cushion and the object ball frozen on the



cushion you are near after it has traveled about 13 diamonds. Move the starting location for the object ball nearer and farther, until you find a place that allows the double freezing with a smoothly rolling cue ball. Call this the "magic bank point" or MBP, because it allows you to do a shot at perfect one-pocket speed with nothing fancy on the cue ball — the object ball ends near your pocket and the cue ball ends frozen to the far cushion.

How does the location of this MBP relate to the speed of the cushion? Imagine a cushion that took no speed from the ball. You would have to shoot much more softly to keep from over-running the second cushion, and the cue ball would not go far after the collision. In fact, the object ball would start only a diamond and a half from the first cushion. So the rule is that the closer the MBP to the first cushion, the bouncier is the rubber. On the pool table where I made the above measurements, the MBP is five diamonds from the first cushion. I also measured a snooker table and a carom table, and they both had MBPs very close to the center of the table. The cloths on those two tables were very different. The snooker table had thick nap, while the carom table had super-fast worsted (napless) cloth.

Now you have two tests to use on a strange table, or even your own if you want to see how it stacks up against others. You will need a stopwatch for the cloth-speed measurement, but all you need for the cushion test is to find where the MBP is.

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