David Alciatore, PhD ("Dr. Dave") **ILLUSTRATED PRINCIPLES**

"Just How Big are the Pockets, Anyway? – *Part III*"

***Note**: Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP) can be accessed and viewed online at **billiards.colostate.edu**. The reference numbers used in the article (e.g., **TP 3.10**) help you locate the resources on the website. You might also want to view the resources from a CD-ROM. See the website for more details.*

In my last two articles, I presented several principles concerning factors that make some shots tougher than others. I covered the effects of speed, angle to the pocket, and aim point. The purpose of this month's article is to take things a little further by including the effects of distance between the cue ball, object ball, and pocket. Everybody knows that the further away a ball is from a pocket, the more difficult the shot. This month's article quantifies this and shows how the results vary with side and corner pockets.

In Technical Proofs **TP 3.10** and **TP 3.11**, I derive the allowable margin of error for different distances from a pocket. As I point out on my website, if you don't have a strong background in mathematics and physics, the technical proofs may not be of interest to you and you should proceed at your own risk (... just kidding). However, the results, which I present in graphical form, should be of interest to most people. Diagrams 1 through 4 are plots of the results for side and corner pockets at slow and fast speeds. The curves in the diagrams show allowable **object ball angle errors** at different positions on the table. The allowable error is a measure of the required shooting accuracy. For example, a margin of error of 3° implies that the object ball can be pocketed with an error in the target-line-angle as large as 3°. In the diagrams, if the object ball lies on or within one of the angle error curves, then the object ball can be pocketed as long as the shot angle error is no more than the value reported. The two shots ("A" and "B") shown in **Diagram 1** help illustrate the type of conclusions you can make. Neither shot has a cut angle, and both are the same distance from the pocket. However, the object ball margins of error are quite different: 3º for shot "A" and 1.5º for shot "B." Therefore, shot "B" would be twice as difficult to make as shot "A."

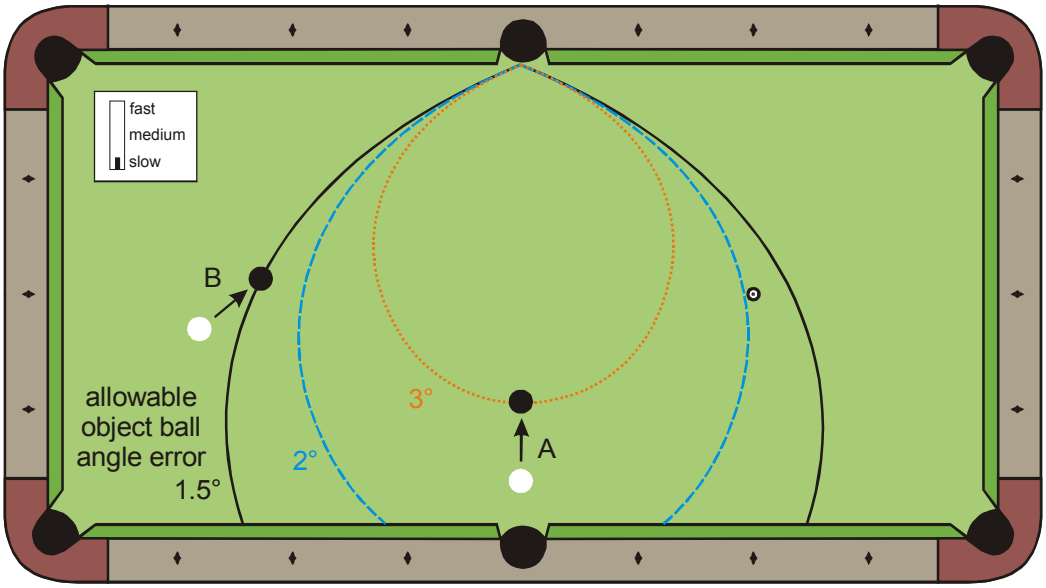

Diagram 1 **Side pocket margin of error regions for a slow shot**

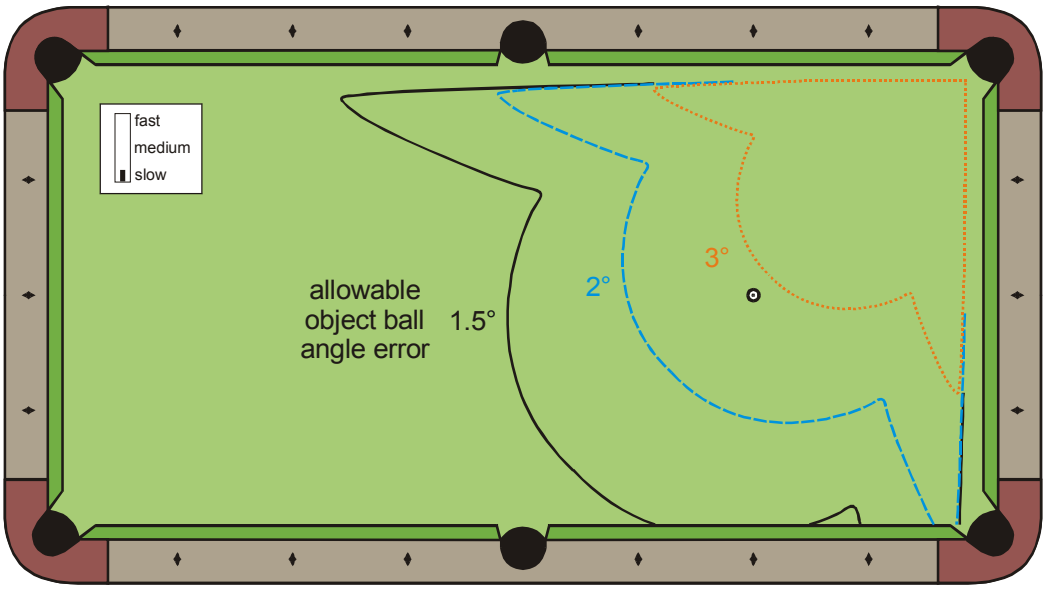

Diagram 2 **Corner pocket margin of error regions for a slow shot**

technical proof

TP 3.10 – Pocket margin of error regions for a slow shot

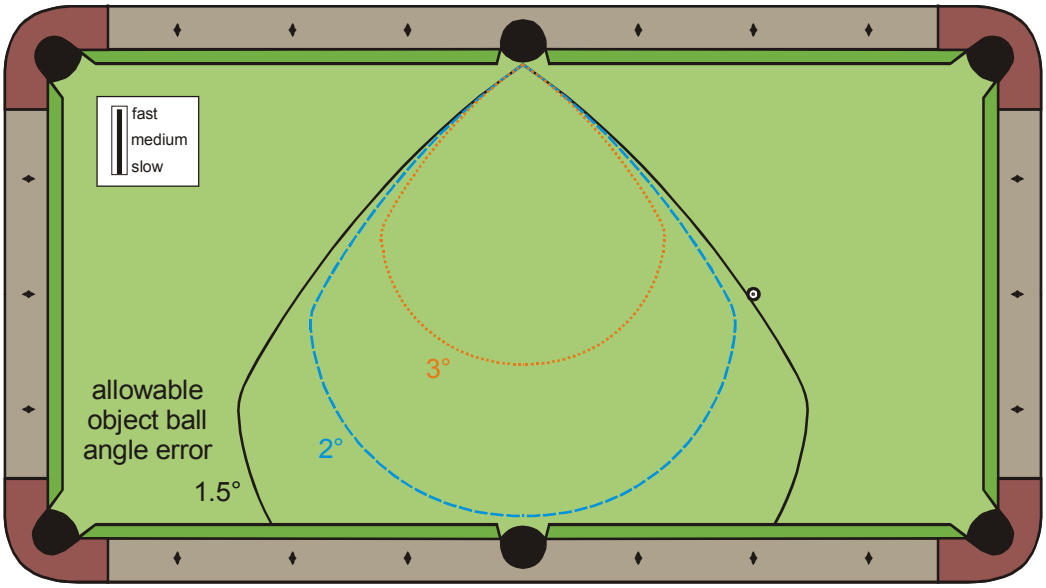

Diagram 3 Side pocket margin of error regions for a fast shot

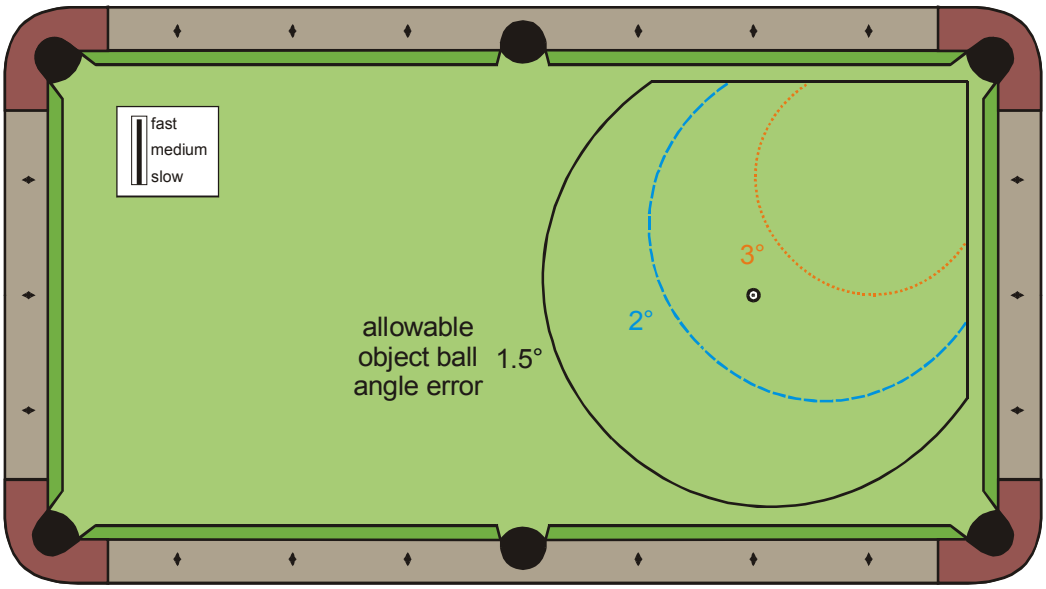

Diagram 4 Corner pocket margin of error regions for a fast shot

technical proof

TP 3.11 – Pocket margin of error regions for a fast shot

Diagrams 5 and 6 illustrate how Diagrams 1 through 4 can be useful in helping you understand shot selection. **Diagram 5** shows two different object ball positions, both of which have the same cut angle and distance to the corner pocket. The question is which shot would be easier, assuming that either shot would create equally good position for the next shot (and assuming you can avoid a scratch with shot “A”). An inexperienced player might think each shot is equally easy (or difficult). However, as shown by the curves, shot “A” would be easier to

execute because its margin of error is 2º vs. 1.5º for shot “B.” That means shot “A” would be 33% easier than shot “B.”

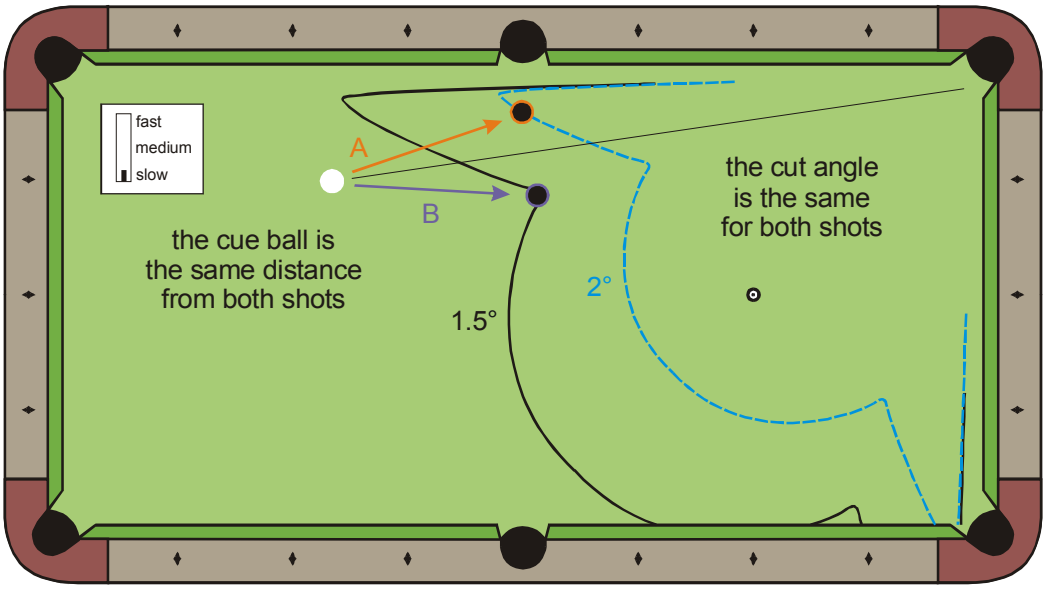

Diagram 5 Choosing a shot based on the margins of error

Diagram 6 shows an example where you need to decide between a corner or side pocket shot for a given object ball location. Three different object ball locations (“a,” “b,” and “c”) are shown. For each of these shots, the cut angle to the side pocket is the same as the cut angle to the corner pocket. Then how do you decide which pocket is easier to shoot at? With the margin of error regions shown, the answer is clear for each object ball position. Position “a” is within the corner pocket region and outside of the side pocket region; therefore, the corner pocket is the clear best choice. Position “b” is within both regions and equally close to each region boundary; so in this case, both pockets have the same level of difficulty, so you should pick the one that feels the most comfortable. Position “c” is well within the side pocket region and just outside of the corner pocket region; therefore, the side pocket is the clear best choice in that case.

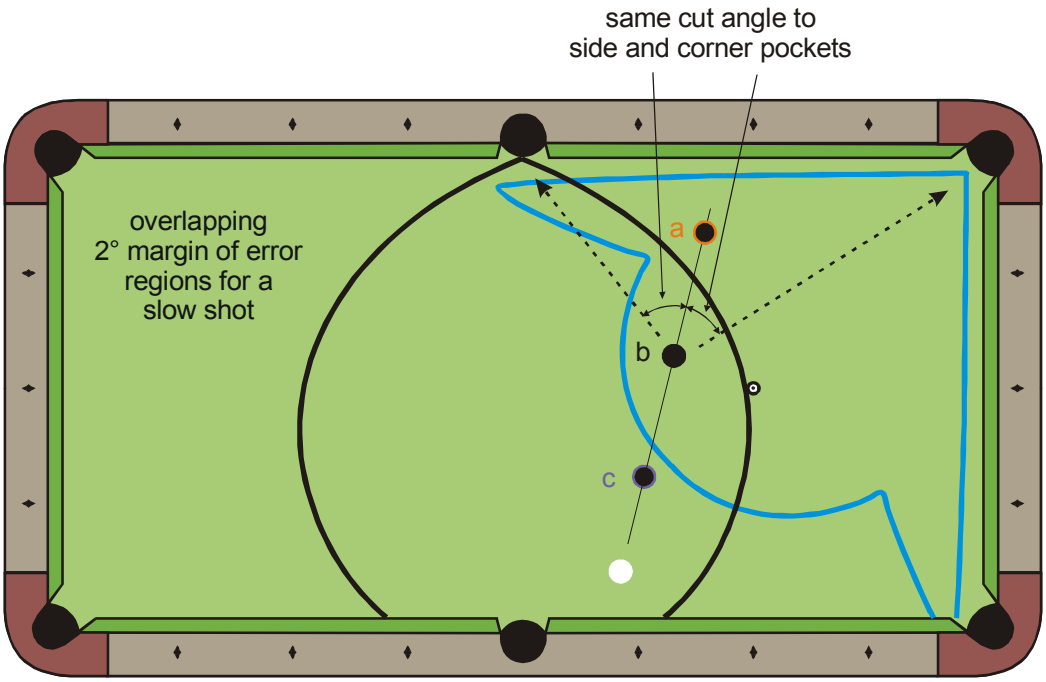

Diagram 6 Deciding whether to shoot at the side or corner pocket

The margin of error region plots above deal with **object ball angle error**, which corresponds to how close the object ball path needs to be to the target line. As **Diagram 7** illustrates, the allowable **cue ball angle error**, measured relative to the desired aiming line, needs to be even more accurate than that. This is because a small error in cue ball aim translates into a much larger error in the object ball direction, especially for larger cut angles (see **TP 3.12**). Furthermore, a shot's difficulty increases as the distance between the object ball and the pocket increases, as the distance from the cue ball to the object ball increase (see **Principle 15**), and as the cut angle increases (see **Principle 16**). If all three measures increase together, the difficulty level increases and your margin of error decreases dramatically. A detailed analysis and plots showing the effects of cue ball distance, cut angle, and cut angle error can be found in **TP 3.12**.

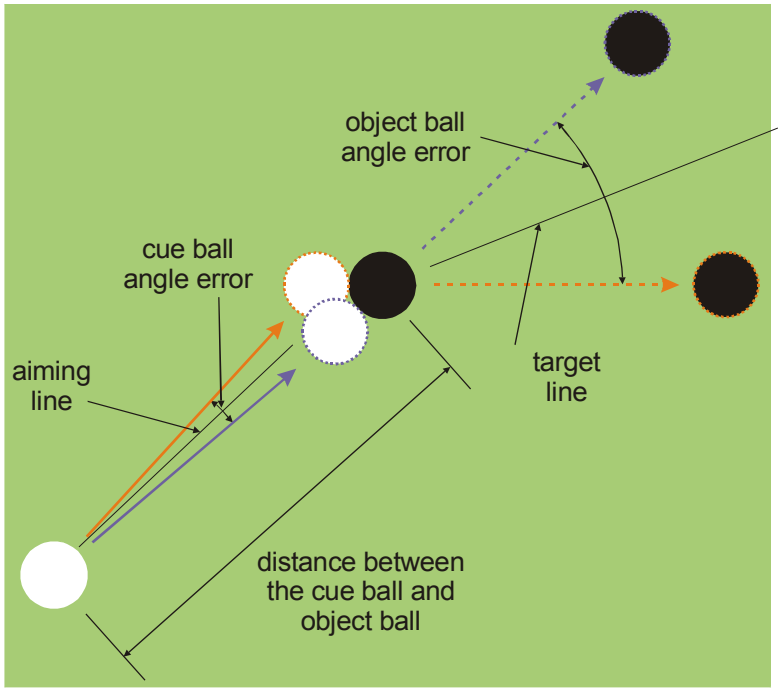

Diagram 7 Cut angle error and object ball angle error

Principle 15 Closer to the object ball is better

The margin of error decreases dramatically as the distance between the cue ball and object ball increases (see TP 3.12).

- The margin of error also decreases with distance between the object ball and the target.
- The margin of error also decreases with cut angle (see **Principle 16**).

Principle 16 Smaller cut angle is much better

The margin of error decreases dramatically as the cut angle increases (see TP 3.12).

- The margin of error also decreases with distance between the object ball and the target.
- The margin of error also decreases with distance between the cue ball and object ball (see **Principle 15**).

technical proof

TP 3.12 – Object ball angle error based on cut angle

Well, by now you might be thinking: "All of these plots are cool (or maybe not), but how can I use them in my game?" In case you haven't noticed, most tables don't have all of these complicated curves drawn on the cloth to help you out. I'm fairly geeky, being an engineer, and even I don't have the shapes drawn on my table (although I have been tempted to do this). I figure the diamonds are there to help you aim kick and bank shots, why not add some margin of error shapes to the cloth? Anyway, given this, how are the plots useful? To me, what is important is understanding the main principles involved (see Principles 7 through 16 in my last three articles). I think the two most important things to remember and keep in mind are:

1. The side pockets are “bigger,” especially for small angles to the pocket.

2. The corner pockets are “bigger” for shots close to the rail, especially when hit softly.

Maybe you instinctively knew these things already, but now you know the details of why and how much. I hope you have enjoyed my series of articles dealing with “Just How Big are the Pockets, Anyway?” I know it may have been a little dry for a non-analytical kind of person, but I hope you still gained some insight from the principles and plots.

Good luck with your game, and practice hard,
Dr. Dave

PS:

- If you want to refer back to any of my previous articles and resources, you can access them online at ***billiards.colostate.edu***.
- I recently released an interactive instructional video DVD. If you are interested, you can view excerpts online at ***billiards.colostate.edu***.
- FYI, over the next three years I will be presenting a multimedia seminar across the country, sponsored by the American Society of Mechanical Engineers. The title is “The Illustrated Principles of Pool and Billiards.” The talks are usually open to the public, so periodically check out the dates and locations on my website. It would be fun to have some BD readers (and not just engineers) in the audience.

Dr. Dave is a mechanical engineering professor at Colorado State University in Fort Collins, CO. He is also author of the book: “The Illustrated Principles of Pool and Billiards” (2004, Sterling Publishing).