

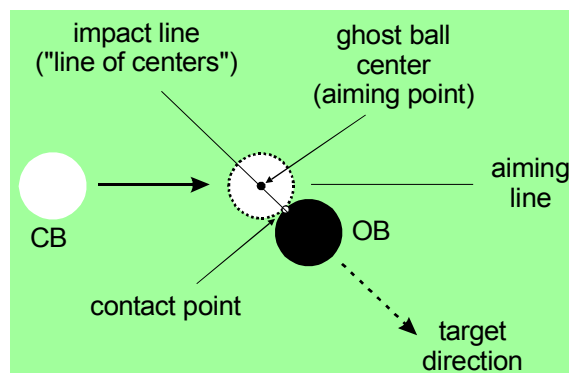
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*Note: Supporting narrated video (NV) demonstrations, high-speed video (HSV) clips, and technical proofs (TP), and all of my past articles, can be accessed and viewed online at [billiards.colostate.edu](http://billiards.colostate.edu). The reference numbers used in the article help you locate the resources on the website. If you have a slow or inconvenient Internet connection, you might want to view the resources from a CD-ROM or DVD. See the website for details.*

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This is the second article in a series on fundamentals. Last month, I presented some background information and touched on the stroke and a useful stroke drill. This month, the focus is on aiming. “Aiming systems” is probably one of the most controversial and emotional topics in pool, so I will just stick to the basics. Recently, the Internet forums have been beehives of activity (more like hornet nests) with various debates (more like “ruthless wars”) concerning various aiming “systems.” If you are interested, a lot more information and discussion concerning aiming system concepts can be found under “aiming” in the FAQ section of my website.

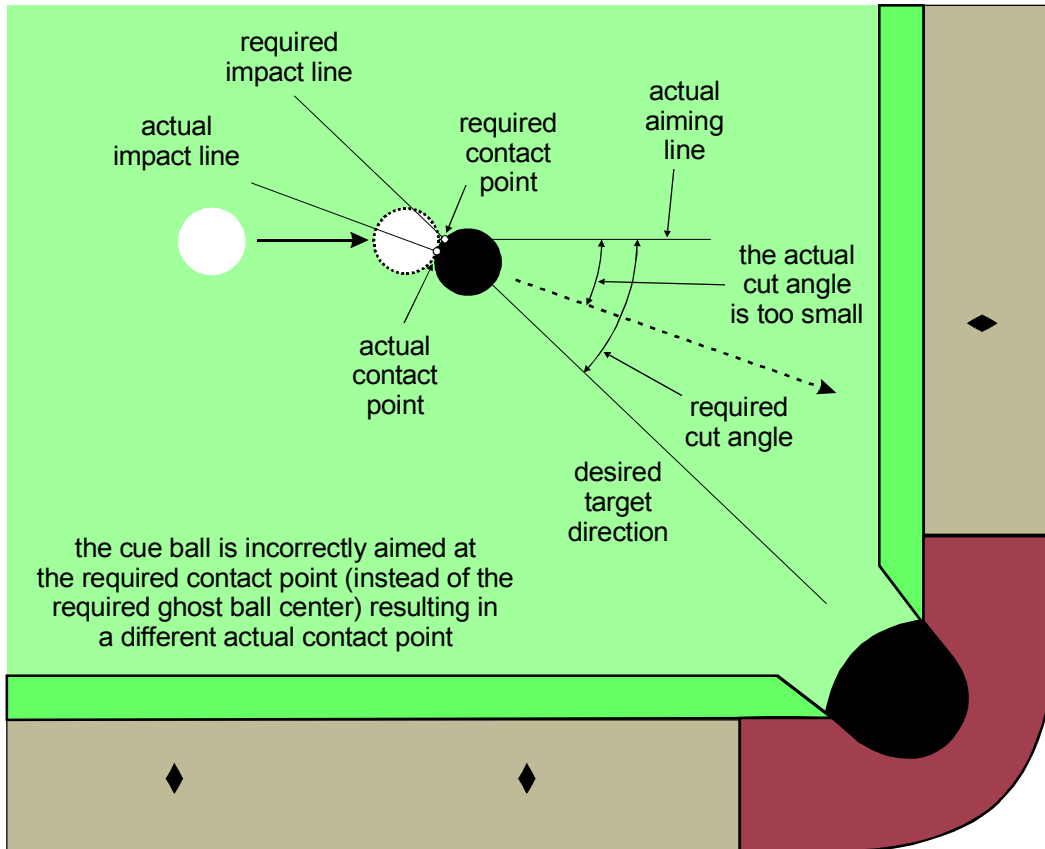
**Diagram 1** illustrates basic terminology concerning aiming. To send the *object ball (OB)* in the target direction, the *cue ball (CB)* must be delivered to the imaginary *ghost ball (GB)* target to create the necessary *contact point (CP)* between the CB and OB. At contact, the line connecting the CB and OB centers is called the *impact line* or “*line of centers*.” Probably the most basic and useful “aiming system,” especially for a beginner, is the *GB aiming system*. To aim a shot, you first align your sight with the OB and the desired target to determine the required CP and impact line. Then you align your sight with the CB and the center of the imaginary GB target, along the necessary *aiming line*. Then, with a reliable stroke, you deliver the CB to the GB target. Note that the CB aiming line does not pass through the CP between the CB and OB. Note also that the basic GB system does not take into account OB throw (see my past articles on this topic); however, if the GB position is shifted to account for throw, then everything else still applies.



**Diagram 1 Aiming line and contact point**

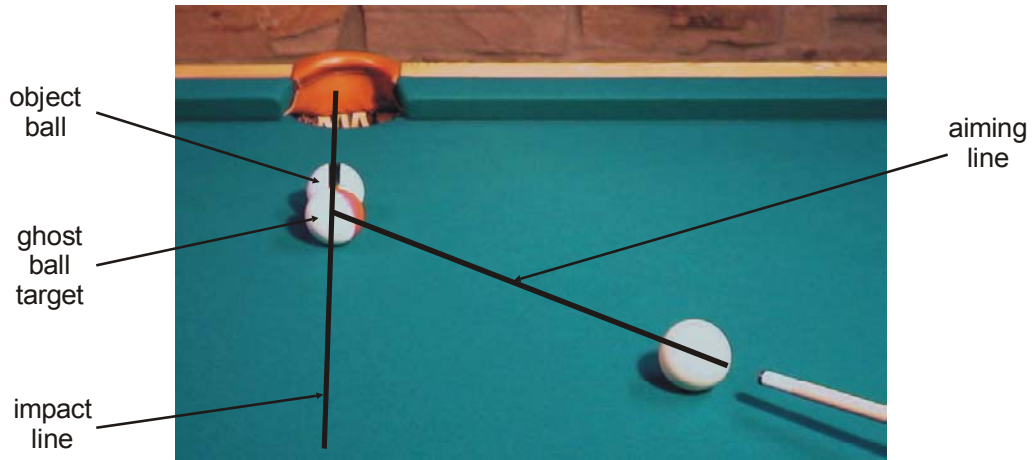
Inexperienced players, and sometimes experienced players, often undercut cut shots (i.e., the shots are hit too full). One reason is the player is not accounting for collision-induced throw (see my September '06 article for more info). Another reason is illustrated in **Diagram 2**. A novice player is often tempted to aim at the required CP instead of the imaginary GB center. This results in a different actual CP. The end result is too small of a cut angle (i.e., the ball is hit too

full), and the shot is missed. In fact, the OB doesn't even come close to the pocket. You must aim at the imaginary GB center (adjusted for throw if necessary), not the desired CP. This example demonstrates, in dramatic fashion, how sensitive a pool shot can be to relatively small changes in aim.

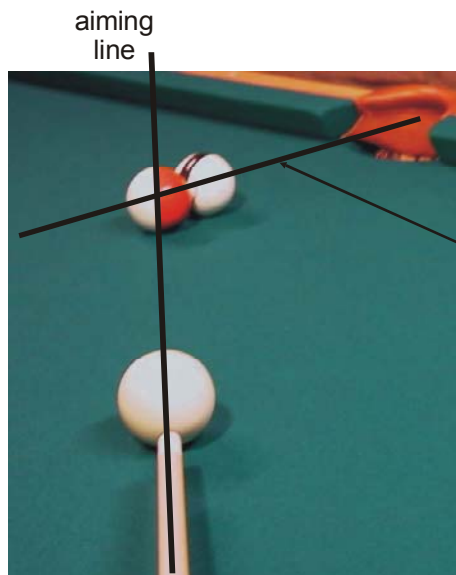


**Diagram 2 Undercutting a cut shot**

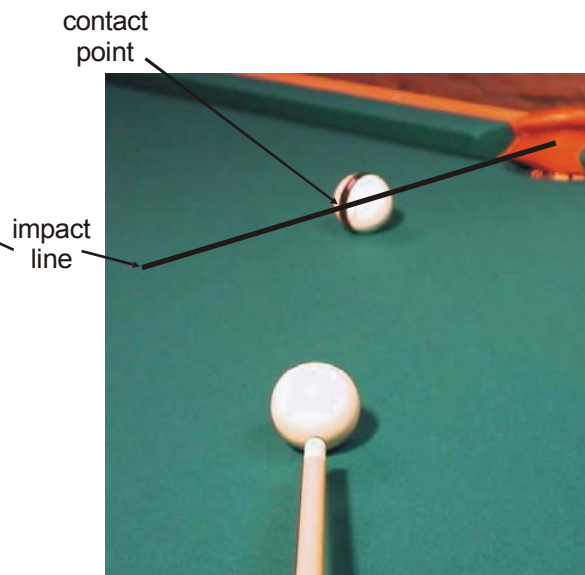
You can practice the GB technique and develop your visualization and aiming skills by having someone place a spare ball at the desired GB location while you are aiming your shot. **Diagram 3** and **NV 3.1** show an example of how this works. When your aim is established, have the person remove the GB, and try to imagine the GB in its place along with the resulting CP. Do this several times (placing the ball and taking it away) with different cut angles and directions to help develop your GB perception abilities. The balls used in Diagram 3 are called Elephant Practice Balls, but regular striped balls can be used instead. The stripes help you visualize the aiming line and impact line directions, and the ball number (or the red circle of the Elephant ball) can be used to help visualize the CP.



a) ghost ball in place (impact line view)



b) ghost ball in place (aiming line view)



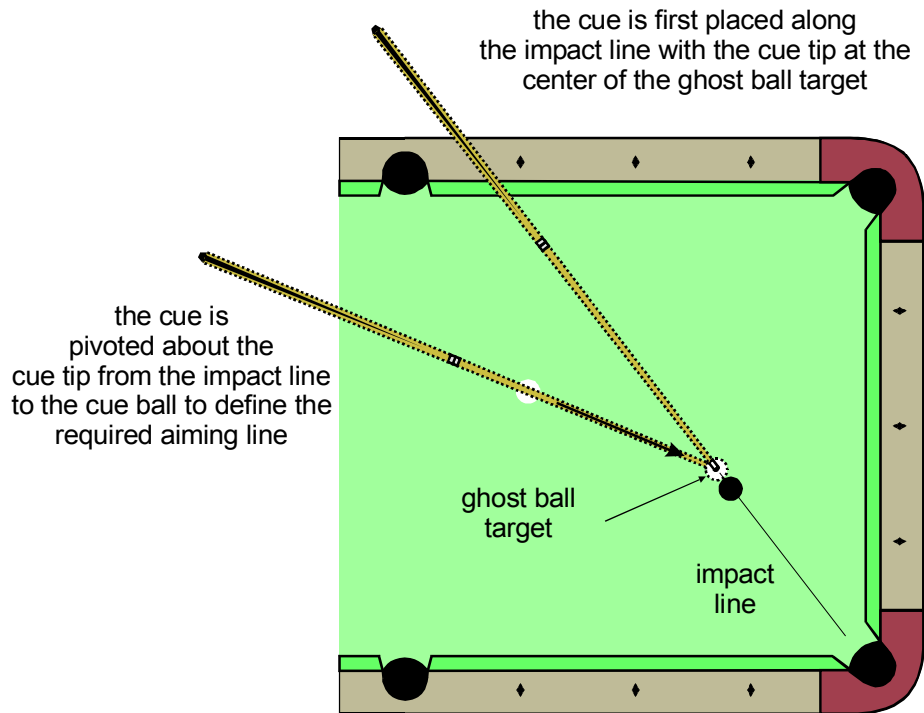
c) ghost ball removed (aiming line view)

**Diagram 3 Ghost ball aiming method**



**NV 3.1** – Practicing contact point and ghost ball visualization

**Diagram 4** and **NV 3.2** show how you can use the cue to help visualize the impact, tangent, and aiming lines for a cut shot. You first place the cue over the OB in the direction of your target to define the impact line (see NV 3.2). The tangent line will be perpendicular to this line. The cue can also help you visualize the GB target location for the CB. The tip of the cue is placed on the table at the center of the imaginary GB target and the cue is pivoted about this point until it is in line with the CB. This defines the aiming line for your stroke.



**Diagram 4** Using the cue to help visualize the aiming line



**NV 3.2** – Using the cue to help visualize the impact and aiming lines

Before addressing the ball and settling into your stance, an upright look helps you visualize the GB and see the angle of the shot before dropping your eye level into the final stance (see **NV 3.3**). From an upright position, with the cue aligned with the aiming line and your head in the aiming plane, gradually lower your upper body and head into the stance, keeping your head and gaze in the aiming plane. While lowering, it helps to move your eyes up and down, between the GB target and the cue, to help maintain the correct aiming plane.



**NV 3.3** – Addressing the ball and taking your stance

As you develop your aiming skills and experience-based intuition, you will learn to “see the angles” and might not need to visualize the impact line and GB target; but, when learning, it helps to methodically line up and aim a shot, using your intuition as a check and reinforcement. I personally use a combination of straight intuition (just “seeing the angle”), GB aiming, and CP visualization. Based on an article written about how pros aim (see [www.sfbilliards.com/PnB\\_aiming.pdf](http://www.sfbilliards.com/PnB_aiming.pdf)), it seems many pros take a similar approach; although, the article is not the result of a rigorous scientific study. The pros use all of the visual information available to them (CP, GB, impact line), and they just “see” the angle of the shot. And when a shot requires English, they usually intuitively compensate for squirt, swerve, and throw. If you want to know more about squirt, swerve, and throw compensation, see the pertinent link under “aiming” in the FAQ section of my website.

Some people seem to think they have magical aiming systems that can help somebody shoot better overnight. I think this is a nice dream, but not a practical reality. Aiming is tough because

it involves 3D visualization, visual perception, and physical and visual alignment. One must also compensate for cut-induced throw when no English is used, and squirt, swerve, and throw when English is used. If precise aiming were simple, pool would be a much easier (and much less fun) game. If somebody claims he or she has a magical system that will work for all shots without special compensation, they are trying to sell you religion, not solid technique. Having said that, any "system" that helps a person focus on aim and alignment consistently and with concentration will be beneficial to many people (especially people who currently don't focus well or long enough), even if the system isn't perfect.

Concerning many of the limited-lines-of-aim "aiming systems" people have proposed, the OB can only go in N different directions with only N lines of aim. So if somebody claims a system with only a few lines of aim can be used to pocket any shot, they are not telling you the whole story. With only a few lines of aim (e.g., the fractional-ball or center-to-edge systems), intuitive compensation based on lots of experience and practice must be part of the aiming and aligning process. In **TP A.13**, I work through some math and geometry that shows how many lines of aim are required for different types of shots. For those not interested in mathematical details, here are some of the highlights for large (5 1/4") pockets:

- To be able to pocket an OB into a pocket about 3 feet away, with an average angle to the pocket, and for any cut angle, the required number of aiming lines is about 19!
- If you consider cut shots only within a typical range (e.g., 7.5 to 52.5 degrees), and use only three equally spaced lines of aim (e.g., with a fractional-ball aiming system):
  - If the OB is less than a foot from the pocket, every shot can be pocketed with the three lines of aim.
  - If the OB is more than two feet from the pocket, less than 50% of all cut shots in the typical range can be pocketed with only three lines of aim.

With "tighter" pockets, the situation is much worse: even more lines of aim are required.



### **TP A.13** – Number of lines of aim required for different types of shots

Well, I hope you are enjoying and benefiting from my series of articles on fundamentals. If you want to read more about aiming systems and concepts, I have much more info under "aiming" in the FAQ section of my website. Next month, we will look at important issues related to CB control.

Good luck with your game,  
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](http://billiards.colostate.edu).
- I know other authors and I tend to use lots of terminology (e.g., squirt, throw, stun, impact line, etc.), and I know not all readers are totally familiar with these terms. If you ever come across a word or phrase you don't fully understand, please refer to the online glossary in the "Instructor and Student Resources" section of my website.

*Dr. Dave is a mechanical engineering professor at Colorado State University in Fort Collins, CO. He is also author of the book, DVD, and CD-ROM: "[The Illustrated Principles of Pool and Billiards](#)," and the DVD: "[High-speed Video Magic](#)."*