GRADIENT LINE BALANCE HOLE™

Time Line

Not that long ago balance or weight holes were strictly thought of as a drilling technique to keep side weights legal (ball balance) as well as helping to control a ball's movement to the pocket. As technology advances, drilling techniques need to change as well. MoRich is pleased to announce the next step in ball drilling --The GRADIENT LINE BALANCE HOLE™. Developed by MoRich with analytical support provided by Steve Freshour, combining this technique with Dual Angle provides the ball driller with an easy, effective and accurate method of choosing the best layout and balance hole location to match every bowler to every lane condition.

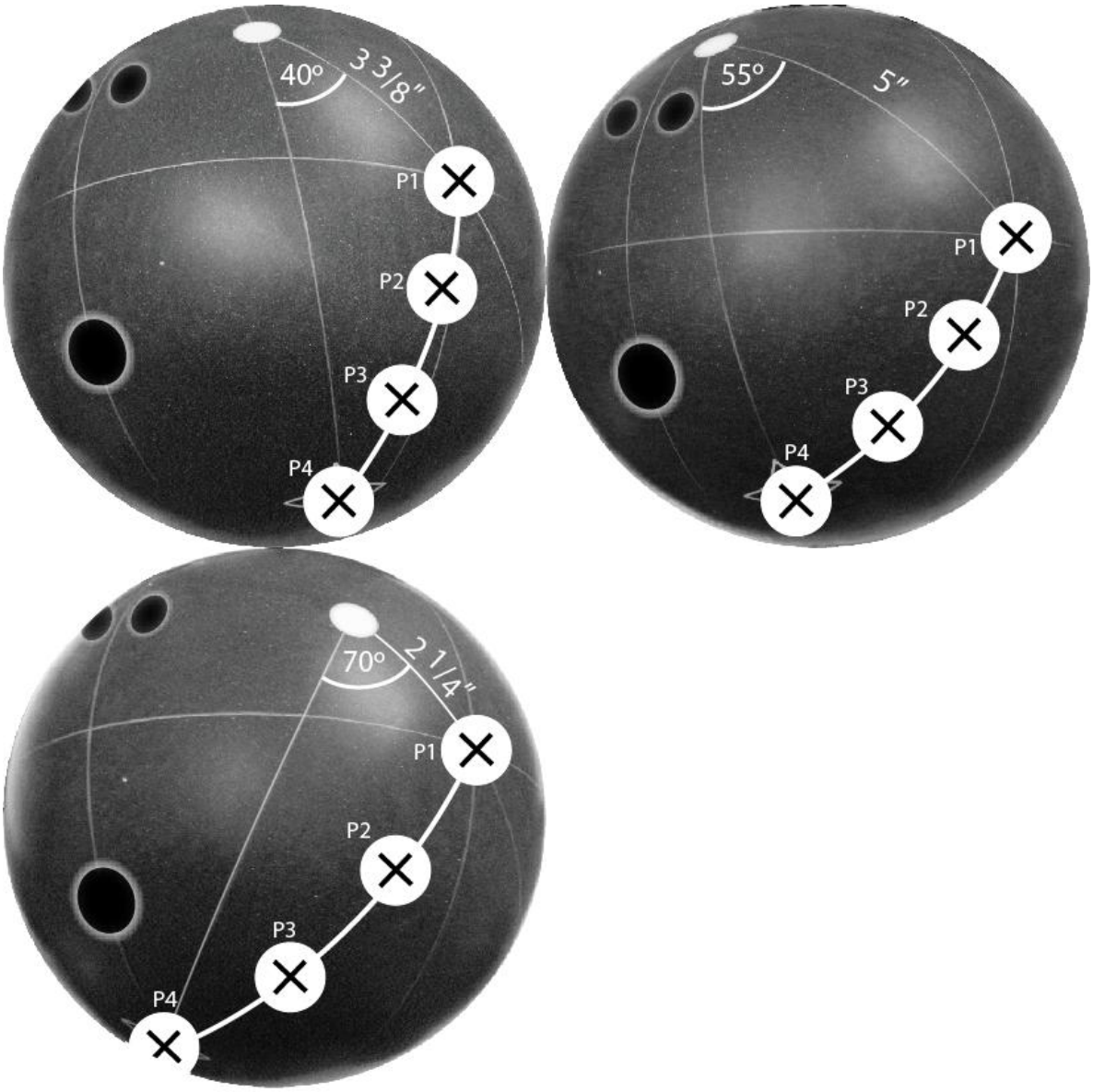
This technique continues with that learned in the DUAL ANGLE DRILLING TECHNIQUE where we now focus on the placement, size, and depth of the balance hole and its effect on the ball.

The following statement is rather important so please read it a few times.

*The **GRADIENT LINE BALANCE HOLE™** works accurately in conjunction with the **DUAL ANGLE DRILLING TECHNIQUE™** for ALL bowling balls. Using longer-pinned balls (pins-out 3 to 5 ½ inches) makes the gradient line balance hole easier to place. Longer-pinned balls will result in the CG being below the midline and therefore eliminating problems with excessive finger weights after drilling.*

Definition

What's a gradient line? It's simply the line drawn from the Positive Axis Point (PAP) to the Preferred Spin Axis (PSA). Notice that there are only 4 equally distant locations along each line. The first (P1) is always on the PAP, the fourth (P4) is always on the PSA, and the second (P2) and third (P3) are equal distant from each other as well as to their respective PAP or PSA points. The shorter the distant between the PAP and PSA, the shorter the distance between P1, P2, P3, and P4 and when the distance between the PAP and PSA is longer, the distance between P1, P2, P3, and P4 will also be longer. Let's get a better visual using the pictures below.



Notice the pin placement, its angle between P1 and P4, and the closeness of P4 to the thumbhole! This later factor is very important as we move along.

Why are we so concerned with the placement of a balance hole? Well because it has the ability to reduce or enhance a ball's potential in coordination with its drilling. Bowlers rarely want to change lines, hand positions, let alone balls. Bowlers are fickle athletes who like what they like and rarely like change. How many times has someone approached you and asked to have the next ball behave exactly like the old one that's several years old and out-of-style according to today's technology? This technique now provides you with an alternative to better match equipment to a bowler's style and needs while restoring a bowler's confidence in newer equipment.

Sounds rather simple, but now it's time to dive into the numbers!

Let's start with the first picture where we're using a 3⅜ X 4½ layout using a 40° drilling angle. Keep an eye on how the numbers (especially the Total Diff) change as the hole location changes.

40° X 3⅜ X 20°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.496	2.493	2.488	2.487	2.489
Int Diff	0.030	0.033	0.039	0.042	0.044	0.047
Total Diff	0.048	0.046	0.055	0.062	0.065	0.069
Side Weight (oz)		-0.515	-0.369	0.330	0.700	0.469
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1.125	1.125	1.125	1.125	**1.25**

**Balance hole has to be shifted down 1" when using P4 for this layout.

40° X 3⅜ X 45°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.502	2.497	2.492	2.491	2.493
Int Diff	0.030	0.032	0.037	0.040	0.042	0.046
Total Diff	0.048	0.039	0.049	0.056	0.059	0.063
Side Weight (oz)		-0.592	-0.377	0.246	0.685	0.400
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1.125	1.125	1.125	1.125	**1.25**

40° X 3⅜ X 70°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.504	2.499	2.495	2.494	2.496
Int Diff	0.030	0.032	0.038	0.041	0.043	0.047
Total Diff	0.048	0.037	0.046	0.053	0.056	0.060
Side Weight (oz)		-0.369	-0.277	0.269	0.608	0.215
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1.125	1.125	1.125	1.125	**1.25**

So what's the bottom line with all of these numbers? P1 placements reduce the dynamics of the ball by almost 20%. P2 placements are so minute in changing the dynamics that its almost the same as if the hole weren't drilled. And the need for a P2 if nothing changes -- to keep side weight within USBC regulations! P3 placements increase ball dynamics by 20% and P4 placements increase ball dynamics by 40%!

Hmmm so before we go much further, can you see how you might be able to adjust a bowler's preferred ball so that it can behave differently without much change required of the bowler?

Let's move to the second picture where we're using a 5 X 4½ layout using a 55° drilling angle.

55° X 5 X 20°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P3**
Low RG	2.488	2.493	2.492	2.491	**P4 is not possible as it's too close to thumb hole	2.493
Int Diff	0.030	0.037	0.043	0.048		0.054
Total Diff	0.048	0.052	0.056	0.060		0.066
Side Weight (oz)		-0.785	-0.385	0.031		-0.523
BAL Depth (in)		3	3	3		**3.5**
BAL Diameter (in)		1	1	1		**1.25**

55° X 5 X 45°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P3**
Low RG	2.488	2.499	2.498	2.496	**P4 is not possible as it's too close to thumb hole.	2.499
Int Diff	0.030	0.033	0.039	0.044		0.050
Total Diff	0.048	0.042	0.046	0.050		0.056
Side Weight (oz)		-0.831	-0.484	-0.100		-0.762
BAL Depth (in)		3	3	3		**3.5**
BAL Diameter (in)		1	1	1		**1.25**

55° X 5 X 70°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.500	2.500	2.499	2.499	2.501
Int Diff	0.030	0.031	0.038	0.044	0.047	0.054
Total Diff	0.048	0.040	0.044	0.047	0.049	0.056
Side Weight (oz)		-0.554	-0.300	0	0.331	-0.138
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1	1	1	1	**1.25**

See how the trend continues? And now let's move to the third picture where we're using a 2¼ X 6 layout using a 70° drilling angle.

70° X 2¼ X 20°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P3**
Low RG	2.488	2.497	2.495	2.491	**P4 is not possible as it's too close to thumb hole.	2.497
Int Diff	0.030	0.031	0.034	0.038		0.042
Total Diff	0.048	0.043	0.048	0.056		0.058
Side Weight (oz)		-0.992	-0.731	-0.285		-0.946
BAL Depth (in)		3	3	3		**3.5**
BAL Diameter (in)		1	1	1		**1.25**

70° X 2¼ X 45°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.499	2.495	2.489	2.487	2.489
Int Diff	0.030	0.028	0.033	0.037	0.040	0.046
Total Diff	0.048	0.040	0.048	0.057	0.062	0.068
Side Weight (oz)		-0.808	-0.538	0.146	0.862	0.885
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1	1	1	1	**1.25**

70° X 2¼ X 70°						
Parameter	**Undrilled**	**P1 (PAP)**	**P2**	**P3**	**P4 (PSA)**	**Max Size Hole @ P4**
Low RG	2.488	2.503	2.498	2.491	2.488	2.490
Int Diff	0.030	0.029	0.035	0.041	0.043	0.047
Total Diff	0.048	0.037	0.047	0.059	0.064	0.068
Side Weight (oz)		-0.931	-0.739	0.023	0.869	0.777
BAL Depth (in)		3	3	3	3	**3.5**
BAL Diameter (in)		1.125	1.125	1.125	1.125	**1.25**

RECAP

Now let's recap by comparing the Total Diffs in terms of percentage increase and decrease with this particular ball whose undrilled total diff is 0.048. Notice how the ball's dynamics weaken as the angles increase for balance holes placed at P1 (PAP) and how they strengthen with reference to placement at either P3 or P4.

40° Drilling Angles				
Angel to VAL	**20°**	**45°**	**70°**	
Min @ P1 (PAP)	0.046	0.039	**0.037**	
% change	-4.2	-18.8	**-22.9**	
Max @ P4 (PSA Max)	**0.069**	0.063	0.060	
% change	**43.8**	31.3	25.0	
55° Drilling Angles				
Angel to VAL	**20°**	**45°**	**70°**	
Min @ P1 (PAP)	0.052	0.042	**0.040**	
% change	8.3	-12.5	**-16.7**	
Max @ **P3**/P4 (PSA Max)	**0.066**	0.056	0.056	P3 is the strongest @ 20°
% change	**37.5**	16.7	16.7	P4 is the strongest @ 45° and 70°
70° Drilling Angles				
Angel to VAL	**20°**	**45°**	**70°**	
Min @ P1 (PAP)	0.043	0.040	**0.037**	
% change	-9.8	-16.7	**-23.5**	
Max @ P3/**P4** (PSA Max)	0.058	**0.068**	**0.068**	P3 is the strongest @ 20°
% change	20.8	**41.7**	**41.7**	P4 is the strongest @ 45° and 70°

Conclusion

The numbers simply prove that in coordination with the drilling layout, placement of the balance hole is rather simple and generates a significant amount of impact on the final product. Armed with this new information, matching bowlers to equipment to lane conditions becomes much easier! The bottom line -- it makes sense!