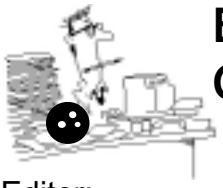
The Coaching Eye

Volume #1 - Issue #6
December 2002



Editor's Corner:

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Well, here it is again guys. Print it out when you desire.

Place selected pages in a binder for your students. Use selected pages in your classes.

In this issue:
Advanced Lane Play:
Matching Up - The Lane Conditions

January Issue:
The Release of the Ball
What, When, Where, Why and How

Matching Up - The Lane Conditions
This issue concentrates on lane conditions and how to get the ball path shape that you desire.

If you have additional topics related to **Lane Conditions**, please Email the document and we will include it in an upcoming issue.

We also publish a technical newsletter though the PBPSI (Professional Bowling Pro Shops International) organization named PBPSI Pro Shop Notes. If you are interested in the technical aspects of bowling balls and how thay are drilled and what the corresponding reaction is expected to be, Email the request and we will place you on that send list also. As with The Coaching Eye, PBPSI Pro Shop Notes is free and always will be.

Note that each issue stands on it's own as a publication. Hence, some topics appear in multiple issues. (As our time permits and the demand requires, we also create a left handed bowler version of all back issues. They are available - free - upon request. Just Email us the request).

Each issue is designed to be a fund raising booklet for your local Youth Bowling Program. Excluding the cover page, make some clean copies and let the Youth Director sell them at the control desk or in the pro shop to raise money for the youth bowling program at your bowling center.

This issue is about **41** pages in length. Check your printer paper before printing it out. Please read it yourself before giving it to your students.

The Bowling School

Stockton, California

Matching Up to the Lane Conditions

by
John R. O'Dell

PBPSI Membership
PBPSI Technical Certification
IBPSIA Membership
IBPSIA Technical Certification
USA Bowling Silver Certification
YABA Master Instructor

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Matching Up to the Lane Conditions

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Controllability

Just like everyone has a certain comfort zone that they are comfortable with, they are also comfortable with a certain type of ball path.

Controllability is the name of the game. You should always look for a ball path and a ball choice that gives you that ball path shape that you desire. It's what you really really want and what has worked best for you in the past.

Note that the location on the lane where the ball path is located is secondary to the ball path shape itself.

Here's an example:
A snappy ball path is great for really getting a lot of energy to the pins. It gives great length and great angle of attack into the pocket. But, it can be too snappy sometimes when the backend is too aggressive or the oil is too short. It is uncontrollable. The slightest little push to the outside will make the ball accelerate too high into the pocket.

One solution is to move inward into a greater density of oil to give greater length, more oil tracks and a larger oil splotch area at the bow ties. By moving inside the desired ball path shape may be attained.

The other choice is to choose another ball with a less snappy backend reaction.

The example is just that, an example. The concept of a desired ball path shape cannot be overstated. Almost every bowler has a desired ball path shape. Whether it be snappy or arcy doesn't matter, it's what really works best for you.

The idea of a desired ball path shape defines your controlability. You have the highest controllability for a specific ball path shape. If you diverge from that ball path shape too much, you will decrease your controlability.

The Best Match of the Bowler, the Ball and the Lane Conditions
The best match possible is one that allows the bowler to roll the desired ball path shape ending up at the pocket with the desired impact parameters speed, location and angle of attack into the pocket.

The Contents of the Rest of this Issue
The rest of this issue will in many diverse topics try to accumulate the ideas necessary for helping the bowler make the right choices for getting the best match.

Track Analysis, the Oil Splotch and the Ball Path Reaction

Reading the tracks that the oil conditioner leaves on the surface of the bowling ball as it rotates while rolling down the lane can give you some valuable information. Let's look at a detailed analysis of the oil tracks.

Ball Path Reaction is the other primary indicator of the oil conditions. If you look at how the ball reacts as it goes down the lane surface, you will absolutely have the best analysis tool available.

The Oil Splotch area is located at the "bow tie" points also known as the Flaring Axis Points. It's where the flaring oil tracks rotate about. That Oil Splotch area is the primary cause of "carry down." Every rotation of the ball goes over the oil splotch. The size of the Oil Splotch area for a specific bowling ball is dependent upon the density and length of the oil. Longer oil yields a larger oil splotch.

Track Analysis and Ball Path Reaction Analysis are like brothers standing together to fight their arch enemy, the oil conditions. When the two brothers get into an argument about the lane conditions, they both look at the oil splotch area for confirmation. So the Oil Splotch Area acts as man's best friend helping the two brothers. (Well . . isn't that special . .).

(Ball Path Reaction is the smarter of the two brothers. He does most of the talking. Track Analysis is kind'a like a yes/no guy. He's kind'a digital. About all he can do is verify or deny what his taller and smarter brother determines). Let's call the smarter of the two brothers "Reactor", the smaller dumber brother "Tracky" and the oil splotch area just simply "Spot."

Did anyone see the motion picture "A Beautiful Mind" . . . . .

Looking at the Oil Tracks

If you have a dark colored bowling ball, you have a distinct advantage. You will be able to see the oil tracks easier. Roll the ball like you normally do for a strike. If you are lucky, your lane guru has placed a perfect oil pattern on the lane surface. There is ample oil in the heads and the oil tapers both laterally and down the lane surface.

Let's say the first noticeable edge for the oil pattern is at the 10th board and you roll the ball swinging across the 10th board after launching it at the 13th board. The ball slides through the heavy oil in the heads and gets to about the 8th board at about 35 feet and starts to hook back toward the pocket.

The ball has gone through
1. very heavy oil initially until it gets to the 10th board laterally
2. medium dense oil until it gets to the down the lane to the end of the oil at about 35 feet.
3. no oil after the 35 foot distance.

So, what's on the surface of the ball?

Nasty ole oil tracks. Lets see if we can get some information from them. Any little piece of information is better than no information at all

The Longer the Oil, the Greater the Number of Tracks
Assuming that you roll the ball at about the same rotational speed (rev rate), the number of tracks can tell you something about the length of the oil. You cannot get an exact number but you can get a comparative number. You can compare the number of tracks that you are seeing with the number of tracks that you are accustomed to seeing.

There is also another little trick. If there is some kind of label of mark on the surface of the ball, you can use that for a length comparison indicator. If the present visible oil track is past that indicator mark, the oil must be longer than usual. Neat, huh!

No don't go placing a huge mark on the surface of your bowling ball. Remember, it's in your track area. Well, just a teenie weenie little indentation might be acceptable. (Don't tell anyone though).

Example:
Let's say that your ball has a label that is about where your oil tracks appear. You roll the ball normally on your normal lane conditions and the tracks end at near the top side of that label.

Okay, now you are at a tournament ($500 entry fee 3 game tournament). Only two practice balls are allowed. You roll a practice strike ball. Oh darn, you didn't get a strike. No, it's too late to get your money back. Look at your ball and ask Tracky and Reactor for a little help.

Reactor:
Well you rolled the ball normally but it didn't begin to hook as early as it usually does and the snap at the back end just wasn't there either, it may be longer oil.

Tracky:
Heh, the oil tracks go way past the indicator. It's longer oil.

Spot:
Yep, Yep, Yep!

Where Does Longer Oil come into Play?
Everywhere is the correct answer. Mostly though it will be felt in the lack of aggressiveness of the bowling balls. They simply have less dry lane length to work with to get to the pocket.

Spot:
Yeah and the Oil Splotch area is larger and therefore there is less total dry ball surface exposed to the lane surface at the backend. The ball hooks less.

Since the oil is probably tapered both laterally and down the lane surface, the most impact may be the left side and middle spares. For such a lane condition, the heaviest oil is in the middle of the lane . . and now that oil is longer. So, those left side and middle spares may be a lot less aggressive. The ball is going through the maximum density and the maximum length of oil.

Ball Choice for Longer Oil
A more textured surface ball may be the better choice for long oil. Many of the new balls feature particles in the coverstock to allow the ball to "see" the lane surface a little earlier. The denser and larger the particles, the earlier the ball will see the lane surface and start to hook

toward the pocket. If you like a ball path shape that has snap to it, lean toward a lower RG ball. And since the oil is longer, lean toward a large DRG ball specification, it will flare more and expose a great amount of ball surface to the lane surface.

Shorter Oil
If for the same reasons and in the same manner, there are fewer oil tracks, the oil must be shorter.

Reactor:
Yes, and the ball will inherently react earlier.

Tracky:
That's because the ball surface starts to actually touch the lane surface earlier. The shorter the oil, the earlier the ball touches the lane surface.

Spot:
Yep. Yep. Yep! And the Oil Splotch Area is smaller so the ball has a greater dry area to interact with the lane surface friction.

How does the Shorter Oil Affect the Roll of the Ball
If the oil is shorter the choice of ball may lean toward a smoother less aggressive surface and less aggressive in the midlane area (after the end of the oil).

Reactor:
Sounds like a good plan to me. If the ball is too aggressive, the slightest little push into the drier outside area will accelerate the ball left toward the 7 pin.

Tracky:
Sounds like a good plan.

Spot:
Yep. Yep. Yep!

Ball Choice for Shorter Oil
A shinier surface ball may be the better choice for short oil. Most of the balls manufactured today are still reactive resin bowling balls. Since the oil is short, a mellow reactive resin with a very smooth surface may be the best choice for the short oil. If you like a ball path shape that has snap to it, lean toward a lower RG ball. (But, beware, a low RG ball on a dry surface may "roll out - straighten out" before it impacts the pocket if the rev rate is not high enough. Overall, a higher RG ball will be a better choice. And since the oil is shorter, lean toward a small DRG ball specification, it will flare less and expose a less of the ball surface to the lane surface. The ball will be less aggressive to balance the more aggressive oil pattern.

Heavier Oil - Average Length
The More Oil that is Applied, the Wider and Wetter (shinier) the Tracks will be.
A lane surface with heavier oil (more oil applied) than what you are accustomed to will seem to have wider and shinier oil tracks.

A bowling ball in the heavy oil in the heads area actually slides just above the lane surface in most cases. It kind'a floats like a fluid bearing does in an automobile. The distance above the

lane surface that the ball slides is very small and is proportional to the weight of the ball. Heavier bowling balls are closer to the lane surface, lighter balls are higher above the lane surface.

For a given bowling ball, when more oil is applied to the lane surface, the ball still slides about the same distance above the lane surface, so the tracks are wider because the oil is deeper. And, since there is physically more oil on the track, it usually looks shinier.

So, wide shiny oil tracks are an indication of more oil applied, usually in the heads area, but maybe all over the oil pattern.

Spot:
And, the Oil Splotch area will also be larger and shinier, a lot shinier. That means that the ball will react less overall and be less aggressive.

Reactor and Tracky together say:
Yep. Yep. Yep!

Where does the Heavier Oil Application Come into Play?
Since it affects the Oil Splotch size, it may be felt everywhere. And as in the longer oil case, the middle of the lane is the wettest, so the left side spares and middle spares may be affected the most.

Ball Choice for Heavier Oil
It's almost the same choice as for longer oil. A more textured surface ball may be the better choice for really heavy oil. As stated before, the new balls feature particles in the coverstock to allow the ball to "see" the lane surface a little earlier. The denser and larger the particles, the earlier the ball will see the lane surface and start to hook toward the pocket. If you like a ball path shape that has snap to it, lean toward a lower RG ball. And since the oil is longer, lean toward a large DRG ball specification, it will flare more and expose a great amount of ball surface to the lane surface.

Detecting Where You Should and Shouldn't Roll the Ball

The number of tracks and shinyness of the oil tracks give a good indication of where you should and shouldn't be rolling the ball. (How dense and how long the oil is).

Remember "Practice Balls" and "The Triple Tests" that appeared in an earlier issue?

You don't.

Well in that case here they are again for review.

Practice Balls (from The Coaching Eye - August 2002 issue)

The practice you take just before league is a little different than the practice just before a tournament starts in a bowling center you've never bowled in before. Practice just before league is not as critical because you bowl there every week. You know about what the shot is going to be and you are probably prepared to perform well.

Practice just before you start a tournament is a very anxious time. You can only estimate what the lane conditions are going to be from what you see that other bowlers are doing in the previous squad and what you have "heard" from previous bowlers. The practice balls you roll therefore are very important.

League Practice Balls:
There is usually an opportunity to roll about 5 or 6 practice balls just before league play. I will list the top 6 practice balls that you should try to roll in the order of their importance. It is assumed that each of the practice balls is rolled well and that you hit your intended aiming mark and released the ball in the intended direction.

1. The Strike Shot
2. The 10 Pin
3. The 7 Pin
4. The 2 Pin
5. The Strike Shot
6. The Strike Shot

Each of these shots simply verifies that the lane conditions are about the same as they were the week before. They are truly practice balls. You are only looking for verification that the lanes are about the same or that they are a little drier or that they are a little wetter.

Tournament or New Bowling Center Practice Balls:
(Breaking Ball Spare Shooter)
You are about to start the tournament in a bowling center where you have never bowled before. You have heard rumors of terrible lane conditions and you don't really know what to expect. Each one of your practice balls needs to tell you some specific information. The combination of the practice balls should give you a picture of where the oil is located.

These practice balls also should be used when the bowling center where you bowl is hosting a tournament and has changed the lane conditions.

1. **The 10 Pin** - This practice ball tells you what the condition is like on the outside boards. Line up like you do for a 10 pin shot at your home bowling center. Roll a breaking ball like you normally do for a 10 pin when you roll a breaking ball at a 10 pin in practice at your home bowling center. If the ball slides into the gutter well before the 10 pin, it indicates that the outside boards are very wet compared to the conditions at your home bowling center. If the ball breaks too hard and misses the 10 pin on the left side, it indicates that the outside boards are very dry compared to the conditions at your home bowling center.

2. **The 7 Pin** - This practice ball tells you what the condition is like in the middle part of the lane (assuming you roll the ball at the 7 pin from the right side of the lane across the middle part of the lane to the 7 pin). Roll your strike ball like you normally do for a 7 pin at your home bowling center. If the ball breaks into the gutter well before the 7 pin, it indicates that the

middle of the lane is very dry compared to the conditions at your home bowling center. If the ball misses the 7 pin on the right side, it indicates that the middle of the lane is very wet compared to the conditions at your home bowling center.

With these first two practice balls you should know the approximate conditions. The next ball needs to test out your best estimate at a strike shot. This is not an easy task. There are lots of "if's" that dictate where to roll that third practice shot. And, some tournaments only allow two practice shots. Regardless, the first two practice balls should be as described above.

Tournament or New Bowling Center Practice Balls :
(Straight Ball Spare Shooter)
Even if you roll a straight ball at most spares, the order of the spare shot is the same as above and you should roll a breaking ball for the pins specified even though you will roll a straight ball at the spares during the game. The reason for rolling a breaking ball at the corner spares is to find out the information pointed out above. So, roll the breaking ball at practice time the first time you practice for those spares. After that you can roll the practice straight balls. So, the order of the practice balls for a straight ball spare shooter is recommended to be as follows:

1. The 10 Pin (breaking ball). See above.
2. The 7 Pin (breaking ball). See above.
3. The Strike Shot (breaking ball). See above.
4. The Strike Shot (breaking ball).
5. The 10 Pin (straight ball).
6. The 7 Pin (straight ball).

The Strike Practice Ball
This is the most important of all of the practice balls. More than 50% of the game is the strike shot, so you must establish whether or not your plan of attack for the strike shot is correct based on past records of that league.

There are a few spares that will also use the strike line rolling path. The strike line is recommended for the 5 pin and some miscellaneous spares.

The Right Side Spare Practice Ball
The right side spares usually cause more damage to a bowler's average than any other part of the game. The 10 pin is of course the primary culprit.

Stand as far left as you can with the appropriate Aiming Mark.

By standing far left you do 3 positive things. You increase the available lane area for the ball to roll on, you decrease the intersection angle between the pin line and the ball path and you increase the amount of oil that the ball rolls through.

Further improvement can be obtained by rolling a different ball for the right side spares, a ball that is harder, smoother and has a non-reactive surface, a ball that is less apt to curve at all. You release the ball in the same way as your other ball but it simply reacts less and curves less.

Last and not recommended without a vast amount of practice but highly successful with some bowlers is the technique of rolling that "less reacting" right side spare ball and releasing it

differently. If you release that “less reacting” ball as a straight ball, you will have a greater probability of covering the right side spares.

But, there is a trade-off. Since you are not releasing this way each time, you may not be consistent in the release. (That’s why the “not recommended without a huge amount of practice” is the recommendation). If however you practice that straight ball delivery a lot and get very proficient with it, you should use it every time for those right side spares.

The Left Side Practice Ball

Except for the 7 pin, the majority of the spares that occur frequently are left side spares. More spares are left side spares because of the dependence upon the head pin impact to clear away the left side pins. If you don’t impact the head pin correctly, the spare will most likely contain some of the left side pins.

But your bowling ball naturally breaks from right to left and can easily be directed toward most of the spares in the center of the lane as well as the left side of the pin deck area.

The Aiming Mark should be near the middle of the lane surface. Roll one of the practice shots at the 7 pin.

The Far Left Side Spare Practice Ball

If you look at a list of spares you will notice that the far left side spares are only those spares that require you, a right handed bowler to roll the ball down the far left side of the lane. There are only a few spares that require this, but some of them do appear pretty often. (Mostly splits)

Choose an Aiming Mark that is at the left to far left side of the lane surface. The associated Standing Spot will then most likely be at the left side of the approach. With this combination, the rolling path should be almost totally in the left side oil pattern. It is recommended that the ball for these spares should be just as for the right side spares, very hard, smooth and a non-reactive surface. If you roll the ball for minimizing the curve of the ball, you increase your probability of converting the far left side spare.

The choice of left or strike aiming alignments for the spares near the center of the lane depends a lot on how much your bowling ball naturally curves.

The Triple Tests (from The Coaching Eye - August 2002 issue)

Finding the Initial Alignment

Sometimes it may seem almost impossible to initially line up your strike shot. That may seem so, but there is a set of procedures that can be followed to very quickly get aligned for both league and tournaments.

The best start is to have some historical data on what the conditions have been like before. That means that you need to have knowledge of what the conditions have been like over the past few days and possibly weeks. If you have been writing down where you have been starting for an aiming mark and a standing spot you will already have a good idea of where to approximately line up the initial shot.

But that approximate alignment is not necessarily the correct one for that night of bowling. Many things force the conditions to change slightly from week to week in league play. You have to verify that your estimated alignment fits some basic criteria.

Getting set for the correct alignment for strikes at the beginning of a league or a tournament can be a problem. Correct alignment involves passing three tests that define a method of initial alignment called The Triple Tests.

The one oil pattern characteristic that is assumed is that you have tentatively lined up at a location that has more oil to the inside, so there is less oil to the outside of where you are rolling the ball. It is also assumed that you rolled the ball properly in the usual manner and speed.

When you roll the ball, you will miss to the inside sometimes, miss to the outside sometimes and a few times you actually get it just about right. The shape of the distribution of rolling path directions form a pie (a piece of pie) shape.

Getting aligned properly involves putting that piece of pie shape at the right location so, when you miss (not if you miss), the outcome will not be tragic.

The Triple Test for an Aiming Mark

If when you roll your bowling ball for a strike, the rolling path satisfies 3 requirements, there is no reason for making a change in your Aiming Mark and Standing Spot (your alignment).

Requirement #1: Hit mark and swung correctly - the ball returns to the pocket for an acceptable pocket hit.

Requirement #2: Hit mark and swung the ball out further than normal - the ball returns to the pocket with an acceptable pocket hit, probably a light pocket hit, but still acceptable.

Requirement #3: Hit mark and swung the ball outward less than normal - the ball returns to the pocket after sliding through more oil than usual. The ball usually ends up as a high pocket hit, but still acceptable.

Aiming Mark Incorrect - Too Far to the Right

Case #1: Hit mark and swung correctly - the ball returns to the pocket as a high pocket hit, direct head pin hit or a Brooklyn hit. The lanes, being drier on the outside boards, have caused the ball to break more than usual even though you know that you have not swung the

ball anymore than usual. The Aiming Mark must be moved further inside into the heavier oil.

Case #2: Hit mark and swung the ball out further than normal - the ball returns to the pocket and zooms back to the pocket area ending up on the opposite side of the head pin, possibly even missing the head pin on the opposite side. You noticed that you swung the ball outward a little more than usual, but this kind of reaction is caused by more than the errant swing of the ball. The lanes are simply drier and more aggressive than you estimated where you rolled the ball. You must move your Aiming Mark further inside into the heavier oil.

Case #3: Hit mark and swung the ball outward less than normal - the ball returns to the pocket and hits the head pin directly and you leave a beeeg split. You know that you did not swing the ball as much as usual but the fact that the ball still went high means that the oil was not heavy enough to keep your ball from going into the head pin when you did roll it a little more inward than usual. You must move your Aiming Mark a little further inside so that when you do swing the ball a little inward, you won't end up directly on the head pin because of the heavier oil you found after you moved.

Aiming Mark Incorrect - Too Far to the Left

Case #1: Hit mark and swung correctly - the ball just barely returns to the pocket as a very light pocket hit if it makes it back at all. You know that you hit your mark and swung the ball correctly. The Aiming Mark must be moved further to the outside into the outside boards where there is less oil.

Case #2: Hit mark and swung the ball out further than normal - the ball returns to the pocket and ends up as a very light pocket hit. You know that you swung the ball more outward than usual and you expected a heavier pocket hit, but the ball just barely made it back to the pocket. You must move your Aiming Mark into the outside boards where there is less oil.

Case #3: Hit mark and swung the ball outward less than normal - the ball does not return to the pocket at all and you get a washout. You know that you did not swing the ball outward as much as usual but the fact that the ball did not make it back to the pocket means that the ball rolling path is in too much oil. You must move your Aiming Mark a little further outside so that when you do swing the ball a little inward, the ball will still make it back to the pocket acceptably.

Moving left and the Decreasing Angle of Attack

As you are moving inside trying to find that perfect location where you pass all three tests, you are decreasing the angle of attack that the ball has when entering the pocket area. There is a limit for moving inside. That limit is not just a visual one. If your angle of attack is not great enough, you will begin to get more spares that include the 5 pin. If you can see the ball as it leaves the pin deck, you will also see that the ball is leaving the pin deck to the outside of where it normally does.

Too Much Ball

If you are moving too far inside (decreased angle of attack) and you can't pass Test #2 or Test #3, because the ball keeps coming up high, the ball is simply too aggressive. The solution is to switch to another less aggressive ball. Since it is less aggressive, when you find the correct alignment for a strike (passing Test #1), you have a higher likelihood of passing Test #2 and Test #3.

Too Little Ball

More than likely, when moving outside, you won't have a problem with the angle of attack. If however you pass Test #1 and Test #2 but you can't pass Test #3 because the ball doesn't make it back to the pocket, it's an indication that the ball is not aggressive enough.

The higher the number of tracks, the earlier the roll (hook) of the ball needs to be because the indication that the oil is longer.

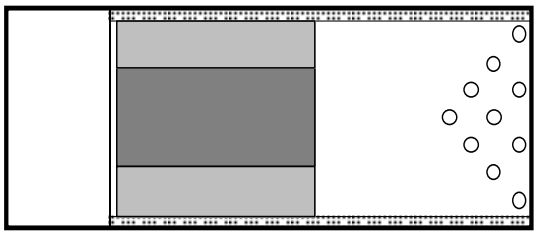
Oil Patterns and Where the Best Shot is.

Look at the Oil
If you can take a quick look at the lane surface just beyond the foul line, you will be able to see where the oil, also called lane dressing, is applied heavily and where it is applied lightly. If you roll the ball down the "edge" of the more dense area of the oil, it will tend to stay on the edge. Assuming you roll a curve ball, if you miss a little to the right, because it is drier, the ball will curve into the edge. If you miss a little to the left, the ball simply slides longer.

The composition of the oil has changed over the years. The oil is not WD40. It was a variation of Mineral Oil for many years, but now is a composite of several compounds to give the spreading characteristics desired (and sometimes undesired effects) as bowlers roll games during league and tournament play.

The bowling establishments would like not to place any conditioner on the lane surface. Excessive oil generally causes equipment to malfunction (i.e., the ball returns don't work, etc.). But the bowlers are happier when they score higher, so most bowling establishments use the 3 unit rule to their advantage.

The Blocked Oil Pattern
The oil is at least 3 units on the outside boards (usually about 7 boards), but the "8 to 8" boards, sometimes 10 to 10, (the inside boards) are oiled very heavy.



The block can vary from very wet (20 units) to very dry (3 units). The edge of the block is usually somewhere near the 10th board (the second arrow), has a significant meaning for a high scoring shot.

Simply stated, it is easier for a house to set up a block shot, and the results are excellent. It probably best satisfies the "down and in" bowlers. (Because most bowlers roll the ball "down and In").

Detection of the Blocked Oil Pattern
If you go to the foul line and simply look at the oil pattern, you may be able to detect it. The outsides will look dull and the inside will be very shiny. There will be a very distinct single edge to the oil pattern.

Usually, the newer lane machines are able to put out a nice Christmas tree oil pattern, so it's not very likely that a bowling center with that capability will put a blocked oil pattern on the lane surface. If however the lane machine is an older one, the blocked oil pattern may still be used occasionally. Be careful, it's out there still lurking in the shadows.

Characteristics of the Blocked Oil Pattern
This is the pattern that was used many years ago. It exhibits very dry conditions on the outside and very wet conditions on the inside. (Not a good combination for today's aggressive bowling balls).

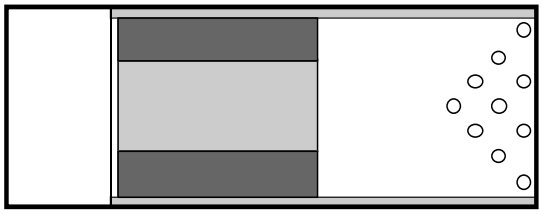
Ball Path Shape Location for the Blocked Oil Pattern
About the only shot that will be consistent is down the edge of the oil. And even using that area, if you miss to the right, the dry outsides may make the ball overreact.

And that's the primary problem with this oil pattern. It's too easy to get an "over and under" reaction from your bowling ball. (Over react on the outside and under react on the inside).

What is the Forgiveness of the Blocked Oil Pattern
Since there is no gradual lateral tapering there is no gradual forgiveness if you miss to the outside or to the inside. If you miss a little to the outside too much, the ball will react the same as if you miss a lot to the outside. It is not a gradual forgiveness; it's a brick wall that you bounce off of.

Ball Choice for the Blocked Oil Pattern
It's an okay pattern if you have a mellow reactive bowling ball and can roll the ball consistently down the edge of the oil.

The Reverse Block Oil Pattern.
The oil is denser at the outer edge than at the center. This is a very difficult bowling condition. No one in his right mind would ever purposely setup this condition. Basically, if you roll the ball out of the dry area, it probably won't come back. That's why it's called "out of bounds."



Bowling on Reversed Blocked Lanes
When the lanes are much dryer in the middle than on the outside boards, they are called reversed blocked. (In some instances the much heavier outside oil is called an "out of bounds"). This condition occurs sometimes when the middle of the lane has literally been "used up." If everyone is rolling their ball in the middle of the lane, the oil on the outside of lane never changes very much. This can happen in tournaments that have many sessions in a row without an intermediate oil application.

This is absolutely the toughest bowling condition that you will encounter. It's very difficult because you cannot roll the ball from a position where even accidentally you swing the ball a little and allow the ball to get into the heavy oil on the outside where it will not return to the intended target.

The Narrower Lanes
The lanes are in effect narrower because the heavy oil is on the outside boards. It like having a lane that is not 39 boards wide, now it's about 29 boards wide.

You must stay in the middle of the lane where they are at least consistent. And, you need to bowl with a ball that hooks less, not more. Since your intent is to stay in the middle, you must consistently get the ball to the pocket and with the reverse blocked condition the lane is a narrower. So, don't be concerned so much with how much the ball hooks. As long as the ball consistently gets to the pocket, it's acceptable for these very difficult conditions.

Full Length vs Short Reverse Blocked Condition
There are bad reverse blocked lanes and then there are really bad reverse blocked lanes. The really bad ones have heavy oil all the way down both sides of the lanes. That means that the lane is literally a narrower lane. You can imagine that the widened gutter extend the full length of the lane.

If however the heavy oil is only down the lane a certain distance, it may be easier to handle. The picture you should have is that the widened gutters only extend a certain distance down the lane. You may or may not be able to see how far that outside oil extends. If you can determine how far it extends during practice, you will be able to determine how much you can angle the ball over the middle of the lane. That angle must be defined by a line that does not intersect the heavy oil area. So, as you roll the ball over the middle of the lane you can roll the ball out to the outside as long as it is beyond the end of the heavy oil (widened gutter area).

Detection of the Reverse Blocked Oil Pattern
Remember the paragraphs on Practice Balls. It was pointed out that if the 10 pin shot was missed to the right and the 7 pin shot was missed to the left and the 2 pin shot was also missed to the left, the oil pattern may be reversed blocked (drier in the middle than at the outsides).

You also may be able to detect the oil pattern simply by looking at the oil pattern from across the foul line. It will appear dull in the middle and shiny on the outsides.

Ball Path Shape Location for the Reverse Blocked Oil Pattern
There are two recommended standing positions. If you are a classical "down and in" bowler, you should still roll that shot but from a position that is safer. If you are a "swinger", you can still swing the ball a little, but you must keep the trajectory totally in the dry part of the lanes.

If you do roll the ball down and in, where you roll the ball depends on where the edge of the heavy oil is. Remember that when the ball hits the pocket, the center of the ball is rolling on about the 15th board. That alone limits where you can roll the ball straight down a board and have it curve up into the pocket. If the heavy oil is on the first 5 boards and you allow an error of 4 boards, that means that the starting aiming mark can only be at about the 9th board. That also means that the ball cannot hook more than about 6 boards.

If you swing the ball, you will need to stand at the left side of the lane and swing the ball across the middle of the lane while still keeping the trajectory of the ball completely in the middle of the lane. Moving to the left side will give you a little more freedom and psychologically it will relax you because you will not be as apprehensive about dumping the ball in the right gutter.

The left side position in this case is “very far left side”. You might end up against the ball return or even in front of the ball return. You should pick you aiming mark as far left as you can and still be able to view it comfortably. For reverse blocked conditions the aiming mark should be at least as far left as the 4th arrow. If possible it should be even further left.

If you can stand in front of the ball return, your aiming mark could be even further left, possibly the 4th arrow or even further left. I have seen bowlers stand to the left of the left gutter and roll the ball over the 5th arrow. That allowed the ball a longer trajectory and the use of a ball that hooked many more boards.

What is the Forgiveness of the Reverse Blocked Oil Pattern

The far right side shot is not forgiving at all. If you miss to the right, you will get a washout or worse a gutter ball. If you miss to the left, you may take out the 7 pin. That’s no forgiveness at all.

But, if you utilize the far left side shot, you will have some level of forgiveness. Using the left side oil edge and swing the ball to the right across that edge is very similar to rolling the ball down the edge of a blocked oil pattern on the right side. It’s not great forgiveness, but it’s better than no forgiveness at all.

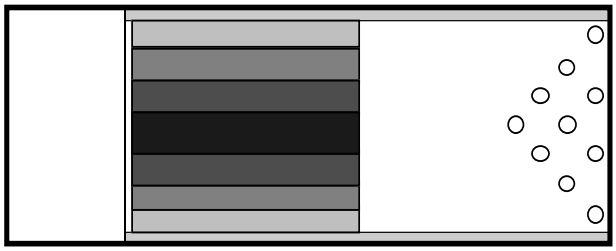
Ball Choice for the Reverse Blocked Oil Pattern

Since you will stay in the middle of the lanes and never intend to roll or swing the ball out into the heavy oil, the ball surface must be less reactive than normal. A plain ole garden variety low porosity urethane surface ball is probably a good choice.

If you intend to use a reactive surface ball, make sure that is a less reactive type. Remember that you have less lane to work with and that you still intend to consistently get the ball to the pocket and not come into the pocket high or go Brooklyn at all. And, remember, it's more important to get the ball to the pocket consistently.

The Tapered Oil Pattern. (Lateral Taper Only)

The oil in this case has several edges. The pattern usually is made up of several steps of succeeding increasing oil densities. Each step up in density has it’s own edge. So, it is denser in the middle of the lane and about 3 units at the far outside boards.



This is a more difficult application but it may be higher scoring for more bowlers. The overall amount of oil is usually greater in this case compared to the block oil condition. This condition can be used to advantage by both the “swing” and the “down and in” bowler.

ABC recommends that there be a slight crown in the oil application. There is a gradual increase in oil as you get towards the center board. The lane is "drier" outside to help the ball curve back when you errantly roll the ball further outside than usual. There is in effect several

stages that go together to form several “block” effects.

It is very difficult for a lane conditioner machine to distribute the oil in a true taper fashion. The usual attempt at a taper pattern is to apply the oil in successive increasing discrete intensities across the lane from the outside boards to the middle of the lane. So the pattern is actually several different intensity blocks of oil. The far outside block might have about 5 units of oil from board #1 to board #4, then from board #5 to board #8, the intensity might be 7 units, then from board #9 to board # 12 the intensity might be 15 units, then from board #13 to board #20 the intensity is the maximum, what ever that value usually is, maybe 20 to 30 units.

Although the tapered pattern has less oil on the outside (tapered from the center to the outside), the intensity of the oil does not decrease down the lane except for the buff out of the oil remaining on the roller of the lane machine. So there is no well defined taper down the lane toward the pin deck.

But, compared to the purely blocked oil pattern, it is a very high scoring pattern because of it’s versatility of satisfying the way that more bowlers actually roll the ball.

The slightly tapered pattern has less of a difference in the density of the oil than the heavily tapered. Whereas a heavily tapered oil pattern might go from 3 units to 30 units of oil from board #1 to board #20, the slightly tapered pattern might go from 8 units to 20 over the same boards.

For the heavily tapered pattern the difference in the oil density from the outside boards to the inside boards is greater. The common trait to both the slightly tapered and the heavily tapered pattern is that they both make the change from the low density oil to the higher density oil gradually from the outside to the inside boards.

The tapered oil pattern is probably the most widely used for league play. It is a cross between the heavily tapered pattern and the block pattern. In a step block pattern the far outside boards have the lowest density oil (5 units for example). On about the 8th and 9th boards a slightly heavier oil density is applied (10 units for example). Then beginning at the 10th board the heavy oil is applied (25 units for example).

The tapered oil pattern is a high scoring pattern. Bowlers that swing the ball outward across the edge of the high density oil beginning at the 10th board actually have a small tapered pattern across the 10th through the 7th boards. The more they miss there intended trajectory outward slightly, the more the ball encounters the less density oil and the greater the ball hooks in those outside boards. It promotes the idea of a self correcting delivery of the ball. The phrase used most often is that the bowler has a very wide area to roll the ball in to still get the ball back to the pocket.

Most bowling centers taper the oil laterally and down the lane toward the pin deck. Usually, the lane machines work in a two step process. The oil is applied in the first step. Oil is actually applied to wiper device that then rubs on the lane surface to apply the oil. When the desired distance of oil application is reached, the oil stops going onto the wiper device. The wiper device still has oil on it and if the oil machine continues to travel down the lane, it gradually releases the oil from that wiper device. That second step of oil application is called the “dragging” of the wiper device to release that oil. The oil then tapers from the heavy oil at that location where the oil is switched off to very little oil at all (at least 3 units), where the machine

finally stops.

Detection of the Lateral Tapered Oil Pattern
Lateral taper is difficult to detect visually but it is possible. Mostly it's a matter of eliminating the other choices. If you can't detect that it's a block or reversed block, then it's probably either a "flat" application (the same density of oil) or a lateral taper. Only the "sport" shots use a "flat" application, so it's most likely not that one, so it's probably a tapered oil pattern.

You might visually be able to detect several different levels of oil from outside to inside (different levels of shine on the surface of the lane). If so, it's probably a lateral taper.

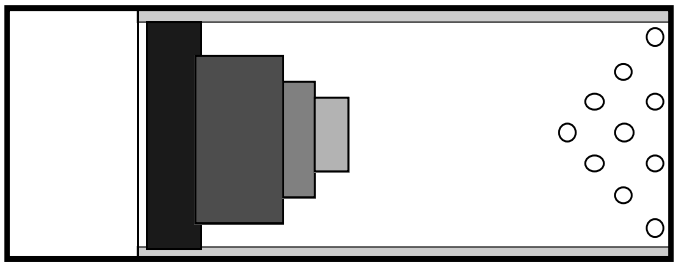
Ball Path Shape Location for the Lateral Tapered Oil Pattern
Since the lateral taper oil pattern is actually several steps of "small blocks", there are several "edges" to the oil pattern. That means that bowlers that want to roll the ball down and in may do so effectively at or near any one of those edges. Bowlers that swing the ball outward may do so with equal success.

What is the Forgiveness of the Lateral Tapered Oil Pattern
This is the most popular oil pattern configuration applied today. It can be applied by almost every lane machine existing today. And, it is one of the two most forgiving oil patterns possible. Generally, the greater the taper, the more forgiving the oil pattern is. The amount of oil on the outside may be a little as 5 units and the middle oil may be as much as 30 units. That's a 6 to 1 lateral taper ratio, a very forgiving oil pattern.

The "sport shot" oil pattern, a less forgiving taper, may be as little as 2 to 1 or maybe even zero. Yuck!

Ball Choice for the Lateral Tapered Oil Pattern
Almost every bowling ball ever made will work on this oil pattern. The less aggressive the ball, the farther outside the shot is located.

The Christmas Tree Oil Pattern
If the lane machine can control individual areas of the wiper device, then the oil pattern can be triangular in shape with the point of the triangle at the center of the lane. As the lane machine goes down the lane it works the same as before except that gradually the outer area oil is stopped being applied before the center area. Once the center oil stopped being applied, the lane machine still drags the remaining oil on the wiper device down the lane to where it finally stops. The result is that the lane surface has a triangular oil pattern. The further down the lane, the sooner the drier area of the lane begins further inward.



The Christmas Tree oil pattern is the highest scoring oil pattern of all. The taper of the oil laid down onto the lanes is both across the lane laterally and down the lanes toward the backend.

Basically the pattern is decreasing oil density in just about all directions. It also fits just about all bowling path trajectories, from “Down and In” to “Swinging the Ball.”

The Christmas Tree oil pattern is an attempt to be able to correct the errant path of the bowling ball regardless of where the bowler rolls the ball. The more the bowler misses, the more the oil pattern allows correction by the friction of the lane surface.

Detection of the Christmas Tree Oil Pattern
Since this oil pattern is actually a lateral taper along with a taper down the lane, it looks like a lateral taper as viewed from the foul line. So, the detection is that same as that of a simple lateral taper. It’s the lane machine that the bowling center has that really determines which pattern it is.

The older lane machines cannot put a Christmas Tree oil pattern down on the lane surface. So, if they have one of the newer lane machines that utilize computer programming to specify when and where the oil is applied on the lane surface, they most likely put down a Christmas Tree oil pattern.

Ball Path Shape Location for the Christmas Tree Oil Pattern
Since the oil pattern tapers in “all” directions, you can roll the ball in just about any reasonable direction and the lane will forgive any errant shot.

What is the Forgiveness of the Christmas Tree Oil Pattern
The real difference in the simple lateral tapered oil pattern and the Christmas Tree oil pattern is the forgiveness farther down the lane surface. The simple lateral oil pattern is very forgiving for a “down and in” style bowler. It is not as forgiving for a bowler that swings the ball outward. The Christmas Tree oil pattern is very forgiving for both style bowlers.

Ball Choice for the Christmas Tree Oil Pattern
Any ball can be used. The less aggressive, the farther outside the bowlers needs to roll the ball to be to get the ball to the pocket at a reasonable angle of attack.

Matching Up Problems

Corner Pins

Leave a Lot of 10 Pins by Themselves (10 Pin Taps)
Very few people leave the 10 pin. . . you must really be a terrible bowler.

Just kidding. The 10 pin seems to have glue on it some games. Don't blame the 10 pin though, blame the 6 pin. That's the pin that usually takes out the 10 pin.

A light pocket hit sometimes produces a 10 pin tap. It causes the 3 pin to be deflected directly back just barely clipping the 6 pin. The 6 pin deflects too far to the right to impact with the 10 pin.

One remedy is to roll the ball a little higher into the pocket.

Another cause of the 10 pin tap is too much angle into the pocket. It produces the same effect. The 3 pin is deflected back too directly.

The most common 10 pin leave results from the angle of attack being too shallow, too direct into the pocket. Increase the angle of attack and the 10 pins will decrease.

Leave a Lot of 7 Pins by Themselves (7 Pin Taps)
Light pocket hits sometimes leave the 7 pin. The problem is that the 4 pin is deflected to much to the right and not far enough back.

One remedy is of course to hit the pocket a little higher.

The location where the ball hits the head pin is the real reason. The location is too far to the right (low in the pocket) and the direction that the head pin deflects is not the same as the direction of the 1-2-4-7 pin angle line of 30 degrees. The farther the ball diverges from that ideal impact location (the 1-2-4-7 pin line angle), the more likely you will leave the 7 pin.

Pocket Hit Splits

Pocket 7-10 Split
You say you just left the pocket 7 - 10 split. Well if you have just read the above paragraphs you should already know why.

Repeated Here:
10 Pin - The most common 10 pin leave results from the angle of attack being too shallow, too direct into the pocket. Increase the angle of attack and the 10 pins will decrease.
7 Pin -The location where the ball hits the head pin is the real reason. The location is too far to the right (low in the pocket) and the direction that the head pin deflects is not the same as the direction of the 1-2-4-7 pin angle line of 30 degrees. The farther the ball diverges from that ideal impact location (the 1-2-4-7 pin line angle), the more likely you will leave the 7 pin.

So, if the ball is low in the pocket and more direct in it's angle of attack, bingo . . the 7-10 split.

Realistically, the previous explanation does not include all of the reasons for a pocket 7-10 split leave. Lower ball speed and energy is a major contributor.

What's the solution for leaving less pocket 7 - 10 splits. More angle of attack and a higher pocket hit are the two best recommendations. An increase in ball speed will help if you retain controllability of the ball at the higher speed.

Pocket 8-10 Split
The 8-10 split is easy to explain also. The reason is a lack of angle of attack into the pocket and an impact location that is too low at the pocket.

The 10 pin part of the split comes from the more direct impact with the 3 pin after impacting the head pin. Insufficient angle of attack causes the ball, after deflecting from the 3 pin, to just barely impact the 5 pin on the right side. The 5 pin is deflected to the left of the 8 pin. Yuck!

Pocket 7-9 Splits
The 9-10 split is easy to explain also. The reason is too much angle of attack into the pocket and an impact location that is too low at the pocket.

The 7 pin part of the split comes from the low position of the ball as it impacts the head pin as described previously for the 7-10 split.

Too much angle of attack causes the ball, after deflecting from the 3 pin, to impact the 5 pin near the center of the 5 pin. The ball doesn't deflect to the right enough to impact the 9 pin.

The solution is to back off on the angle of attack into the pocket.

Single Pins

Leave a Lot of 9 Pins by Themselves (9 Pin Taps)
The nine pin tap is caused by the ball gripping too much through the pin deck area and too much angle of attack into the pocket area. It impacts the 5 pin too directly and does not deflect to the right to impact the 9 pin.

The remedy is to use back off on the angle of attack or use a less aggressive bowling ball.

Leave a Lot of 8 Pins by Themselves (8 Pin Taps)
This happens because the ball is not driving through the pin deck area. The ball hits the 5 pin too far on the right and is deflected too far to the left, missing the 8 pin.

One remedy is to use a greater angle of attack into the pocket or a more aggressive angle of attack into the pocket.

Leave a Lot of 6 Pins by Themselves (6 Pin Taps)
A high pocket hits will cause the 3 pin to be deflected around the 6 pin and into the 10 pin.

Leave a Lot of 5 Pins by Themselves (5 Pin Taps)
There are three reasons why you leave a 5 pin. When you roll a light pocket hit and the ball does not have adherence to the lane, (a non-porous ball), it will not continue to try to curve into

the pocket further. The result is that the ball slightly deflects off the 1 pin and hits the 3 pin directly and then deflects to the right of the 5 pin.

The remedy is to us a more reactive surface bowling ball that adheres better in the pin deck area.

The second type of 5 pin tap is when the weight of the ball is not enough to drive through the pins without loss of energy. (As the ball rolls through the pins each impact causes the ball speed to decrease a little. The more weight your ball has the more energy it has for the same speed). When a light weight ball hits the pocket, it deflects off of the 1 pin and directly into the 3 pin and as before the ball misses the 5 pin.

The third type of 5 pin tap is when your ball hooks violently in the pin deck area and the placement shallow into the pocket. The ball, after barely impacting the 1 pin deflects into the 3 pin and then continues on past the 5 pin on it's left missing it. This doesn't happen often, but it can happen.

The remedy is to hit the pocket more directly.

The most likely reason why the 5 pin is left is because the angle of attack is is too low. Increase the angle of attack and the ball will have a better chance to deflect properly off of the 3 pin into the 5 pin.

So, anytime you start leaving the 5 pin in spares, it's probably an indication that the angle of attack is too low.

Leave a Lot of 4 Pins by Themselves (4 Pin Taps)
The 4 pin tap can happen a couple of ways.

A very high head pin impact placement and low entry angle pocket hit causes the 1 pin to just barely impact the 2 pin on the right side. The deflected 2 pin misses the 4 pin goes around it and takes out the 7 pin.

The remedy is to hit the pocket with a little more angle and not quite so high.

The other 4 pin tap is when you have a very light pocket hit and the 1 pin impacts the 2 pin just barely on it's left side. The 2 pin then is deflected to the right and misses the 4 pin. The ball impacts the 5 pin on the right side and it and the deflected 2 pin take out the 7 and 8 pins.

The remedy is to hit the pocket more directly, higher into the pocket.

Leave a Lot of 3 Pins by Themselves (3 Pin Taps)
This does not happen very often for a right handed bowler. It can happen when the ball with a violent entry angle impacts the 1 pin directly. If you don't leave a split and if somehow the 6 and 10 pins get knocked down, the 3 pin will be left standing.

The remedy is to hit the 1-3 pocket not the 1-1 pocket.

Leave a Lot of 2 Pins by Themselves (2 Pin Taps)
A very light pocket hit may cause the 1 pin to deflect to the left of the 2 pin. This is the most

often left spare other than the 10 and 7 pins.

The remedy is to hit the pocket more directly

Leave a Lot of 1 Pins by Themselves (1 Pin Taps)
Videotape one of your games and send it to me, I gotta see that.

Technical Section

Larry, Curly and Moe - The Three Stooges

Larry, the Pin
Curly, the CG
and Moe, the Mass Bias Point (MBP)

It's purely by accident that the third dynamic effect (the Mass Bias Point) is named Moe in this case. There is no relation or intent meant to connect any famous bowling technical speaker or executive of MoRich Enterprises Inc. with this topic.

Yeah, right . . . . . .

Subtitle: First we had the Engine - the Weight Block.
Next we had the Tires - the Coverstock Surface.
Now we have the Transmission - the Flaring Forces

The Desire of the Ball to Get to the Stable Rolling Position
The reason why a bowling ball flares is that it wants too. It has a mind of it's own . . . . You mean you didn't know that! If you roll a bowling ball with the Pin away from the initial rolling track at about 45 degrees, the ball will, on it's own try to get that Pin to roll straight over the rolling track. So to do that, it must force the Pin sideways around a specific point on the ball called the Flare Axis Point (Bow Tie Point) until it is in line with the rolling track.

If you stick a piece of gum on a balloon at 45 degrees from the rolling direction and roll the balloon, it will very quickly re-orientate the gum so that it is directly over the rolling track of the balloon (until of course the gum gets stuck in the carpet).

Okay, I've Released the Ball, Now What?
Once you release a bowling ball, there are only three forces that are acting on the bowling ball, friction at the surface, inertia forces both rotational (rotating effects) and translational (movement down the lane) and thirdly centrifugal force that works to reposition the orientation of the ball by pulling on the mass imbalances inside the ball as the ball is rotating.

The drilling layout of the ball determines how those forces are going to act together to form the shape of the rolling path of the ball.

As a ball is rolled down the lanes the centrifugal forces acting on the mass imbalances of the

ball (primarily the weight block inside) cause the ball to slightly rotate about an axis near the top of the ball as it rolls down the lane. That's what causes the oil tracks on the ball. It's called flaring. It is the dynamic effect that is the primary control of the shape of the rolling path as the ball rolls down the lane.

The Flaring Forces

Their are actually two parts to the centrifugal forces. One part tries to pull the ball apart separating the coverstock from the weight block. The other tries to slightly rotate the ball so that the imbalance is directly over the rolling track. It is the second one we are concerned with (although for high rev bowlers separation of the coverstock due to their high separation forces does happen occasionally.

So, for the rest of this document we will just call the flaring force the one that tries to rotate the ball.

Note also that the flaring force is just that, a force acting on the mass of the ball trying to rotate the ball faster than it was initially. So the speed at which the flaring occurs does change slightly. But that's all it takes to get a difference in the rolling characteristics of the ball as it rolls down the lane. The need of the ball to change it's flaring rate is what gives the ball it's rolling path shape. When it increases the flaring rate, the ball, if there is enough friction, will break harder across the lane surface by exposing more fresh ball surface to the lane surface thus yielding higher friction and the ability to hook more. It takes two to Tango though. The ball can flare all it wants and if there is too much oil, the ball will not even wrinkle. It will still go absolutely straight.

When the ball is released it is instantaneously given a certain amount of flare rate by the release of the ball from the hand. That means after that instant, the rotation of the ball itself supplies the force to change the flaring rate and the lane surface/ball surface interface friction can only decrease the flaring rate.

The Flaring Rate

The flaring rate is directly proportional to the centrifugal forces acting on the mass imbalances inside the ball at any one instant. The greater the flaring rate, the greater the amount of surface of the bowling ball that is exposed to the lane surface. The more surface that is exposed, the greater the chance is that the ball will break more toward the pocket. A high flaring rate at the right time yields the desired results.

The Leverage Line (Leverage Circle)

The Leverage Circle is an imaginary line whose center at any instant is located at the Axis of Rotation of the ball at that instant that the ball is rolling down the lane. Usually the Leverage Line is pictured at its initial location and the center of the Leverage Line (Circle) is located at the Principal Axis of Rotation (PAP). The Leverage line is 3 3/8th inch from the PAP (The radius of the circle is 3 3/8th inches).

Drilling a Bowling Ball Based upon the Bowler's Release Characteristics

Remember that a bowling ball is drilled based on the initial release characteristics of the bowler, which gives us the location of the initial rolling track and the location of the initial axis of rotation, the PAP. When a ball is drilled so that the Pin is located on the Leverage Line for the drilling layout, the ball, when released by the bowler will have a large flaring rate for that ball released by that bowler.

But What Does Flaring Really Mean?
A large flaring rate means that the ball will be exposing a large amount of new surface to the lane surface. The more new surface (that has not encountered any lane oil yet), the greater the possible break of the ball across the lane surface is if enough friction of the lane is available to allow it.

The Primary Flaring Rate Influence Points of the Bowling Ball
There are many mass imbalances inside of a bowling ball. Three of the imbalances are usually marked on the surface of a bowling ball. They are the Pin, the center of Gravity (CG) and the Mass Bias Point (MBP).

The Pin is usually the location of the largest mass imbalance. The CG is the next but much smaller influence. And finally the Mass Bias Point is also a large mass imbalance location. Locating these three points during the layout of the bowling ball for drilling determines the shape of the rolling path during the roll of the ball down the lane.

The Changing Location of the Axis of Rotation and the Leverage Line
As a bowling ball rolls down the lane, flaring causes the orientation of the axis of rotation and consequently the Leverage Line to change. By choosing a specific drill layout, we are specifying that the initial axis of rotation and the Leverage Line location with respect to the three primary imbalance points marked on the surface of the ball. For another layout we might want the maximum flare effect to be earlier of later in the roll of the ball depending upon how and where the bowler rolls the ball with respect to an anticipated set of lane conditions.

The flaring effects are actually an expression of the “desire” of the ball to get to a rotational orientation forced upon it by centrifugal forces.

The Desire of the Ball and What the Friction Allows
When various primary locations on the ball, the Pin, the CG and the Mass Bias Point, are located on or near the Leverage Line, they cause the same effect, the flaring rate increases. So, any time any one of the these flaring effects points on the surface of the ball is at or near the Leverage Line at that instant, it is increasing the flaring rate and more surface is being exposed to the lane surface to try to get the ball to break across the lane more.

When you can get all three of the flaring effects points to be located at or near the Leverage Line during the roll of the ball, the flaring rate is maximum.

The ball desires to break more at the flare effects points but it’s the friction between the ball and the lane surface that allows the ball to break more across the lane.

So, if you want a ball to snap more at the end, you determine the layout of the ball initially so that when the ball flares, one or more of the major contributors of the flaring rate will be located at the Leverage Line during the latter part of the roll of the ball. You want the ball to want to break more during that part of the roll of the ball if there is enough friction available during that part of the roll of the ball.

If you want the ball to arc more, place the imbalances so that their influence is more mellow so that neither of the two major flare effects are near the Leverage Line acting to make the ball flare.

The Flare Effect Points and their Relative Magnitudes

Usually the largest of the flaring effects points is the Pin. Historically, bowling balls have their largest part of the total mass on the top of the ball near the Pin. Hence, the largest effect is usually the Pin. The least flaring effect is the CG. Depending on the location of the weight block inside the ball, the CG effect may be almost zero. But, almost zero is not zero. Usually most bowling balls do have some dynamic effect caused by the location of the CG. (Remember we used to drill balls based entirely on the location of the CG).

The second major contributor to the flaring effects is the Mass Bias Point (MBP). So, it has quite an effect on the shape of the rolling path because it usually effects the shape last. (More about that later).

Who's on First, What's on Second and I Don't Know is on Third

First up to bat is the Pin. The Pin location determines the initial flaring rate of the ball. It gets the ball started and usually is the maximum influence on the dynamics of the ball.

Next is the Center of Gravity (CG) of the ball. It has the least dynamic effect on the shape of the rolling path. Nonetheless, it does have a small effect.

Last is the Mass Bias Point (MBP). For some balls it is simply a manifestation of the location of where the weight block is closest to the surface of the ball, but in some ball designs, it is the actual location of an extra mass that makes up part of the weight block.

Normally the Pin, CG and MBP are located on a straight line. The shape and design of the weight block determine the straightness of the line.

That line is called the Imbalance Line.

The Imbalance Line

The Imbalance Line is the straight line drawn from the MBP through the CG to the Pin. Where that line is located and the direction that it points determines the rolling path influences of the weight block/coverstock mass combination.

Remember though, it's the friction at the interface between the ball surface and the lane surface that is going to allow the ball to release those "desired" dynamic effects caused by those imbalances.

Location of the Pin, the CG and the MBP for Stacked leverage Drilling

When the Pin of the ball, usually the primary location of mass imbalance, is located at the Leverage Line initially for drilling, the ball has a large flaring rate as the ball is released. If the CG and the MBP are also located on the Leverage Circle centered at the initial axis of rotation, the ball has the maximum flaring rate possible. That means that the ball tries to hook the second you release the ball. It creates the maximum number of flare tracks possible.

(In fact, any time all Three Stooges, the Pin (Larry), the CG (Curly) and the MBP (Moe) are all on the Leverage Line, the flaring rate is at it's maximum.

Additional drilling layouts included in this issue will explore those layouts. For the stacked leverage layout all Three Stooges are initially on the Leverage Line. So, the Imbalance line coincides with the Leverage Line in this case.

Strong Flaring Forces at the Beginning and Weak Flaring Forces at the End
When the imbalances are in an unstable position flaring results. Once the imbalances have flared enough to get to where they need to be to balance themselves, flaring ceases.

Stable position means that the zero total flaring force position has been reached and any further flaring it the same direction will be in the opposite force direction and bring the ball back to the zero flaring force position. But the ball flare doesn't just stop instantly from a large value of flare rate to zero. It gradually goes from the large value at or near the Leverage Line to zero at the Stable rolling position.

Even the "large" value at the beginning is not really that large. One complete revolution of the ball may only make the ball flare a half inch or so.

At any one instant during the roll of the ball, the greater the amount of oil on the lane at the location of the ball, the less the ball slows down it's flare rate. Realistically though, there is no such thing as zero friction lane oil. So there will always be a tendency for the flare rate to decrease to zero after that initial input gained from the release of the ball.

And of course with the higher friction bowling balls now, once the ball hits the dry part of the lane it will begin to decrease it's flare rate very rapidly.

Stop the Flaring Forces, Stop the Flaring Forces!
If you take just about anything symmetrical and spin it, why does it stop spinning and why do some things stop faster than others? If you spin a basketball on your finger for instance it will stop very quickly compared to when you spin that same basket ball on some lane oil for instance. One of the reasons that the old style "tops" had a pointed end was to decrease the friction at the location that they were touching the surface whatever they were spinning on.

The flaring of a bowling ball works basically the same as a spinning top. And as the flaring bowling ball starts to encounter more lane friction, the flaring rate (speed at which the flaring tracks are rotating) decreases. More friction means decelerating flaring. The only way to counteract the decelerating effect of friction is to shift gears.

The Imbalance Points do exactly that.

The Transmission of the Bowling Ball
The flaring forces increase the flaring rate to overcome the decrease in the flaring rate due to the friction. So what they actually do is accelerate the flaring to give a higher flaring rate. So the flaring forces are only accelerating the flaring and the friction forces are only decelerating the flaring.

Although the graphics show only 3 distinct imbalance points, the Pin, the CG and the MBP, they're aren't just 3 little masses inside the bowling ball. The 3 points only define where the maximum mass effects are located with respect to the surface of the ball. The weight block and the coverstock inside are actually very complex. Many are computer generated now.

Because of the usually smooth changes from one maximum to another, the actual flaring rate does not change abruptly at all. It is all very smooth. So there's no shifting like a manual transmission; it's more like an automatic transmission shifting gears. Some transmissions are

better than others however.

The Coverstock is the Tire, the Weight Block is the Engine and the Shape of the Weight Block is the Transmission.

The Shifting of the Gears

If all three imbalances are located on the Leverage Line initially, the ball layout is set up to have a really good low gear. It's a screamer. It leaves so much rubber on the road that you can almost see smoke behind the bowling ball just after it is released.

Regardless of the location and orientation of the imbalance forces when any of them get close to the Leverage Line, the ball shifts gears. Normally the Pin is the Low gear, the CG is Second gear and the MBP is the high gear. (They can be reversed however. Maybe that's like driving a car backwards?).

So the ball starts out in 1st gear with the Pin near the Leverage Line. The flaring begins at the rate (speed) given to the ball at the release. Because of the oil in the heads, the flaring rate stays at about the same speed. When the CG of the Imbalance Line rotates around to where the CG is close to the Leverage Line, the ball shifts into 2nd gear and the flaring rate increases speed. (It's not a very big increase. Bowling balls usually have a mellow 2nd gear because the effect of the CG on the dynamics of the flaring is so small). The shift to 2nd gear may occur before or after the transition from the heavy to no oil on the lane surface, but remember most of the flaring rate due to the 1st gear is still there.

Somewhere at the backend usually, 3rd gear is shifted and the effect of the Mass Bias Point comes into play. At this location, since the lane/ball surface friction are trying to reduce the flaring rate, the effects from the 1st and 2nd gears may be dissipated and the total effect is the 3rd gear, the MBP.

So, the MBP is rather important.

If you want a ball that has a strong backend effect, choose a ball with a strong MBP. That strong 3rd gear will enhance the "drive" into the pocket.

What is a Usual Stable Dynamic Position?

Usually, there are two stable dynamic positions for a bowling ball. One stable position occurs when the ball is rolling with the Pin (the greatest dynamic imbalance) is positioned on the rolling track. The other is when the Pin is at the axis of rotation. The reason that both are stable is the same. Both put the Pin in a position so that any movement from that position results in a force that pulls it back to that position. Both of these stable positions are for bowling balls with symmetrically shaped weight blocks and a weak mass bias and a bowler with a medium to weak rev rate.

Note that the stability is usually defined as above, but actually it is more complicated than that. It is always the combination of the position of the Pin and the position of the MBP that determine stability. Most bowling balls have their mass bias at or near a distance of 1/4 of the way around the bowling ball along the Imbalance Line from the Pin to the MBP. That's 6 3/4 inches away from the Pin. Remember, that's in most cases (usually for symmetrical weight blocks).

So what's really going on is that while the Pin is reaching the stable "rolling on the track" position, the MBP is reaching the "spinning at the axis of rotation" position. And the reverse is also

stable. The MBP can roll over the track while the Pin can spin at the axis of rotation.

Now, What about the Unusual Weight Blocks?
Bowling balls with high large mass bias can also overcome the stable rolling positions depending upon where the mass bias is located. The mass bias is "usually" 6 3/4 inches from the Pin, but some are near 1/2 that distance and that can be a really big problem for medium to high rev bowlers.

When the Pin is at the distance 3 3/8 inches from the axis of rotation (the Leverage Distance), the ball has the largest flaring force due to the imbalance at the Pin that it can have. When the Pin is at that leverage distance and the distance to the MBP is close to being 3 3/8 inches from the Pin, that places the MBP near a stable position of the MBP. But since the Pin usually dominates over the MBP in it's instability, the flaring does indeed begin.

Ah yes, but what happens when the Pin reaches the "rolling over the track" position? Not a good thing! Since the MBP is now at that unstable 3 3/8 inches from the axis of rotation (depending upon the layout), it now dominates over the instability of the Pin and the flaring continues. The Pin flares past the rolling track and flares until the MBP gets to the rolling track.

Now since the MBP is on the track and the Pin is 3 3/8 inches on the other side of the track, it may want to keep flaring (in the same direction) depending on the rev rate of the bowler.

Expletives deleted here for convenience and thoughtfulness of the author and the respect for the readers. Just be careful of the bowling balls with Imbalance Lines that are only 3 3/8 inches long.

A High Rev Rate Bowler and Just about Any Bowling Ball
A bowler with a strong rev rate will be able to overcome just about any stability once the ball is at a high rev rate and the ball has even a small mass bias imbalance. What happens is simple. When a high rev bowler places so many revs into the ball at the release, they create a tremendous amount of centrifugal force on all of the imbalance masses. When one mass reaches the position where the flaring force is at zero (at the Pin for instance), the still large flaring force on the other imbalances will be more than friction can dissipate and the flaring will simply continue. If the revs are high enough, the ball will simply flare all the way around the ball. The layout chosen for a high rev bowlers needs to be carefully chosen because of this.

The "Usual" Overall Flaring Picture
The ball is released with a specific amount of sideways and forward roll placing the axis of rotation pointing to the rear at some angle (45 degrees for example). Because the ball is drilled with the ends of the Imbalance Line away from the stable rolling locations, as the ball is released, it begins to rotate the ball about a point on the top of the ball, the primary flaring axis point. The ends of the flaring axes are also called the Bow Tie Points.

Depending upon which imbalance force predominates (usually the PIN) either the Pin will flare to the track and the MBP will flare to the axis of rotation or just the reverse.

When Do You Want Flaring to Stop with Respect to the Position of the Ball Down the Lane?
When the ball reaches the pocket, hopefully the total flaring has been such that the Pin is in the intended position for the greatest impact with the head pin with the Pin rolling right over the

final track of the bowling ball. That's usually the largest rotational inertia position. That's a good thing.

Frequently Used Layouts

Stacked Leverage Layout:

This is a layout that provides the maximum flaring rate initially, just as the ball is released. The Imbalance Line is located on the Leverage Line. All three imbalances are located on or near the Leverage Line.

The layout is included later in this issue as a Flip Pad so that you can see when, during the roll of the ball, the dynamic effects try to interact to make the ball break across the lane surface.

Singles Leverage Layout:

This layout has the Pin located on the Leverage Line and the CG at or near the center of the grip. The Imbalance Line is pointing from the CG at the center of the grip to the Pin at the Leverage Line.

This layout is also included later in this issue.

Long and Snappy Layout:

The Pin is located away from the Leverage Line farther than 3 3/8th inches and usually close to or above the fingers. The CG is located at or near the center of the grip. The Imbalance Line is pointing from the CG at the center of the grip to the Pin (usually above the fingers).

The dynamic effect of the PIn in this layout is smaller than with other layouts. Since it is farther away from the Leverage Line, it promotes flaring less. Thus the ball desires to go longer. The CG and MBP act on the dynamics during the latter part of the roll of the ball. During that part of the roll of the ball, the CG and MBP are near the Leverage Line; they are increasing the flaring rate near the end part of the roll of the ball. Hence, the ball is snappy. It helps of course if the ball is a low RG weight block so that the sideways rotation can be expended quickly. In that case, it will be very snappy.

This layout is also included later in this issue.

Roll Early:

Initially the Pin is closer to the midline of the layout, usually below and to the right of the fingers.

Take care with this layout. If the Pin is too far below the fingers, there is a possibility of flaring over the finger holes.

The CG is located at or below the midline of the ball. The Imbalance Line is generally pointing from somewhere near the thumb through the CG further up and to the right toward the Pin even farther up and to the right. (Remember, the Pin is closer to the midline than for other layouts

As the ball flares the Pin ends up being at near the Leverage Line just as the ball is near the end of the oil on the lane surface. So, a large flaring effect occurs and a large desire of the ball to break across the lane surface occurs just as the ball is seeing the beginning of the high friction part of the lane surface.

This layout is also included later in this issue.

Strong Mass Bias Point Weight Block Design

Some bowling ball weight block/coverstock combinations are designed to have strong influence by the mass bias point. The manufacturer will usually tell you such information. The usual reason for designing a bowling ball weight block so that it has a strong mass bias is to have a larger influence on the flaring rate and thus potential to break more across the lane when the ball is in the later part of the roll of the ball.

Mo Pinel is Right, Core Shape Controls Path Shape

If you've been able to understand some of this, you should be ready to understand the statement that Mo Pinel makes so many times. "Core shape determines path shape."

If you design the core (the weight block) correctly, the initial location of the Pin, the CG and the MBP (which define the Imbalance Line) and the direction of the Imbalance Line can be used to drill a ball so the it will have the ball path shape that a bowler wants.

So, if we get the Imbalance Line positioned and orientated correctly during the layout of the ball, we get a specific rolling path design.

Thanks Larry, Curly and especially Moe.

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Want to see some very creative weight block designs? Check out www.morich.net, the web site for MoRich Enterprises.

Bowling Terminology Definitions

Arc Point - The transition point where the ball changes it's rolling characteristics from sliding with little or no curve to the beginning of a pronounced curve.

AFR Number
The Actual Flare Realized Number is a product of the PTF Number and the DRG (the flare potential).

Axis Balance - The PIN of the bowling ball is positioned on the bowler's axis point with respect to the initial rolling track of the ball.

Axis Drilling
The bowling ball is drilled so that the initial axis of rotation is on or very close to the PIN of the weight block. Since the ball starts out at or very near one of the two stable rotational modes, the ball has a very stable and very smooth arcing rolling path.

Positive Axis of Rotation - The center of the bowling ball opposite to the bowler's initial rolling track on the ball on the same side as the gripping holes. This is also called the Positive Axis Point (PAP).

Axis Point - The point on the surface of the ball at the end of the Positive Axis of Rotation.

Backend - The rear part of the lane surface, usually categorized as the part of the lane where little or no lane conditioner has been applied. Depending on the bowling center, the backend can be the last 15 to 25 feet of the lane surface.

Backend Potential - This is a parameter that is sometimes used to compare the amounts of reaction on a drier backend bowling lane surface for bowling balls of a single manufacturer. Note that the backend potential ratings for one manufacturer are not necessarily the same scale as for another manufacturer.

Balance Hole - An extra hole positioned so as to statically balance and finalize the reaction characteristics of the ball. ABC limits the size of a balance hole to diameter of less than 1 1/4".

Ball Rolling Track - The circular region on a bowler's bowling ball where it makes contact with the lane surface. The initial rolling track is usually the most visible because it is usually the wettest.

Borden Number
It's a number that can be used to compare bowling balls of the same manufacturer or different manufacturers because, it only uses real numbers that describe the bowling balls. The best results come from comparing balls of the same type and manufacturer.

Break - The movement of the bowling ball laterally across the lane surface.

Center of Gravity (CG) - The location on the surface of the bowling ball where gravity acts straight down from the center of all of the weight of the ball. Manufacturers float a newly manufactured bowling ball on a cushion of air. Once the ball stops moving, the very center of

the bottom of the ball is marked as the Center of Gravity (CG).

Core - The inner portion of a three (or more) piece bowling ball consisting of lighter weight filler material just between the cover stock and a heavier and very hard center material.

Coverstock - The outside material of a bowling ball. It can be as thin as about 1/4" to 1 1/2" thick and be made of various materials such as rubber, polyester, urethane and some exotic new reactive or composite materials.

Differential of Radius of Gyration - Radius of Gyration is measured with respect to the "Z" axis which is defined as the direction the PIN points outward from the surface of the ball from the center of the ball. The two other directions are perpendicular to that direction and the Radius of Gyration for those two axes can also be measured. The difference between the Radius of Gyration measured at any two of the three axes is defined as the Differential Radius of Gyration. (The largest is listed as the DRG).

Dynamic Balance - Drilling the bowling ball in such a position as to cause a specific ball reaction during the rolling path of the ball.

Dull Surface - A bowling ball surface that has not been polished so as to allow the ball to exhibit it's porosity characteristics. A bowling ball that has been sanded at the factory with a specific lower grit numbered sandpaper leaves a dull finish on the surface of the ball. Using a ball spinner and the appropriate sandpaper, the surface dullness can be adjusted to fit the desire of the bowler.

Final Rolling Track (FRT)
The final rolling track on the ball surface. It is usually associated with the desired "over the PIN" orientation after flaring is completed.

Flare - A measure of how much the track changes position during the roll of the ball. It is caused by the bowling ball changing it's axis of rotation during the roll of the ball.

Flaring Potential - This is a parameter that is sometimes used to compare the amounts of track flare for bowling balls of a single manufacturer. The track flare potential is measured in inches, so all of the manufacturer's can reasonably be compared with each other.

Forward Roll Axis - The axis of rotation for the movement of the ball down the lane surface toward the pin deck. If you hold your right hand out with the palm facing downward and your fingers representing the direction of the top surface of the bowling ball, your thumb represents the axis of rotation of the forward roll of the ball.

Friction - The interaction between the lane surface and the bowling ball surface which causes the ball to slow down as it rolls farther down the lane after leaving the oil conditioned frontend of the lane.

Heads - The front portion of the lane surface, usually about 20 feet. When they say that they are re-oiling the heads, they usually mean that only that first 20 feet or so is being oiled.

Hook Potential - This is a parameter that is sometimes used to compare the amounts of hook for bowling balls of a single manufacturer. Note that the hook potential ratings for one manu-

facturer are not necessarily the same scale as for another manufacturer.

Initial Rolling Track (IRT)
The initial rolling track on the ball surface. It is usually the wettest track on the ball.

Label Balance - Drilling a bowling ball so that the CG is near the center of the gripping area of the ball.

Layout Instability
The range of the Layout Instability is from zero to one. For stacked leverage, the Layout Instability Number has a value of one. For a layout with the Pin on the PAP and the Mass Bias Point located on the initial rolling track (axis drill layout) has a value of zero.

Length Potential - This is a parameter that is sometimes used to compare the amount of delay a bowling ball can have before arcing. Note that the length potential ratings for one manufacturer are not necessarily the same scale as for another manufacturer.

Leverage Drilling - The bowling ball is drilled so that the maximum instability from the initial rolling track to the final rolling track is attained. The theoretical location for the PIN is 3 3/8th inches from the initial axis of rotation of the ball.

Leverage Line - An imaginary circle on the bowling ball located 3 3/8” from the current positive axis of rotation. When the PIN of the ball is located on the Leverage Line in the upper right quadrant, the greatest potential for the maximum break possible is realized.

Moment of Inertia - It is the resistance to change in angular velocity of the bowling ball. A bowling ball with a low moment of inertia will be easier to spin up to a high rotational velocity. And conversely, a ball with a high moment of inertia will not spin up easily. It’s related to the Radius of Gyration (RG) of the ball.

Mo Number
Mass bias is a measure of how the weight block is shaped. The more that the weight block is protruding to one side, the more mass bias it has.

PIN - The point on the surface of a bowling ball that represents the balance point of the symmetrical internal weight block of a bowling ball. It can be thought of as extending from the exact center of a symmetrical weight block. If you were to have the symmetrical weight block by itself, you could turn it over and stand it on the PIN point on the weight block.

Positive Axis Point - It is the center of the hemisphere on the ball defined by the initial rolling track of the ball. With the fingers at the top of the ball and the track to the left of the fingers and thumb, the Positive Axis Point is at the right at the center of that hemisphere. (Same side as the gripping holes).

Preferred Spin Axis - The rolling axis which the bowling ball searches to reach by flaring the rolling track. One preferred spin axis is at the PIN of a symmetrical weight block (spinning the ball about the PIN of the ball). The other two preferred axes are perpendicular to the PIN axis at the center of the ball (the PIN would be right on the rolling track of the ball).

PTF Number
The PTF Number is the rotational speed times the instability of the layout.

Radius of Gyration - The relationship between the moment of inertia and the mass of a bowling ball. A bowling ball with a higher radius of gyration has it's overall mass shape located further away from the center of the ball. A low radius of gyration ball has most of the mass near the center. A low RG ball is easier to "rev up."

Reactive Resin - A coverstock material which is usually a blend of urethane with different additives. It has the property of reacting violently on the drier backend portion of the lane surface. It has higher friction on a dry surface.

Revolutions (Revs) - The number of times a bowling ball makes a complete rotation about it's axis of rotation as it rolls from the foul line to the head pin.

Rev Rate - The rotational speed of the ball can measured in revolutions per second although it can be stated as revolutions per minute (RPM). And since that's a much higher number and much more impressive, that's the number you will usually see in the literature.

Rudy Numbers
Release strength is related to the Rave Rate and the Radius of Gyration. It takes more strength in a release to get a high Rev Rate. It also takes more strength in a release to rotate a higher RG ball.

Sideways Roll Axis - The axis of rotation for the movement of the ball across the lane surface. If you hold your hand up and face the palm to the left with your fingers curled, your fingers represent the moving top surface of the ball and your thumb represents the direction of the sideways roll axis pointing to the rear.

Three Piece Construction Bowling Ball - A bowling ball with a dense inner core, a filler material and a dense coverstock.

Two Piece Construction Bowling Ball - A bowling ball with an inner weight block and an outer shell.

Weight Block - The custom shaped inner mass of a bowling ball.

Bowling Ball Ratings Supplied by Manufacturers (Fudgable Numbers)

The Hook Potential
This rating is a number related to how much the ball could possibly hook.

The Length Potential
This rating is a number related to how long the ball will travel down the lane before it begins to hook across the lane.

Back End Potential
This rating is a number related to how aggressive the ball is on the back end compared to the front end of the lane surface.

Flare Potential
This rating is a number related to how far the ball may flare around the surface of the ball.

Ball Manufacturer Real Numbers

These are real numbers, not some evaluation by some 7 foot tall white rabbit with a bad fitting ball.

RG - Radius of Gyration
This parameter is related to how much of the mass of the ball is toward the surface of the ball. The higher the RG, the greater the percentage of the mass is located farther away from the center of the ball. Since the RG is measured about three axes X, Y and Z, there are three RG values. The average RG is usually what is listed, but usually stated in some easier to read scale.

Remember, low RG balls are easier to rev up to a high rotational energy state and just as easily release their rotational energy quickly. Your hand inputs the energy and the dry lane at the back end takes it away as the ball breaks toward the pocket.

DRG - Differential Radius of Gyration
This parameter is related to the shape of the total mass distribution inside a bowling ball. It is mostly related to the shape of the weight block. The highest difference between the RG values is what's generally stated as the DRG for a bowling ball. It is also usually stated in an easier to read scale.

Remember that the DRG is directly proportional to the flare distance, The higher the DRG, the higher the flare distance.

Grit Number - Surface Texture Roughness
This number is usually the out of box surface texture that the ball was processed to at the final stage before packing. The Grit Number is an inversely stated number. The higher the number is, the smoother the surface is. So, a 400 grit is much rougher than 2000 grit surface.

So, What are the Bowling Ball Design Characteristics to Look For?
The greater the reactive surface usually is, the greater the listed hook potential is.

The softer the surface, the greater the hook potential is.

The greater the porosity (and Coefficient of Friction), the greater the ball will hook early in the roll of the ball.

The lower the Radius of Gyration, the easier you will be able to "rev" the ball up to a higher rotational velocity, but the easier it will spin down after it comes off the front end oil. The lower RG ball will be more "snappy".

The higher the Radius of Gyration, the harder you will be able to "rev" the ball up, but the ball will maintain the rotational velocity longer in the roll of the ball. The higher RG ball will be more "arcy."

The greater the Differential Radius of Gyration, the greater the flaring distance is on the surface of the ball.

The harder the central core of the ball, the higher the Coefficient of Restitution will be and correspondingly, the more energy will be available to be imparted to the pins by the ball.