A typical scratch bowler that bowls in a scratch league is capable of maintaining a high average (220-240) in his home bowling center on an easy “House Condition”. These players usually have one (1) type of “style” (game) and are extremely limited to what they can do. A top Regional Pro is capable of maintaining a high average (200-220) over a variety of tournament conditions. These players usually have “one” solid game. A typical Touring Player is capable of maintaining a high average (200-220) over a variety of Tour conditions. These players usually can do more than one thing with their games and are fairly versatile. A very successful [PBA] Touring Player can easily go from his “A”-game to his “B”-game and is comfortable doing that. They are usually a Champion with a title or two. The Hall of Fame players and multiple champions can (and could) do 2 or 3 things comfortably with mixing their styles based on the environment. They are well practiced and possess the knowledge needed to succeed.

With this issue of State of Our Sport, I share with readers the first installment of a series of articles dedicated to sharing the knowledge needed to become a world-class player. In part 1, I introduce readers to the five critical ball reaction manipulations that a bowler can make to change the reaction of a bowling ball: axis of rotation, axis tilt, revolutions, ball speed and loft. In subsequent installments, I will discuss how you can manipulate each of these adjustments with confidence and repeatability as well as how to utilize combinations to play lanes most effectively.

As an international coach, I often see bowlers setting-up in the stance with their index finger, little finger and wrist in certain positions. Yet, when asked, they can’t articulate how the ball reaction will change when they modify finger placement or wrist position. To become a world-class player, you must possess the knowledge of ball reaction that will occur with a precise manipulation of the wrist, hand or finger.

The best bowlers in the world, such as Chris Barnes and Norm Duke, know how to make the bowling ball dance where and when they want it to dance. They understand that by manipulating minor changes in their ball reaction, this will allow them to be more competitive more of the time. To illustrate, Chris Barnes has a USD$1,000,000 contract with Columbia 300 and he won nearly USD$400,000 in a one month period last year with titles in the Tournament of Champions, the PBA Motel 6 Roll to Riches and the World Tenpin Masters. It really pays to be able to change ball reaction based on knowledge! Are you ready?

**The Five Adjustments Elite Bowlers Should Master**

Specifically, there are five adjustments that a bowler can make to manipulate ball reaction. These include: the axis of rotation, axis tilt, revolutions, ball speed and loft. Each of these adjustment domains needs to be understood in isolation. In simple terms, these five adjustments control the length of the skid of the bowling ball as well as the strength of the backend reaction.
The 5 World-Class Manipulations and Ball Reaction Change

<table>
<thead>
<tr>
<th>Axis of Rotation</th>
<th>As the axis of rotation increases, both the skid and backend reaction strength increases</th>
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<tr>
<td>Axis Tilt</td>
<td>As the axis tilt increases, both the skid and backend reaction strength increases</td>
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<td>Revolutions</td>
<td>As the rev rate increases, both the skid and backend reaction strength increases. The rev rate actually controls the amount of push past the end of the lane pattern more than speed does.</td>
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<td>Ball Speed</td>
<td>As ball speed increases, the ball will skid further down the lane</td>
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<td>As the ball is lofted more, the ball will skid further down the lane</td>
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Positive Axis Point

Before we discuss the five adjustments, you need to understand the Positive Axis Point (PAP). Begin by imagining the earth’s North or South Pole. As you know, the earth rotates around these poles. The same goes for a bowling ball. As the ball is initially released from the hand, the bowling ball rotates around a positive and negative pole, the Positive Axis Point and the Negative Axis Point. In simple terms, these poles are the point on the bowling ball that is the same distance from any part of your initial ball track (see the picture). Your PAP is located on the opposite side of the ball as your initial track and is visible when you throw the ball.

To determine your PAP, throw a ball down the lane. When it comes back, immediately look at your ball and find your track, the oil lines. You will likely see several lines of oil, due to the flaring of the ball. The initial ball track is the line of oil that is closest to your fingers and thumb holes. The PAP is perpendicular to this point. Literally, this is the point that is equidistant from any point on this track to that point. As you see in the picture, this is the point of intersection of any two lines, perpendicular to your initial ball track. If you drew a perpendicular line, from any point on the initial track line, it would intersect at the PAP. To locate the PAP, throw a shot. When the ball returns place the initial track parallel to the ground. Put a piece of white tape on the top of the ball. This will give you an approximate PAP placement. Your pro shop professional can help you find this more accurately with a quarter scale. If you get the placement right, the tape should be perfectly still, as the ball rotates around the axis, in the first five to ten feet. This tape will then move outward as the ball travels down the lane and ball moves toward its preferred spin axis.

Axis of Rotation

![Image](image_url)
The axis of rotation (AoR) is the measure of the axis the ball rotates around as it leaves your hand. This is measured by the position of the PAP in the horizontal plane. For example, if you throw the ball straight it would roll around an axis that is perpendicular to the lane. This release, 0 degrees, would yield a roll that is parallel to the lane or directly toward the pins. Conversely, if you rotated your hand around the side, as you threw the ball, the ball would be initially rotating perpendicular to the lane. As you can imagine, this would cause more skid because the ball is rotating in a direction 90 degrees relative to the direction of the pins.

The easiest way an elite bowler changes axis of rotation is by changing the position of the ring and middle fingers at the point of the release. This is measured from 0 to 90 degrees. 0 degrees is the equivalent to a 6 o’clock release, with your middle and ring fingers directly up-the-back of the bowling ball. This release will lead to a straight ball with an end-over-end roll, perfect for spares. With 90 degrees, the ball is initially rotating in the opposite direction of the pins, with the middle and ring fingers at 3 (RH) or 9 (LH) at release. For comparison, most professional bowlers throw the ball around 45 degrees for many more challenging conditions.

The only method to find AoR is to review your release on video tape. Where do you see your PAP just after it leaves your hand? In the diagram, the X represents the PAP with the dotted line illustrating the axis the ball is rotating around.

<table>
<thead>
<tr>
<th>0 Degrees of Axis Rotation</th>
<th>45 Degrees of Axis Rotation</th>
<th>90 Degrees of Axis Rotation</th>
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Elite bowlers can change the axis of rotation to manipulate the ball reaction that they want to achieve. As the Axis of Rotation increases, both the amount of skid increases as well as the amount of backend reaction.

**Axis Tilt**
Think about a picture of the earth. It has a natural tilt of 23.5 degrees. For bowling, axis tilt is the measure of the amount of spin that is imparted on the ball by the bowler at release. Visually, you can measure tilt, in degrees from 0 to 90, by the amount the PAP is above the horizon in the vertical plane. To illustrate, a spinner has nearly 90 degrees of axis tilt. The PAP would be on the top of the ball. To determine tilt, you can review the position of your PAP at the release point to determine approximately how much you have. Elite bowlers can actually alter the amount of axis tilt in their release to change the length and backend reaction.
Revolution (Rev Rate)
An elite bowler is able to also alter the number of revolutions. Revolutions are calculated by determining how many times the ball makes a complete rotation, on the track, around the ball. You can measure this through the use of video tape as well. The individual taking the video should be in a position to see the ball for the complete shot, from release to hitting the pins. After marking your PAP, on the ball, place a piece of white tape approximately 6 inches long on your ball from your PAP to the top of your finger holes. Throw some shots and video tape. In slow motion, count the number of times you see the tape strip, from release to pins. This is the number of revolutions on one throw. Or, you can estimate by counting the number of revolutions the ball makes from the foul line to when it passes the 4th arrow, approximately 15 feet. This will give you the number of revolutions for one-quarter of the lane. Simply multiply this number by four. Now, you need to obtain the time it takes for the ball to travel down the 60 feet of the lane in order to determine your RPMs. Take a stop watch and measure the amount of time, in seconds, from the point that the ball passes the foul line until it hits the pins. Then, plug this time into the following formula.

\[ \text{Revolutions Per Minute (RPM)} = (\text{Rev # on 1 throw}) \times (60 \text{ seconds} / \text{time on 1 throw}) \]

Ball Speed
Elite bowlers are able to alter their ball speed in order to change the ball reaction. Ball speed is measured in Miles Per Hour or Kilometers Per Minute. This is the average velocity of the bowling ball as it travels down the lane. With a stop watch, take times for ten throws and calculate the average time (t) and put this t into the following formula to calculate ball speed: \(40.91/t\) (MPH) or \(65.45/t\) (KPH).

Loft
Loft is measured as the distance from the foul line to where the ball lands on the lane surface. This is normally measured in inches or feet. Elite bowlers can change the amount of loft to control their ball reaction since increasing loft shortens the lane.

Conclusion
When bowling, you want to constantly gauge how far the ball skids down the lane as well as how strong the backend reaction is with your release in terms of each of the individual five ball manipulations. In upcoming installments of State of Our Sport, I will discuss how you can make adjustments in each of these five domains competently and confidently. This will provide you with world-class knowledge. Then, if you want to be an elite player, you will need to practice these adjustments to become skilled. Just remember the following motto:

\[ \text{Knowledge + Practice} = \text{Competence and Confidence} \]