Assessing lift & forward spine tilt

How they are measured

In this month's installment of Slowinski at-large, I present a method for evaluating certain aspects of the physical game with quantifiable data. From an analysis perspective, I constantly reflect on how to best evaluate players over time. If I can quantify physical movements in terms of data points, it will provide an accurate assessment as well as a method to determine change over time. This provides a better opportunity to illustrate areas of weakness, cause and effect systems, and effect meaningful change.

These analysis points include the release lift angle, the forward spine tilt throughout the approach, step distances, step velocity, and the downswing angle. Each of these components can be measured, recorded, assessed, and compared.

The collection will provide a coach or player with data to be added to an in-depth physical game profile. Most importantly, through this ongoing assessment, current physical game efficiency can be determined and improved efficiency assessed.

Release lift assessment

When referring to biomechanical efficiency, maximizing energy transfer to the bowling ball is the most important goal. Many factors contribute to the transfer of energy. Accordingly, we want to determine any part of the physical game that might be leaking energy from the kinetic energy chain.

With this in mind, one of the measures I would like to see become commonplace for coaches is a lift angle assessment. Lift takes away from efficient energy transfer because the ball is moving upward and not going smoothly onto the lane. Specifically, with any amount of lift, the bowling ball becomes a projectile and consequently loses speed.

Obviously, for the lift assessment data to be meaningful, the measurements need to be taken at consistent points in a player's release.

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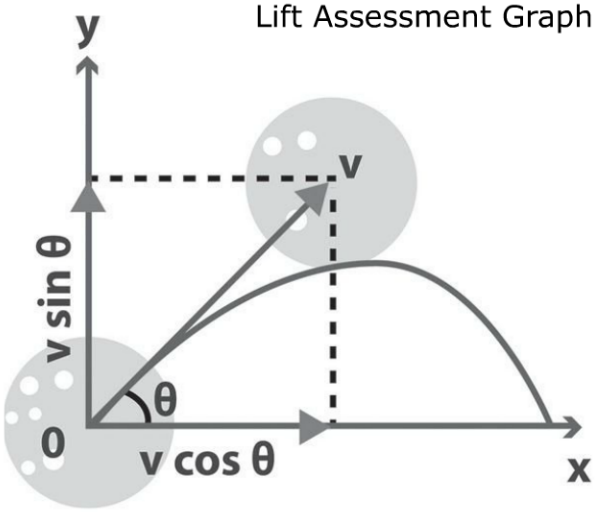
Some players lift while the thumb is in the ball while others lift after the thumb exits and still others, not at all. Therefore, coaches would need to assess when the ball is lower and moves higher (the lifting motion) in an individual player's delivery to accurately gather this data for that player.

This chart illustrates the reduction of speed using from 1 to 20 degrees of lift as compared to no lift at that speed. The speed reduction was calculated using the projectile formula for the horizontal speed (Initial Velocity (V_0) X cosine of the angle = the actual horizontal

Lift Assessment Graph



Lift Assessment Chart

Lift Degrees	1	2	3	4	5	6	7	8	9	10
Cosine of Angle	0.9998	0.9994	0.9986	0.9976	0.9962	0.9945	0.9926	0.9903	0.9877	0.9848
MPH	20	20	20	20	20	20	20	20	20	20
Speed Reduction (mph/%)	19.997 -0.02%	19.988 -0.06%	19.973 -0.14%	19.951 -0.24%	19.924 -0.38%	19.891 -0.55%	19.851 -0.74%	19.806 -0.97%	19.754 -1.23%	19.696 -1.52%
MPH	19	19	19	19	19	19	19	19	19	19
Speed Reduction (mph/%)	18.997 -0.02%	18.988 -0.06%	18.974 -0.14%	18.954 -0.24%	18.928 -0.38%	18.896 -0.55%	18.859 -0.74%	18.815 -0.97%	18.766 -1.23%	18.712 -1.52%
MPH	18	18	18	18	18	18	18	18	18	18
Speed Reduction (mph/%)	17.997 -0.02%	17.989 -0.06%	17.975 -0.14%	17.956 -0.24%	17.932 -0.38%	17.901 -0.55%	17.866 -0.74%	17.825 -0.97%	17.779 -1.23%	17.727 -1.52%
MPH	17	17	17	17	17	17	17	17	17	17
Speed Reduction (mph/%)	16.997 -0.02%	16.990 -0.06%	16.977 -0.14%	16.959 -0.24%	16.935 -0.38%	16.907 -0.55%	16.873 -0.74%	16.835 -0.97%	16.791 -1.23%	16.742 -1.52%
MPH	16	16	16	16	16	16	16	16	16	16
Speed Reduction (mph/%)	15.998 -0.02%	15.990 -0.06%	15.978 -0.14%	15.961 -0.24%	15.939 -0.38%	15.912 -0.55%	15.881 -0.74%	15.844 -0.97%	15.803 -1.23%	15.757 -1.52%
Lift Degrees	11	12	13	14	15	16	17	18	19	20
Cosine of Angle	0.9816	0.9782	0.9744	0.9703	0.9660	0.9613	0.9563	0.9511	0.9456	0.9625
MPH	20	20	20	20	20	20	20	20	20	20
Speed Reduction (mph/%)	19.633 -1.84%	19.563 -2.18%	19.488 -2.56%	19.407 -2.97%	19.319 -3.40%	19.226 -3.87%	19.127 -4.37%	19.022 -4.89%	18.911 -5.44%	19.249 -6.02%
MPH	19	19	19	19	19	19	19	19	19	19
Speed Reduction (mph/%)	18.651 -1.84%	18.585 -2.18%	18.514 -2.56%	18.436 -2.97%	18.353 -3.40%	18.265 -3.87%	18.171 -4.37%	18.071 -4.89%	17.966 -5.44%	17.855 -6.02%
MPH	18	18	18	18	18	18	18	18	18	18
Speed Reduction (mph/%)	17.670 -1.84%	17.607 -2.18%	17.539 -2.56%	17.466 -2.97%	17.387 -3.40%	17.303 -3.87%	17.214 -4.37%	17.120 -4.89%	17.020 -5.44%	16.916 -6.02%
MPH	17	17	17	17	17	17	17	17	17	17
Speed Reduction (mph/%)	16.688 -1.84%	16.629 -2.18%	16.565 -2.56%	16.496 -2.97%	16.421 -3.40%	16.342 -3.87%	16.258 -4.37%	16.169 -4.89%	16.075 -5.44%	15.976 -6.02%
MPH	16	16	16	16	16	16	16	16	16	16
Speed Reduction (mph/%)	15.706 -3.87%	15.651 -3.87%	15.590 -3.86%	15.525 -3.85%	15.455 -3.84%	15.381 -3.83%	15.302 -3.81%	15.218 -3.80%	15.129 -3.78%	15.036 -3.75%

velocity). When you lift the ball, it adds angle and reduces velocity. This formula provides the initial horizontal speed and gives us an illustration of the speed reduction based on the lift angle and hypothetical speed of the hand.

Lift Assessment Chart

To measure the lift angle with a video analysis program, draw a circle around the ball at the lowest point and again at the highest point. With the center marked on each circle, you can calculate the lift angle as you can see in the Lift Assessment Graph.

Swing start type and forward trunk flexion

Another important evaluation area is the forward spine tilt (trunk flexion) angle throughout the approach. Timing and how the bowler starts the ball into the swing has a major impact on how the trunk moves forward and how early it does so in the approach. Consequently, with changes to the physical game, the forward trunk angle will change greatly when improving efficiency and is an essential measurement area to build a bowler profile.

Using a video analysis tool, I recommend assessing the forward spine tilt angle when each step compresses, (most importantly in steps 2, 3, and 4), as well as when the slide foot is beside the ball side foot. The measurement is taken from the armpit to the waist as you can see in the photo (See Forward Spine Tilt photo, next page). These four locations allow a coach to compare any forward spine tilt changes of a player over time since they will change with coaching interventions.

In the included example, the forward spine tilt angle transitioned from 18 to 26 to 28 to 31 degrees. As a way to be more consistent in my measurements, I utilize the angle of the back from the side view since torso rotation will make it difficult to get an accurate measure of forward spine tilt from the side. For more information on the impact of the swing start and forward spine tilt, please read my "Hinge it to a better physical game" article in the February 2009 edition of Bowling This Month.

Approach consistency - step speed and step length

Approach consistency is a measure of the time to complete the approach, from the initiation of movement to the spot when the slide foot stops. From an evaluation point of view, this will provide us with the ability to determine changes in timing and subsequent speed between steps as well as the consistency of the approach. This can be broken down into step segments to determine the time and velocity between steps as well as step lengths.

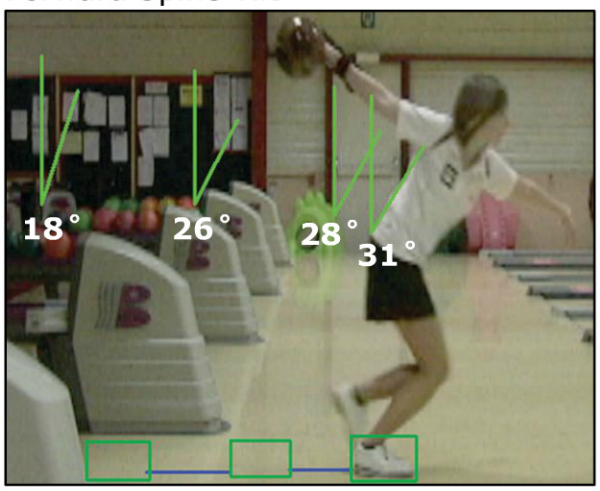
To complete this evaluation, a coach/bowler needs a stopwatch which includes a lap timer. As the bowler initiates movement, start the stop watch. As each step fully compresses, click lap time. At the conclusion of the approach, review the lap times to determine the time between steps.

In addition to step speed, capture the length of the steps with the distance estimate tool in your motion analysis program. Measure as you see in the Forward Spine Tilt photo from the toe of one step to the heel of the next step. Motion analysis programs with such a distance tool can compute an estimate of velocity and velocity changes between steps as velocity = time/distance = feet/second.

Downswing angle

The downswing angle is a function of the trunk angle and determines how the ball moves laterally in the downswing from the top of the swing. Due to the space-creating trunk movement of elite players, the downswing moves inward allowing the swing to stay close to the body and the hand to be inside the bowling ball, promoting the potential for increased rotational velocity (RPMs). Most professionals have a downswing angle from 6 to 12 degrees.

Forward Spine Tilt



The downswing angle will change greatly with coaching interventions of lateral spine tilt in the setup and swing start. For details on how to measure the downswing angle, read my "Calculating a downswing angle" article in the May 2012 Bowling This Month.

Concluding remarks

The primary goal of this month's article is to facilitate a richer and deeper profile of each bowler grounded in quantifiable data. This allows a coach or player to better evaluate the current level of biomechanical efficiency as well as determine change over time.

Without data, this process remains random to some level. I have included a Physical Game Profile record sheet to help those who want to collect more data and complete an efficiency assessment. I have created a table for both strike shots and spare shots to complete a holistic assessment and determine if there are differences between them. You can view or download the table online at www.bowlingthismonth.com/extras ("Physical Game Profile.")

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