12.Swing Metrics

Thebaseball swing has been one of the most studied motions in sports, and yet there are still a great number of questions for individual players regarding what it takes to perfect the art of hitting. At Diamond Kinetics we understand how complex the swing is and the variety of swing approaches there are. Because of this, we crafted SwingTracker.

Built around revolutionary discoveries in motion analytics, SwingTracker removes all the guesswork from swing analysis and delivers instantaneous data that allows coaches and players to identify opportunities for technique improvement.

12.1. Power

Power at it's core is a measure of energy and how that energy is transferred to the ball at contact. Power is directly related to speed, but also includes such important factors as the mass and acceleration of the bat. There are three metrics that make up the Power category:*Applied Power, Max Acceleration,*and*Impact Momentum*.

12.1.1.Applied Power

The Science Behind It

Theamountofpower–measured in watts – that is applied to the bat during the swing by the hands and body.

What It Means For Hitters

Higher AppliedPowercauses the bat to reach a higher momentum quicker and thus allows for the batter to hit the ball further. Plus, more Applied Power allows for the batter to start a swing later, thus giving more timeto recognize a pitch and still hit the ball far.

What It Means For Coaches

Since thedistancea balltravels after contact depends on barrel speed at impact and the weight of the bat, more Applied Power during the swing means that it takes the batter less time to reach their Max Barrel Speed.

Furthermore, more Applied Power means the batter is transferring more energy from his body to the bat,

andthentotheball. Thiswill result in more bat speed and ultimately more power.

Real World Similarity

Carswith higher poweredengines go from 0-to-60 miles per hour faster than cars with lower powered engines. Therefore, a batter who generates more Applied Power during a swing would have a ‘higher powered engine’, thus allowing for the bat to reach a higher swing speed quicker.

DK Pro Tip

Onecanimprove their Applied Power by integrating the lower body in sequence with the upper body.

Furthermore, a heavier bat will also result in higher Applied Power because there will be more energy transferred from the body to the bat in order to swing the heavier bat. However, higher Applied Power will only result if barrel speed is maintained with the heavier bat.

12.1.2.Max Acceleration

The Science Behind It

MaximumAccelerationcaptures how quickly a batter speeds up their swing from start until impact, and relatesdirectlytotheforceand torque applied to the bat.

What It Means For Hitters

HigherMaxAcceleration allows you to start a swing later – thus giving you more time to recognize the pitch –butstillproduceahigh rateof bat speed and momentum in the bat.

What It Means For Coaches

Byapplying more force andtorque– and thus having more Max Acceleration – one can get the bat up to speedina shorter time, allowing the batter to wait longer to recognize the pitch.

Real World Similarity

When two cars accelerate from 0-to-60 miles per hour, the car with the highest acceleration gets to 60MPH the quickest. Therefore, a batter with a quicker acceleration rate from the beginning of the swing until impact will be able to wait longer than his counterpart to identify a pitch, thus allowing for more time to identify if the pitch is a ball or strike.

DK Pro Tip

More Maximum Acceleration also allows the batter to get the bat up to a higher speed over a given period of time, thus generating more exit velocity after making contact on a squared-up ball.

A bat that is too heavy, though, could potentially affect the Max Acceleration of a swing.

12.1.3.Impact Momentum

The Science Behind It

ImpactMomentumis theamount of momentum in the bat when the bat makes contact with the ball. It is determinedbybarrel speedatimpact, and the weight of the bat.

What It Means For Hitters

The higher the Impact Momentum, the further the ball will travel after contact.

For every additional +1 of Impact Momentum, the batter increases exit velocity by + ~1.5 mph. For balls with a HR trajectory, every + ~1.5 mph of exit velo = + ~10 feet of carry.
With this in mind, the difference between an Impact Momentum score of 24 and one of 25 is + ~1.5 mph of

exit velocity and + ~10 feetof carry for a home run trajectory fly ball.

What It Means For Coaches

Thismeasureisthe onemost closely associated with the power of the hitter. This is because higher momentumdirectly relatesto further hit balls.

Real World Similarity

Ifa sports car and a dump truck are both moving at 60 miles per hour, the dump truck – in this case the heavier object – has more momentum than the sports car. Therefore, if two batters both had the same swing speed, the batter using the heavier weighted bat would have more momentum, and thus be able to hit the ball further after contact.

DK Pro Tip

Aheavier batmay lead to higher momentum, and therefore more exit velocity and distance for a hit ball – as long as the heavier bat does not cause too much loss in barrel speed.

12.2. Speed

Bat speed is a crucial factor in creating a high amount of ball exit velocity, which directly correlates with how far and how fast the ball will travel after impact. There are three metrics that make up the Speed category: *Speed Efficiency, Max Hand Speed*and*Max Barrel Speed*.

12.2.1.Max Barrel Speed

The ScienceBehindIt

Themaximumspeedofthebat'sbarrel during your swing, at a point 20% from the tip of the bat.

What It Means For Hitters

MaxBarrel Speed greatlyaffectsboth the distance and speed at which the ball travels after impact. According to Diamond Kinetics technical advisor Dr. Alan Nathan, "bat speed is roughly six times more important to batted ball exitvelocitythan the incoming velocity of the pitch."

What It Means For Coaches

Faster barrel speed leadsto morehard hit balls and a higher ball exit velocity, which in turn, increases the chance forthe ball to result in a hit.

DK Pro Tip

Max BarrelSpeed directly correlates with the SwingTracker metric Impact Momentum. Users will see high Impact Momentum scores, assuming the same barrel speed is maintained at contact with a heavier bat as with a lighter bat

12.2.2.Speed Efficiency

The Science Behind It

SpeedEfficiencycalculatesthe exact percentage of Max Barrel Speed that occurs at the precise moment of impact.

What It Means For Hitters

Itis ideal for the barrel of the bat tobe moving at its maximum speed – 100% Speed Efficiency – when it contacts the ball, in order to maximize distance and exit velocity. Even a small drop in Speed Efficiency can have alarge effect on batted ball outcome

What It Means For Coaches

Ahigh Speed Efficiency scoremeans the optimum amount of Max Barrel Speed occurred at the moment of impact, thus increasing the chances for higher exit velocity and optimal batted ball outcome potential.

DK Pro Tip

According to Diamond Kinetics' Technical Advisor Dr. Alan Nathan, "bat speed is roughly six times more important to batted ball exit velocity than the incoming velocity." With that in mind, it is imperative to have maximum barrel speed occur at impact in order to maximize your Speed Efficiency and potentially your chance for a hard-hit ball with a high amount of ball exit velocity.

12.2.3.Hand Speed

The ScienceBehindIt

Themaximumspeedofyourhandsduring the swing.

What It Means For Hitters

Faster handspeed, alongwith faster bat rotation, leads to faster barrel speed which positively affects the ballexit velocityand distance a ball travels.

What It Means For Coaches

Fasterhandspeedwillhelp thebatter get the bat in the hitting zone sooner. But keep in mind, a bat that is tooheavy,could potentially decrease hand speed.

DK Pro Tip

MaxHand Speed correlates with Trigger To Impact relative having excellent quickness and timing in the swing. This is necessary in order to make consistent, solid contact with the ball.

12.3. Control

Having Speed, Quickness and Power means very little unless you can put the bat on the ball. Control directly correlates with the path, angle and plane of the swing and is a large determinant of ball flight and ball contact point. There are three metrics that make up the Control category:*Approach Angle, Hand Cast Distance*and*Distance In The Zone*.

12.3.1.Hand Cast

The Science Behind It

HandCast Distance measures how far the hands move – in a lateral direction – away from the player's load positionat thestart oftheswing,to the point where the hands are at impact.

What It Means For Hitters

Hand Cast Distance canbe the result of a true hand cast away from the body, or because of a shoulder turn during the load process.

A larger Hand Cast Distance indicates an inefficient hand path to the ball and can cause a decrease in power metrics. Understanding this number will help the player create an efficient path with the hands to the ball.

What It Means For Coaches

Hand CastDistance allows coaches and players to quantify if a player is staying inside the ball, swinging with his 'hands back' and keeping the bat in the best possible position – over the back shoulder – before uncoiling thehands and the bat toward the pitch.

DK Pro Tip

Havinga large amount of Hand Cast Distance makes it difficult for a batter to hit the fastball, and/or adjust to hitting balls that occupy the middle or inside part of the plate.

In an ideal swing that results in a minimal amount of hand cast, the hands stay close to the shoulder, with the hands and barrel staying inside the baseball before the barrel gets on plane with the path of the pitch.

12.3.2.Approach Angle

The ScienceBehindIt

ApproachAngleistheangle/direction of your swing plane just prior to, and at the moment of impact.

What It Means For Hitters

When evaluating andanalyzingApproach Angle please note that a swing that is “on plane” will result in a slightly positive Approach Angle.

While the optimal Approach Angle is dependent on the type of pitch, it typically needs to be between +5° degrees and +15° degrees in order to hit a hard line drive and between +20° degrees and +35° degrees in order to hit a home run.

Anegative ApproachAngle is the result of a ‘chop’ type swing and usually leads to ground balls.

What It Means For Coaches

According to Dr. Alan Nathan’s research, the optimum launch angle of a home run is between +20° and +35° degrees. In order to achieve this goal, the batter must swing below the path of the incoming pitch, with the bat moving upwards in order to get a positive approach angle. This will ultimately lead to the desired results of the optimum launch angle for a home run.

DK Pro Tip

Data from the 2015MLBseason shows that batters hit the most home runs (1,407) with a launch angle between +25° and +29° degrees and had the highest batting average (.775) with a launch angle between +10° and +14° degrees. In order to achieve these results, batters must have a very positive (home run) or slightly positive (line drive) Approach Angle right before and at impact.

12.3.3.Distance in the Zone

The Science Behind It

DistanceIn The Zonemeasures the length of the hitting zone along a line toward the pitcher. It is determined by theregion‘swept’ by the bat.

What It Means For Hitters

Alonger hittingzonemeansa greater opportunity for the bat to make contact with the ball and thus, gives thebatter abetteropportunity toputthe ball in fair territory (assuming square contact is made).

What It Means For Coaches

Distance In The Zone is the region(designated as the blue area in the 3D rendering) in which a batter can make square contact with a pitch and hit a fair ball (think of the bat at a 45 degree acute angle, a 90 degree angle and a 45 degree obtuse angle, relative to the dimensions of the field of play).

Thelonger the batter’s hitting zone, the better chance one has at making contact with the pitch.

DK Pro Tip

Abatterwho can maintain an elite Distance In The Zone score has a greater opportunity to produce a higher contact rate and put more balls into play.

Moreover, having a swing that maintains a good Distance In The Zone is also more forgiving for small errors in timing, thus resulting in more balls in play.

12.4. Quickness

Quickness is critical to a hitter's success since it is directly related to timing & therefore one's potential for good contact. There is one metric that makes up the Quickness category: *Trigger To Impact*.

12.4.1.Trigger to Impact Time

The Science Behind It

TriggerTo Impact isthe amount of time – measured in milliseconds – elapsed from the start of your forward bat motion to the moment of impact.

SwingTracker measures Trigger To Impact from the instant the player begins accelerating the bat toward

ball, until the precisemoment of impact.

What It Means For Hitters

Alower Trigger To Impact timeresults in a higher Quickness score. Moreover, Trigger To Impact is directly related to a batter's timing. According to Dr. Alan Nathan, "to get the highest home run probability requires swinging witha largerattackangle,keeping in mind that you will fail often if the swing is mis-timed."

What It Means For Coaches

Improving Trigger To Impact time will:

1) Help the batter wait longer to identify the pitch

2) Help the batter determine the location of the pitch

3) Help the batter catchup to, and make contact with faster pitches or make adjustments mid-swing

Real World Similarity

The amountof timeitwouldtake for a car to go from its starting point until its end point. In this instance, the end pointwould represent the bat making contact with the ball.

DK Pro Tip

Abatthatistooheavy may slow Trigger To Impact time and thus not allow one to maximize their swing potential.