

Trigonometrically Successful: Finding the Ideal Launch Angle for MLB Hitters

Starting in 2015, Major League Baseball unveiled their ‘statcast’ ball tracking technology and began reporting the angle at which a baseball leaves the bat. This statistic is colloquially known as the launch angle. It is one of the many new-age statistics in baseball that fans attribute to player success or scapegoat for poor performance. This begs the question: what is the perfect launch angle for hitters to optimize their swing to generate? My hypothesis is a launch angle of 45 degrees: an angle that theoretically maximizes the combination of vertical and horizontal distance leading to more home runs.

Define Success

In order to find the optimal launch angle, we have to define what optimal means. What makes a successful swing? The point of baseball is to score as many runs as you can, so let’s start there. There are 22 possible outcomes from a hitter hitting a baseball such as a groundout, fly out, a home run, etc. Figure 1-1 shows the average launch angle compared with the average number of runs scored for each of the 22 possible batted ball outcomes. There appears to be a quadratic or exponential relationship between launch angle and runs scored where the highest launch angles have significantly higher run output than lower angles. It is unsurprising that the outlier outcome with an average runs scored of 1.6 is the home run. This seems to indicate that our optimal launch angle will be on the higher end relative to the average launch angles of the various outcomes. It is interesting to note that the highest average launch angle of the 22 results is about 30 degrees, 15 degrees less than my hypothesis; an early suggestion that my prediction is not quite accurate.

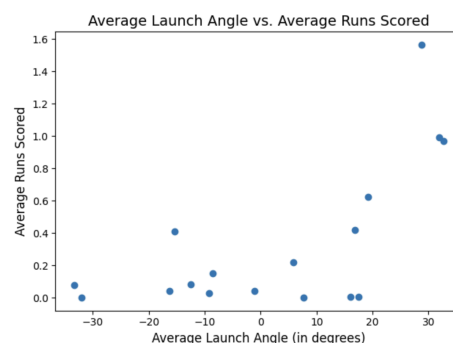


Figure 1-1: Avg launch angle and runs scored for each possible batted ball outcome

Challenge Success

This initial exploration points us in the direction of the optimal launch angle, but we have not reached our destination yet. Our initial definition of success, run production, is also flawed. Run production is circumstantial. You cannot control how many runners are already on the bases when you step up to the plate, and almost no matter what your batted ball result is, you are more likely to score more runs if you have runners on base already. So we must refine our understanding of what it means for an individual batter to have a successful swing and thus a successful launch angle. I used OPS (on-base plus slugging percentage) as my metric to define individualized success. OPS is a fantastic metric that

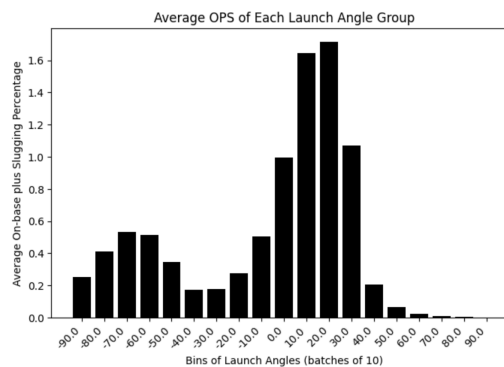


Figure 1-2: Average OPS for each launch angle in groups of 10 (e.g. 0-10, 10-20, etc.)

values the batted ball results in which the batter reaches base while also weighting for more impactful results (i.e. home runs).

Figure 1-2 clusters launch angle into groups of 10 and looks at the average OPS of all batted balls results in the launch angle grouping. This graph passes the sniff test as it largely seems to resemble the shape figure 1-1, but with more nuance. The highest average OPS falls in the range of a 10-30 degree launch angle. Again my hypothesis does not seem to be supported by these results. Nevertheless, let's expand on this visualization to at last unmask our optimal launch angle

Find Success

Figure 1-3 shows the average OPS for each launch angle from -90 to 90 degrees. The launch angle with the highest average OPS is 26 degrees followed closely by 13 degrees. Therefore, I am suggesting that hitters tailor their mechanics and swing path in order to generate a launch angle of 26 degrees.

If I were to investigate these data further, my hypothesis as to why there is a dip in OPS between 13 and 26 degrees is that at 13 degrees these are most likely line drive hits that fall in front of the outfielders for hits. At 26 degrees these are most likely fly balls that go over the heads of the outfielders. 20 degrees seems to result in balls landing at a range that are more catchable for the outfielders and thus results in outs. However, any launch angle in the range of approximately 13 to 26 degrees should yield a high ceiling for success.

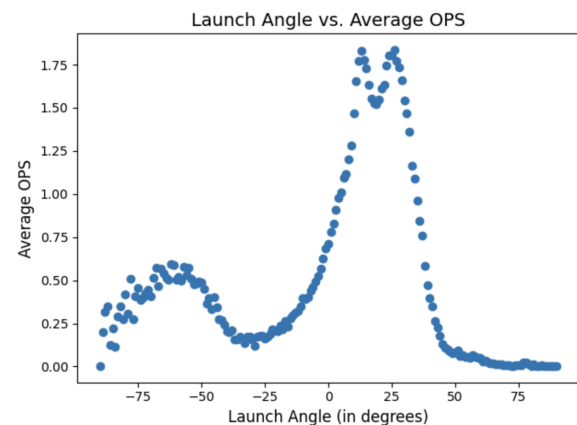


Figure 1-3. Average OPS for each launch angle from -90 to 90 degrees

Success?

At every turn of this analysis, my initial hypothesis that the optimal launch angle is 45 degrees was proven wrong. In fact, a 45 degree launch angle results in one of the lowest average OPS. Upon further research on ball flight, my hypothesis was largely predicated on ball flight in a vacuum, and I did not consider aspects like air resistance. At 45 degrees the ball spends too much of its energy going up instead of going out and thus spends more time in the air, allowing drag to slow it down. My secondary conclusion to this assignment: take some more physics classes.