Point of Contact's Effects on Offensive Variables

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1 Abstract

I explored the relationship between our player's point of contact and variables such as exit velocity. I approached the topic more generally and looked at overall point of contact statistics for the Gauchos. Through the use of Trackman FTP data and local regression models, I was able to discover our player's points of contact which maximized exit velocity. Using these models would allow the coaching staff to discover adjustments which result in our players launching balls with the highest exit velocities, home run rates, and more. The second analysis involved creating a summary table with the Gauchos' point of contact statistics. This table revealed: exit velocity peaks at 5-10 inches in front of the tip of home plate, players begin to pull the ball around 10-20 inches, peak vertical launch angle is at 10-15 inches out, and home run rate is highest when contacting 35-40 inches out. The individual table revealed Tommy Jew and Armani Smith are versatile hitters, Andrew Martinez has the lowest mean point of contact, and Jason Willow has the highest mean point of contact.

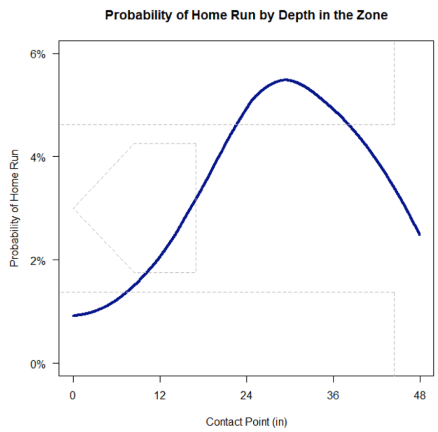
It is hoped this report will help the coaching staff improve players points of contact with the ball, and thus improving the Gauchos overall offensive prowess.

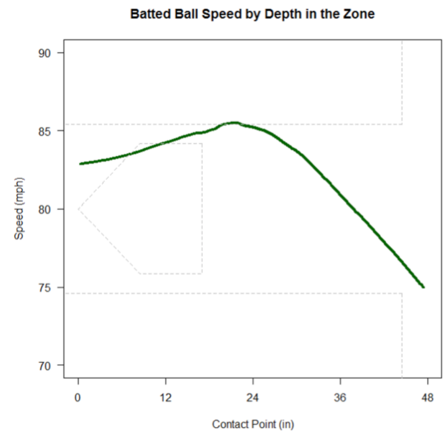
2 Introduction

On April 17th, 2018, Mookie Betts notched his third three-home-run game against the Angels after special batter training the previous day. Betts, in a slump from his previous .897 OPS season, was searching, and unafraid of change. In his search for a new wind, he found success in being more aggressive with his approach, contacting the ball further forward, and as a result, having his upward angling bat make solid contact with the downward angling ball [2].

It is common knowledge hitting out in front is generally better for power hitters. This is because of the tendency to be in the upswing when hitting further out front. While this aligns with conventional hitting philosophy, websites such as Fangraphs and Driveline have shown it is possible to find optimal points of contact through simple analytics tools and sufficient hitting data.

In his analysis on point of contact, Sportvision analyst Graham Goldbeck, found that, in general, batters optimal point of contact for hitting home runs was around 30 inches in front of the tip of home plate, while the optimal point of contact for exit velocity was about 22 inches in front of the tip of home plate [1]. While this analysis gives a general overview into point of contact, every batter differs, requiring personalized analysis to pinpoint optimal contact values. Applying this analysis in the college baseball environment can aid the coaching staff with swing improvements.





3 Questions of Interest

The goal of this analysis is to explore possible optimization of offense potential; the following questions will allow us to approach the issue constructively:

1. Where have our batters contacted the ball in the past, and where can they contact the ball to maximize exit velocity in the future?
2. How does the point of contact affect other variables such as launch angle, exit velocity, home runs, etc.?
3. How does sample size, mean point of contact, and standard deviation for exit velocity batted balls in excess of 90 MPH demonstrate which players are skilled, adaptable, and consistent?

To answer these questions, I am going to plot every player's batted ball exit velocity against point of contact and compare the average point of contact to the optimal value. This will either confirm a player's average point of contact is the optimal point of contact or visualize what changes are necessary to improve the players contact. To answer the second question, I am going to group the point of contact values into 5-inch ranges and look at relationships between certain variables. These relationships will be helpful in demonstrating and improving overall team performance by emphasizing where contacting the ball maximizes exit velocity, home run rate, and other important variables. For the third question, I am going to filter the Gauchos data to only contain batted balls with exit velocities higher than 90 MPH, and calculate mean point of contact, sample size, and standard deviation. The table should be able to demonstrate clear minimums and maximums, showing which of our batters perform best.

4 Data and Methods

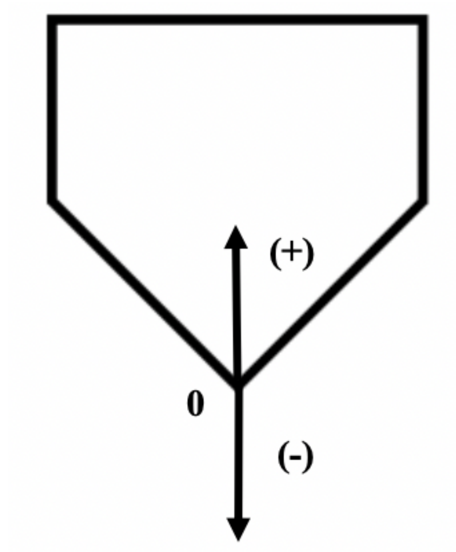
4.1 Data

The data used in the point of contact analysis came from the following Trackman Baseball datasets:

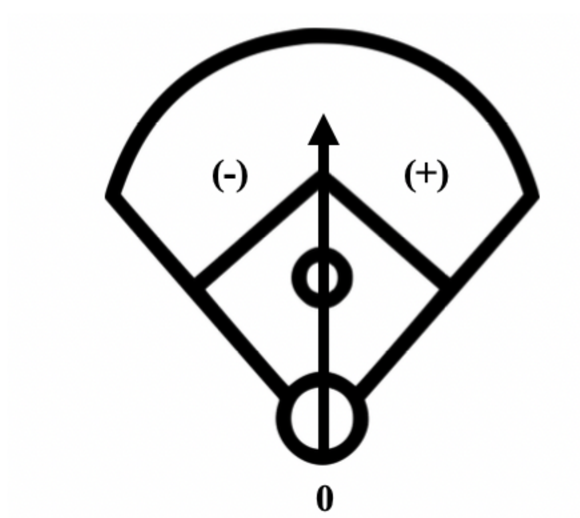
1. Trackman Baseball dataset containing all college baseball games.
2. Trackman Baseball dataset containing UCSB home games from February to late May.

Our relevant variables from the data were the following:

1. Sample: The sample size of each point of contact range.
2. Point of Contact X (POC): The position which the bat contacts the ball on the x-axis, with the tip of home plate being 0. Contact in front of the plate is positive, while contact behind the plate is negative. (Diagram below)



3. Exit Speed (Exit Velocity): The speed of the ball as it comes off the bat at the moment of contact, measured in miles per hour.
4. Pitch Speed: Speed of pitch when the ball leaves the pitchers hand, measured in miles per hour.
5. Horizontal Launch Angle: left-right direction which the ball leaves the bat, measured in degrees. Negative angles represent the ball traveling in the direction of third base, while a positive angle represents the ball traveling in the direction of first base. (Diagram Below)



6. Vertical Launch Angle: How steeply up or down the ball leaves the bat, measured in degrees.
7. Home Runs and Home Run Percentage: Number of home runs and the percentage of home runs, computed as the following:

$$Home\ Run\ \% = \frac{Number\ HR's}{Sample\ Size} \times 100$$

4.2 Methods

4.2.1 Plots

To visualize each player's exit velocity and point of contact, I used scatterplots through the ggplot2 package.

4.2.2 Inferential Methods

The two main inferential methods used in the analysis were simple linear regression (SLR) and local regression models (LOESS). Both of these methods were used in the analysis of exit velocity against point of contact. I used the package ggplot2 to create visualizations of these models.

1. When using LOESS, I used a smoothing parameter of $\alpha = 1$ for all player plots. The smoothing parameter gives the proportion of points in the plot which influence the smooth at each curve. This means 100% of the points in the plot influenced the smooth at each curve.
2. The LOESS curve is in blue, meanwhile the SLR line is in red.

5 Analysis

5.1 Point of Contact and Exit Velocity Analysis

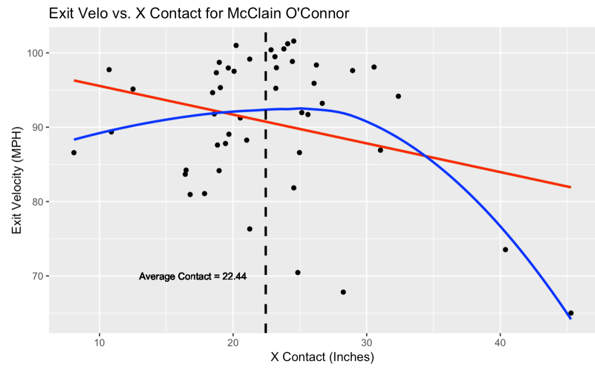
5.1.1 Assumptions

The data used in the analysis of exit velocity and point of contact was filtered with the following criteria:

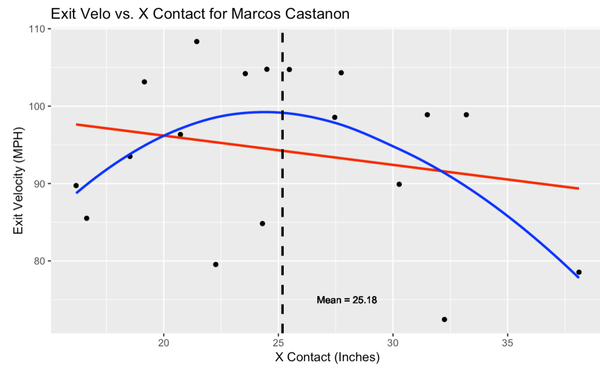
- All bunts or foul balls removed.
- Exit velocity must be higher than 65 MPH.
- Point of contact must be greater than 0.

These decisions were made to remove any outliers and balls which were 'poorly hit'. I assumed 'poorly hit' balls had very poor contact or were improperly tracked.

5.1.2 Analysis



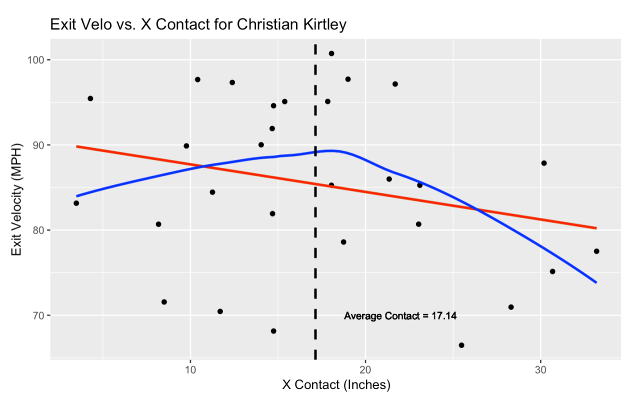
(a) McClain O'Connor



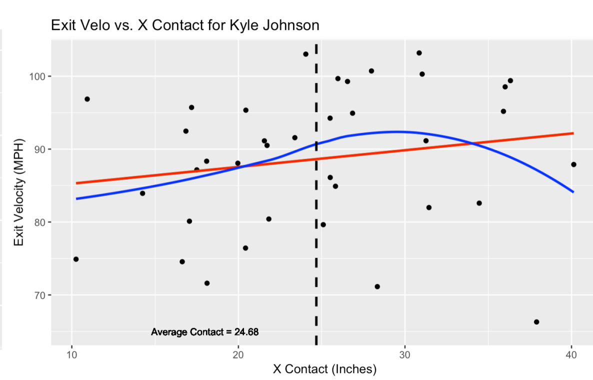
(b) Marcos Castanon

(a) McClain O'Connor makes contact 22.44 inches in front of the tip of home plate on average. The regression curve shows the peak exit velocity being around 28 inches. The maximum is slightly further out front of his average because at a point of contact of 28 inches he launches more balls with a higher exit velocity and less balls with lower exit velocities. This shifts the predicted maximum to be further ahead in point of contact then what may be true. More data points would fix this issue. O'Connor's point of contact variance is very low, with most of his contact being within the 15-27.5 inch range. Another important note is while O'Connor has a few high exit velocities further back, it is possible there is a higher whiff rate around 7.5-12.5 inches out in front of the plate. Since Trackman does not track the location where a strike is swung, it is difficult to tell. The addition of bat tracking would allow us to see the whiff rate at different locations. Pairing the lack of data points and low variance could signal O'Connor can hit consistently in the 15-27.5 inch range, but when he hits outside of this range he has a high strike rate.

(b) Castanon's average point of contact is 25.18 inches in front of the tip of home plate. The point of contact which maximizes exit velocity is around 23 inches in front of the tip of home plate. There is not much data for Castanon, meaning the results are not conclusive as they are not strongly backed with data.



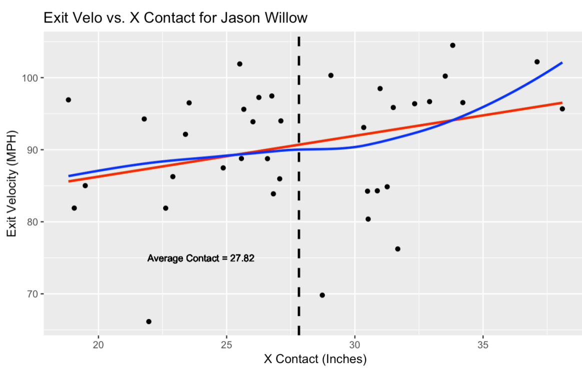
(c) Christian Kirtley



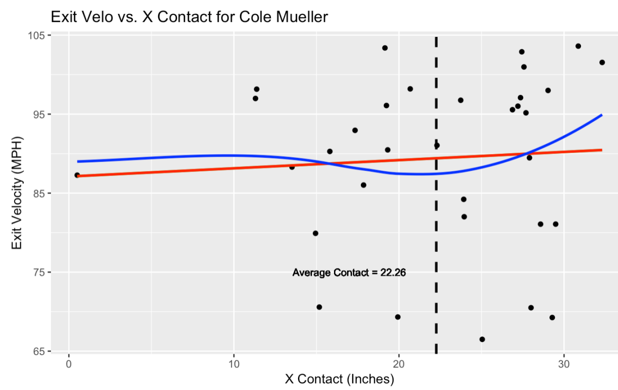
(d) Kyle Johnson

(c) Christian Kirtley's average point of contact is 17.14 inches, while his predicted maximum is 18 inches. Making a small adjustment would be difficult, and most likely negligible. Despite this, hitting further up has the potential to increase exit velocity slightly. While there is a high exit velocity at 5 inches out, the sample size in this range is small. There is no point of contact data for at bats where no contact is made, so the absence of data points could mean Kirtley is whiffing more often when he hits far back.

(d) Kyle Johnson's average point of contact is 24.68 inches and there is a slightly positive linear relationship between exit velocity and point of contact. There is unequal variance, suggesting as Johnson hits further out, his hits become less consistent. When he hits further back, the grouping of his hits is smaller. Both of Johnson and Kirtley do not have much data, which can influence the regression and results.



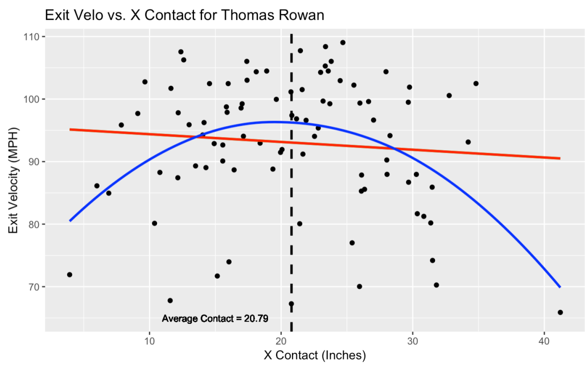
(e) Jason Willow



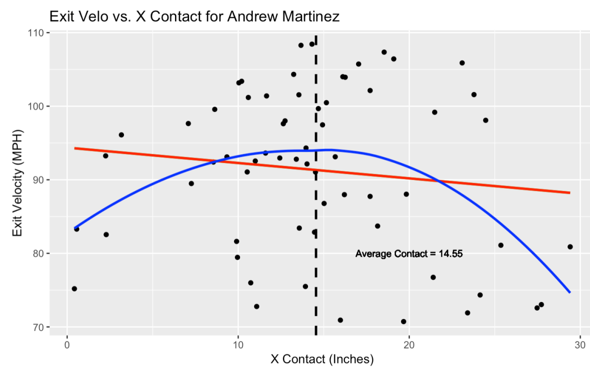
(f) Cole Mueller

(e) Jason Willow's average contact is at 27.82 inches and the local regression shows no predicted maximum value. When Willow hits further out, the average exit velocity and variance increases. The 30-35 inch point of contact range has a greater percentage of high-exit-velocity hits, meaning he is hitting well. Despite this, there is a clustering of low-exit-velocity hits around 75-85 MPH. If Willow made contact 5-10 inches further out than his average, the data shows he could improve the exit velocity of his hits at the cost of inconsistency. While the trend for exit velocity increases for Willow, trackman does not track point of contact for strikes, so it is possible the whiff rate is higher when Willow hits 40 inches out. Additionally, his exit velocities are fairly low, so hitting farther out could be detrimental since it would likely increase fly ball rate which is costly at lower exit velocities. Willow's sample size is small, so it is difficult to make conclusive answers about his point of contact patterns.

(f) Cole Mueller's average point of contact is at 22.26 inches in front of the tip of home plate and has no predicted maximum value. Mueller has constant variance across all his points but lacks any useful information because of a small sample size.



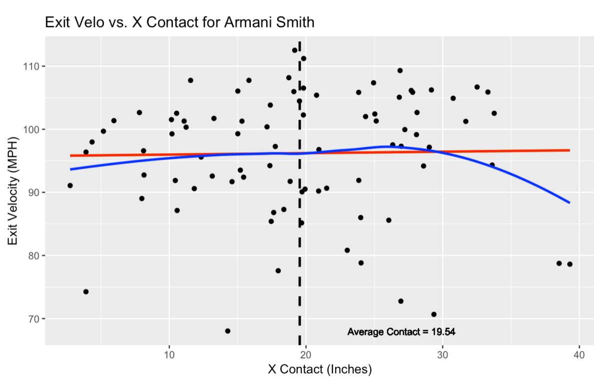
(g) Thomas Rowan



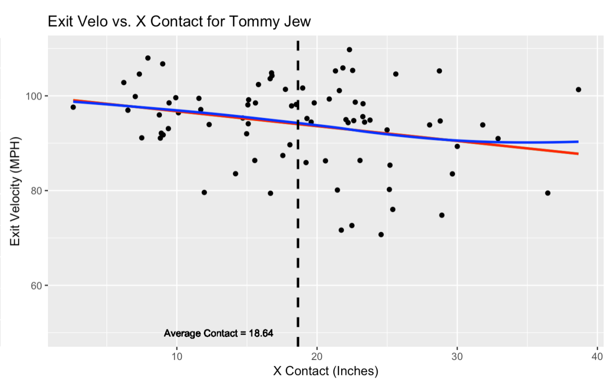
(h) Andrew Martinez

(g) Rowan's average point of contact is about 20.79 inches in front of the tip of the plate, meanwhile, the maximum value of the LOESS regression is around 20 inches. According to the local regression, his average contact is at the point of contact which maximizes his exit velocity. While this may be true, the scatter plot reveals he has an equal spread around the average. The scatter plot and regression show that while Rowan can maximize his exit velocity by hitting 20 inches out, he can still consistently hit outside this range. In the 25-35 inch point of contact range, there is a cluster of points with low exit velocities, suggesting he hits softer when he is hitting in front of his average. This clustering of points also suggests Rowan's hitting is less consistent when he hits ahead of his average point of contact.

(h) Andrew Martinez has a similarly shaped curve to Rowan. Martinez's average is at 14.55 inches and his exit velocity is maximized at approximately 15 inches. Again, this suggests Martinez is making optimum contact on average. While Martinez's data is not dense, there is a tighter clustering of points around the average. This suggests he hits well when he is hitting at his average but is inconsistent when he hits outside of the 10-20 inch range.



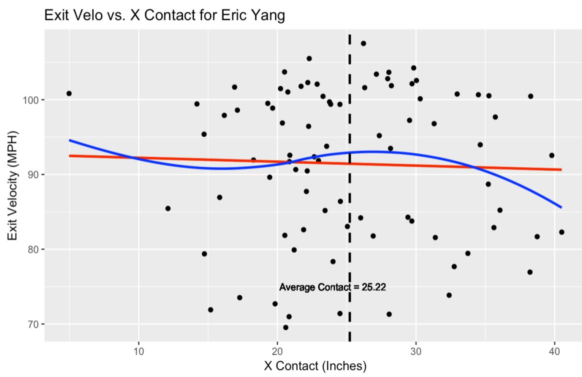
(i) Armani Smith



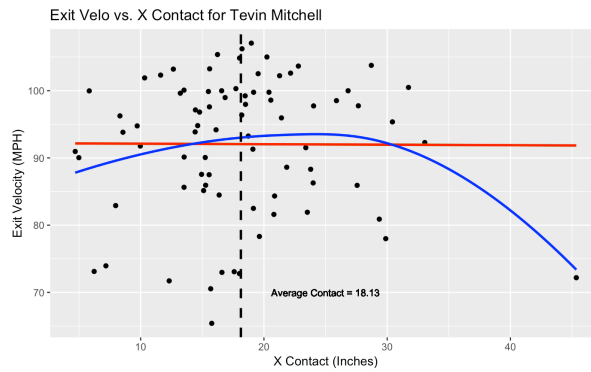
(j) Tommy Jew

(i) Armani Smith's average point of contact is 19.54 inches out in front. There is no clear point of contact which maximizes his exit velocity. This points to Smith being effective at hitting a ball hard from any point of contact. From 0-35 inches out in front, the majority of Smith's batted balls exit with a velocity above 90 miles per hour. There is not constant variance in the exit velocity of batted balls as Smith hits further out, suggesting he hits more consistently when he hits further back.

(j) Tommy Jew's average point of contact is at 18.64 inches in front of the tip of home plate. While there is no clear point of contact which optimizes exit velocity, hitting further out causes the variance to increase and average exit velocity to decrease. This suggests Jew is more consistent when he hits from 0-18 inches out and less consistent when he hits above his average.



(k) Eric Yang



(l) Tevin Mitchell

(k) Eric Yang's average point of contact is 25.22 inches. Yang has constant variance with exit velocity, suggesting there is not a clear optimal point of contact. Observing the scatter of the data reveals there is a possible maximum at 25 inches because the two highest exit velocities are near 25 inches. Despite this, the variance in Yang's exit velocity suggests his at bats can be inconsistent, with most of his exit velocities varying by 35 MPH.

(l) Tevin Mitchell's average point of contact is 18.13 inches, and the curve suggests a possible maximum of 25 inches out in front. The predicted maximum does not seem to yield higher exit velocities, but it does yield higher chances of hitting harder. An important note is the outlier at 45 inches in front; this point appears to be influential to the local regression. More data is needed to make a conclusive answer. Despite this, if Mitchell hit 3-4 inches up from his average, there is a possibility he could hit balls harder with more consistency.

5.2 Overall Point of Contact Analysis

5.2.1 Assumptions

The data used for the Gauchos table contains only UCSB home games and excludes away teams. All foul balls and bunts were removed so only well-hit balls were used. I assumed any data point hit in excess of 40 inches from the tip of home plate was an outlier, and as a result, removed these points. There were only 3 overall observations for UCSB left hand hitters, making any changes to the data negligible. For this reason, the table was not separated into RHHs and LHHs, but is representative of RHHs overall. The individual hitting table contains all batted balls with exit velocities above 90 MPH. Using this subset of the data narrows our analyses to covering only well-hit balls.

5.2.2 Analysis

5.2.2.1 UCSB Gauchos Table

Range	Sample	Exit Velo	Pitch Speed	Horz Launch Angle	Vert Launch Angle	# HR's	HR %
(0,5]	17	88.6664	86.84578	19.60322	3.590728	0	0
(5,10]	44	92.95866	85.52918	13.08868	12.83232	1	2.272727
(10,15]	99	92.5432	84.17178	1.361812	18.73381	1	1.010101
(15,20]	163	92.70366	84.72956	-4.04865	17.48046	8	4.907975
(20,25]	152	92.87854	84.09476	-14.2253	16.60445	10	6.578947
(25,30]	119	91.33384	82.03153	-16.7268	17.70352	10	8.403361
(30,35]	62	91.59348	80.88932	-20.1513	15.19704	6	9.677419
(35,40]	21	89.54872	81.77728	-24.733	13.55094	3	14.28571

For home games, the exit velocity peaks when our players hit 5-10 inches in front of the tip of home plate. While the peak occurs at 5-10 inches, the exit velocity is nearly constant for 5-25 inches out in front, only differing by half a mile per hour. The sample for the 5-10 inch range is small, so the average can be heavily affected by outliers, causing a false maximum. Our players push the ball until around 10-20 inches in front and, for 20+ inches, pull the ball. The vertical launch angle increases until 10-15 inches out in front, where it peaks, meaning more fly balls. When our players hit more than 15 inches out in front, the vertical launch angle decreases. The number of home runs peaks at 20-30 inches in front of the plate, while the home run percentage is highest when contacting 35-40 inches out.

5.2.2.2 Individual Hitting Table (Exit Velocity Greater Than 90 MPH)

5.2.2.2.1 Important Notes on Terminology

Standard deviation is the dispersion in the data relative to the mean. It is important to look at the standard deviation of our players batted balls with exit velocities above 90 MPH because it shows a player can hit hard at many different points of contact. If a player has a low standard deviation, then the player can hit hard at only a small range of contact. On the other hand, if a player has a high standard deviation, then the player can hit hard at many different points of contacts, demonstrating versatility.

5.2.2.2.2 Analysis

Batter	Sample	Mean x Contact (in.)	Standard Deviation (in.)
Castanon, Marcos	11	24.84335	4.819793
Jew, Tommy	58	17.34536	7.679416
Johnson, Kyle	19	25.8111	6.890069
Kirtley, Christian	11	14.77435	4.706183
Martinez, Andrew	38	13.7143	4.906176
Mitchell, Tevin	52	17.65629	6.490562
Mueller, Cole	19	22.97979	6.252732
O'Connor, McClain	28	22.48364	4.759198
Rowan, Thomas	58	20.42178	6.21299
Smith, Armani	68	19.15057	8.132865
Willow, Jason	21	28.98936	5.111628
Yang, Eric	50	24.71001	6.69659

Looking at summary statistics individually demonstrates Andrew Martinez has the lowest mean point of contact, meanwhile Jason Willow has the highest. Smith has the largest sample and standard deviation for hits above 90 MPH. The large sample demonstrates Smith hits the ball hard very consistently and the high standard deviation shows he can hit the ball hard at many different points of contact. Tommy Jew is another example of a high point of contact standard deviation, suggesting he is able to launch balls with high exit velocities at multiple points of contact. Castanon and Kirtley both have small sample sizes, suggesting their mean and standard deviations may be different from their true values.

5.2.2.3 RHH All Colleges FTP Data

Range	Sample	Exit Velo	Pitch Speed	Horz Launch Angle	Vert Launch Angle	# HR's	HR %
(0,5]	876	84.62776	87.4087	16.18894	2.417323	6	0.684932
(5,10]	2166	86.56329	87.02401	9.720815	8.28553	31	1.43121
(10,15]	3826	87.42518	86.30991	2.445303	11.04882	83	2.169368
(15,20]	4846	88.59222	85.76906	-3.10953	13.58398	127	2.620718
(20,25]	4749	88.67089	84.50912	-9.41987	13.79901	178	3.748158
(25,30]	3467	88.16921	83.27923	-13.6009	12.93288	199	5.739833
(30,35]	1985	86.71417	82.1735	-15.914	12.84905	123	6.196474
(35,40]	963	84.11963	80.93163	-16.7638	9.93299	49	5.088266
(40,45]	425	80.45326	79.84278	-13.8903	9.82808	25	5.882353

The RHH table has exit velocity peaking at 15-25 inches. This value is higher than the Gauchos peak exit velocity at 5-10 inches. While our peak is at 5-10 inches, the difference between the peak exit velocity at 5-10 inches and the next peak at 20-25 inches is only .08 MPH. This suggests our data may be in line with that of all the other colleges. The horizontal launch angle has players pushing the ball until 10-15 inches and then pulling the ball for 15+ inches in front. This further aligns with the Gauchos data. The number of home runs peaks at 25-30 inches, while home run rate peaks at 30-35 inches in front of the tip of home plate.

5.2.2.4 LHH All Colleges FTP Data

Range	Sample	Exit Velo	Pitch Speed	Horz Launch Angle	Vert Launch Angle	# HR's	HR %
(0,5]	599	86.10684	87.56182	-14.9046	2.824626	3	0.500835
(5,10]	1475	87.28976	87.2501	-8.69151	7.63078	24	1.627119
(10,15]	2463	88.25485	86.68947	-1.91834	10.65848	42	1.705238
(15,20]	3000	89.43096	85.69297	5.012899	11.42928	91	3.033333
(20,25]	2710	89.54534	84.8358	10.38984	12.13156	138	5.092251
(25,30]	1991	88.73577	84.05154	14.00028	13.08474	113	5.67554
(30,35]	1203	87.55867	82.54502	16.32107	13.15718	76	6.31754
(35,40]	571	84.48686	81.95755	17.28424	10.29885	37	6.47986
(40,45]	236	79.876	79.98109	19.79805	6.117983	11	4.661017

The LHH table contains the peak exit velocity at 15-25 inches in front of the tip of home plate, similar to the RHH table. LHHs push the ball from 0-15 inches out in front and start pulling the ball 15+ inches out, keeping in mind pulling for LHHs means hitting towards first base. This aligns with conventional hitting philosophy. The number of home runs peaks at 20-25 inches, while the home run rate is highest at 35-40 inches out in front. Note, these maximums are only slightly ahead of the surrounding contact ranges, suggesting other possible maximums or a maximum lying between two ranges.

6 Conclusion

Plotting every player's exit velocity against point of contact proved it is possible to optimize a player's point of contact. While local regression worked well for players such as Thomas Rowan, Andrew Martinez, and Tevin Mitchell, the models were not as conclusive for players with small data samples such as Christian Kirtley and Cole Mueller. This occurred because local regression requires large data sets in order to produce good models. With sufficient data, either through tracking practices or away games, point of contact analysis would be a useful tool in swing and hitting training. Another valuable resource for finding optimal points of contact would be the use of bat tracking data. This data would allow us to see where players swing and strike the most. Strike point of contact data would be useful in allowing us to be conclusive about a player's consistency at different points of contact. If a player hits balls hardest at a certain point of contact, but they also strike out the most at this range, it may be better to have a player hit outside of this range.

Overall statistics for the team demonstrate where the team can maximize certain variables. The table shows other possible areas of analysis such as launch angles and home run rates. The Gauchos maximize exit velocity when contacting the ball 5-10 and 20-25 inches out, meanwhile horizontal launch angle changes from positive to negative at 10-20 inches out in front. The home run rate peaks at 35-40 inches from the tip of home plate. Taking a more specific look at individual statistics showed Armani Smith and Tommy Jew are versatile hitters and demonstrated which players had the maximum and minimum average point of contacts.

Both of these analyses can be valuable resources to help players succeed in hitting. If more data is collected, the models will be more accurate to a player's hitting patterns and allow for more concrete conclusions.

6.1 Summary Table

Topic	Summary
Player Exit Velocity vs. POC	With enough data, it is possible to see a player's point of contact which optimizes exit velocity by using local regression. This allows players and staff to make necessary adjustments to improve player hitting performance. The addition of practice, away game, and bat tracking data would allow larger sample sizes and strike POC data, leading to better and more precise models for our players.
UCSB Team Table	Team Optimal POC for: 1. Exit Velocity: 5-10 inches 2. Horizontal Launch Angle: Pulling ball for 0-20 inches out, pushing ball for 20+ inches. 3. Vertical Launch Angle: Increases until 10-15 inches in front, decreases for 15+ inches out.

	4. Home Run Rate: 35-40 inches out. 5. Number Home Runs: 20-30 inches out. ***Note:** As shown by the exit velo. vs. POC Analysis, every player is different, but the overall statistics are a good starting point for player improvement.
UCSB Individual Table	Our player's individual statistics show: 1. Standard Deviation: Players with highest POC deviation at exit velos. greater than 90 MPH. Shows which players are most versatile. 2. Sample Size: Demonstrates high-exit-velocity frequency on balls in play. 3. Mean Contact: Shows where, on average, players hit balls the hardest. ***Note:** Similar to the overall table, the individual tables statistics can omit important information, but these statistics can be useful in beginning player improvement.

References

[1] Sarris, Eno. *Power Hitters Should Make Contact Out in Front.* https://blogs.fangraphs.com/power-hitters-should-make-contact-out-in-front/. Fan Graphs. August 24, 2017.

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