BASEBALL BAT SCIENCE EXPERIMENT

Wood or Aluminum?

Abstract

So baseball's your game? Well, slugger, science and math abound in baseball. Just look at the zillions of "stats." In this project, you can produce some interesting baseball statistics of your own and perhaps settle a long-standing debate. You'll set up experiments at your local playing field to find out which type of bat is better, wood or aluminum. Play ball, and batter up!

Summary

AREAS OF SCIENCE

Sports Science

Objective

The goal of this project is to compare the hitting power and "sweet spots" of wood versus aluminum baseball bats.

Introduction

Baseball may be the all-American game, but it's not without its controversy. Players and fans alike hotly debate massive volumes of statistics and data. They compare and discuss players' batting averages, runs batted in, and slugging percentage, along with pitchers' allowed hits and runs, strikeouts, and innings pitched. They argue over the importance of ball park locations, weather, altitude, and left-handed pitchers. One of baseball's long-standing disputes revolves around the question of which type of bat, wood or aluminum, is better for whacking a long one out of the park.

In this project, you'll take the scientific approach to answer this question. You'll set up an experiment to measure and compare the average hitting distances of a wood and an aluminum bat. You'll also investigate how each type of bat affects the "feel" of a hit, and whether that has any correlation to how far the ball flies after it leaves the bat.

Several factors come into play when comparing wood bats to aluminum bats. Aluminum bats are hollow, except near the handle end, so they tend to be lighter and swing faster than a solid wood bat of the same length. The aluminum also tends to "give" a little more than a wood bat when it comes in contact with the ball. This contributes to the different "feel" of a hit between the two types of bats. The greater elasticity of an aluminum bat also means there is a slight "trampoline effect" from its surface so that the ball rebounds differently than it does after it leaves the more rigid surface of a wood bat. Each of these characteristics has been carefully studied by bat manufacturers and baseball physics researchers. In this project, you'll read about or investigate how differences in bat composition, balance, feel, and swing can contribute to the speed and travel distance of a batted ball.

Most seasoned ball players associate solid, long hits with connecting with the ball right on a bat's so-called "sweet spot." Scientific studies have shown that several such points exist near the wide end of the bat. Their exact locations vary with the type of bat, how the bat is held, and the criteria used to define the spot. There are separate and sometimes overlapping sweet spots associated with longer hits, decreased bat vibration, and less bat movement in the hands of a batter after a hit. For these reasons, some scientists now prefer to describe a general region between four and seven inches from the end of the bat as a "sweet zone" rather than use the term "sweet spot." They define the sweet zone as the area of a bat that produces the most powerful hit with the least amount of "sting" or discomfort to the batter. In your experiments, you will mark the "sweet zone" on the end of each of your bats and see if hits from this region actually produce the longest line drives and feel the best to the batter.

What causes a bat to "bite back" or sting a batter's hands during one hit and not during another? Again, there's been interesting research into the physics of bats, balls, and the energetic outcome that results when the bat and ball each rebound after impact. Basically, it's a matter of vibration and location. In general, the bat tends to vibrate more along its length if the ball hits it outside the sweet zone on the bat. The vibrations continue to reverberate along the bat's length down through the handle—and sometimes painfully—to the batter's hands and arms. Bat vibrations can also mean less energy is transferred back into the ball after a hit explaining, at least in part, why the ball travels less when a batter has a hit that stings.

To come up with equally good explanations for the results from your batting experiments, first gather some background on the science of bats, balls, hits, and swings. A list of search terms and questions is included in the next section as a guide.

Now do your research, gather up your gear, then head out to the park to let those line drives fly. Batter up, and may the best bat win!

Terms and Concepts

To do this project, you should do research that enables you to understand the following terms and concepts:

- Physics of baseball
- Baseball bat-ball collisions
- Sweet spot of a baseball bat
- Sting from a bat

Questions

- What factors contribute to a long hit in baseball?
- What and where are the multiple "sweet spots" on a baseball bat?
- What causes a "sting" sensation when you hit a baseball?
- How are aluminum bats different from wood bats in how they interact with a baseball?
- Which type of bat hits a baseball farther?

Materials and Equipment

To do this experiment you will need the following materials and equipment:

- Playing field
- Baseball bats: one wood, another aluminum of equal length
- Baseballs: at least three of the exact same size and type
- Baseball tee
- Long tape measure or electronic measuring device (if not metric, then convert feet to meters)
- Stakes or colored flags to mark where baseballs land
- Powered chalk
- Blue painter's tape (3/4" wide)
- Notebook or paper
- Pen or pencil
- One "slugger" to hit the balls
- One outfield assistant

Experimental Procedure

Arrange with your assistant the day and time to meet at the ball park.

Prepare two "Record of Hits" data tables similar to the example below. Use one to record the data from the wood bat and the other to record the data from the aluminum bat.

The goal is to collect data from at least 30 good hits from each bat, ideally including at least 10 hits from above the sweet zone, 10 hits from within, and 10 hits from below the sweet zone. You should alternate between the wood and aluminum bats every five hits. Line drives down the middle are best, but you can include hits off to either side as long as they are not foul balls.

Wrap two pieces of tape around the bat to mark the outer margins of the sweet zone on each bat (an area between 4–7 inches from the end).

Set up the baseball tee at home plate, and take a few practice swings to warm up.

When you are ready to start collecting data, roll the baseball in powdered chalk before each hit so you'll be able to tell where the ball connects with the bat. Right after each hit, record whether the ball hit above, within, or below the sweet zone on the bat.

Following each hit, also note the "feel" of the hit by rating the amount of vibration or "sting" felt. Use a simple numerical system, i.e. 0 = no discomfort or vibration; 1 = very low; 2 = low; 3 = medium; 4 = medium high; 5 = very high level of discomfort.

For each hit, the out-field assistant should mark where the ball lands with a stake or flag. Measure and record the distance in meters of each hit before the batter takes the next swing off the tee.

Some hints to keep your data consistent:

- The same person should hit all balls.
- Don't do 30 hits in a row with one type of bat. Alternating between the wood and aluminum bats after every five hits gives a fairer comparison, especially when fatigue could be a factor toward the end of the experiment.
- If the batter starts getting tired, he/she should rest a few minutes between switching bats.
- If getting at least 30 good hits, especially line drives down the middle or 10 hits in each of the three areas of the bat, is too challenging for one

day, you can split the experiment between two or more days, but the weather conditions should be similar.

The more hits you have from each area of the bat, the better your statistics will be when analyzing your data. So, 30 total good hits is a minimum; 60 total hits or more would be even better.

Record of Hits	
Type of Bat:	Date:
Batter:	Field Location:

"Good" Hit No.	Distance (meters)	"Sting" Rating (0-5)	"Sweet Zone" Location		
			Above	Within	Below
1					
2					
...cont. to 29					
30					

Analyzing Your Data

Total the distances of the hits for those above, within, and below the sweet zone for each bat. Calculate the average hit distances (in meters) for each category.

Prepare a bar chart of the data for the three sweet zone categories showing the average hit distance from the wood bat and aluminum bat next to each other.

What are the differences in average hitting distance between the two bats? Is one bat consistently better than the other for the three sweet zone categories?

How much difference in distance is there between hits that were in the sweet zone and hits that were out of (above and below) the sweet zone?

Total the numbers of the "sting" rating for the hits above, within, and below the sweet zone of each bat. Calculate an average "sting" rating for each bat in each three sweet zone categories.

Prepare a second bar chart of this data showing the average sting rating of the wood and aluminum bats side by side for each of the sweet zone categories.

Are there any differences in the average sting ratings between the three sweet zone categories? Do the ratings correlate to what you would expect for hits in and out of the sweet zone?

Looking back at your original Record of Hits data table, how many of the hits that felt good (had a low rating on "sting" level) were associated with a long distance? How many of the hits that stung were associated with a long distance?

On the other hand, how many of the hits that felt good (had a low rating on the "sting" level) were associated with short distance? How many of the hits that stung were associated with a short distance?

Do you see any consistencies with the "feel" of a hit and the distance the ball traveled?