CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
J0235

Project Title
The Sweet Zone of a Ball-Bat Collision

Abstract

Objectives/Goals
Recent research on baseball bats by Robert Adair, Rod Cross and Daniel Russell has shown what happens when the bat hits a ball, and why there are some locations on the barrel that result in less vibration for the batter. The goal of my project is to understand where on the barrel of a baseball bat will cause the least vibration when hitting a ball. Is there a single "sweet spot" or a larger "sweet zone" where the vibration is the least?

Methods/Materials
I began by building a model of a freely supported bat holder. Dr. Daniel Russell from Kettering University advised me how to use SpectraPLUS Software to find the frequency of the first three bending modes and the location of the barrel nodes of the first three bending modes for each bat being tested. With some expert help I adjusted the settings on the software to display a graph of amplitude (vibration) vs. frequency. Using this set-up, I tested three bats two times each. First I hit each bat on the tapered end using a plastic handle and found the frequency of the first, second and third bending modes, and the strength of vibration (decibels) for each mode. Then I hit each bat every 1/2" across the barrel, labeling the node as the place on the bat where the vibration for each mode was the least.

Results
(1) The location of the nodes of the first and second bending modes were the same for both trials for all three bats. The location of the node for the third bending mode was the same for two bats, and 1/2" different for the third bat; (2) Subtracting the amplitude at the node for each bending mode from the original amplitude calculated the vibration loss at the node. The node of the first bending mode had the largest effect on reducing the overall vibration. The node of the second bending mode had the second largest effect on reducing the overall vibration. The node of the third bending mode had the least effect on reducing the overall vibration.

Conclusions/Discussion
My hypothesis was that every bat I tested would have a certain area on the barrel of the bat where the vibrations were the least when hit by a ball. This area would be the "sweet zone" of the baseball bat. My results show that hitting a bat between the nodes of the first and second bending modes causes the least vibration. My conclusion is that the "sweet zone" of a baseball bat is between the nodes of the first and second bending modes. This proves that my hypothesis is correct.

Summary Statement
My project uses an accelerometer and vibrational analysis software to determine where a baseball bat hitting a baseball would result in the least vibration; a single "sweet spot" or a larger "sweet zone?"

Help Received
Greg Hildebrand gave me advice on using an accelerometer; Dr. Daniel Russell, Kettering University, advised me on how to test baseball bats using an accelerometer; Will Bagnall and Talitha Stimson helped to install the SpectraPLUS Software; My father helped build the freely supported bat holder.