Vibrating Bats

What is this about?

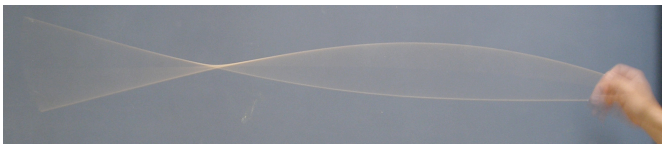
Have you ever hit a ball off the end of the bat and felt the "hand full of bumble bees?" When a bat hits the ball, the bat can start to vibrate. When this happens energy that could go into making the ball go further is used to make the bat vibrate. Part of designing a good bat is to be sure that the part of the bat that is likely to hit the ball should result in as little vibration in the bat as possible. You'll investigate the nature of these vibrations.

What do I need?

The only thing you need is a $1/8^{th}$ inch wooden dowel.

What will I be doing?

Every object has a set of natural vibrational frequencies. That is how most musical instruments work, for example. You will excite the lowest natural vibrational frequencies of the dowel, by shaking it at one end. In the picture you can notice a spot on the dowel that isn't moving. This spot is called a "vibrational node," or "VN".



What to do and notice

1. Hold the dowel at one end and gently shake it at a low frequency. Adjust the frequency until the entire dowel oscillates up and down. This is called the "fundamental frequency."
2. Shake it at a higher frequency until it looks like the picture above. This is called the "first overtone."

Write a description of your results. Draw a sketch of the oscillating dowel in each natural frequency. Label the spot that doesn't move very much with VN.

What did I learn?

All objects, including bats, have a set of natural vibrational frequencies. For each frequency there are nodes where the vibrating object doesn't move. While the vibrational motion of a bat in your hands is a bit different that the vibration of the stick the importance of the VN to hitting the ball can still be understood. If the bat is designed so that the ball is likely to hit a node, then none of the energy of the collision will go into vibration in the bat. The result is that there will be more energy available for the ball to go further. A well-designed bat should have the VN near the CP further reducing the energy absorbed by the bat. This region on the bat where both the VN and CP reside is called the "sweet spot" of the bat.

What else should I think about?

Have you ever noticed that a wood bat has a different sound than an aluminum bat. This is because the natural frequencies of the bats are very different. The aluminum bat has higher natural frequencies than the wooden bat. That is why the aluminum bat makes more of a "ping" sound when it hits the ball.

Catch it in the Web!

- Major League Physics – Dr. Baseball – The Sweet Spot of a Baseball Bat
  (http://phys.csuchico.edu/baseball/DrBaseball/SweetSpot/)
  This humorous video illustrates how bats bend and vibrate.

- Acoustics Animations by Dan Russell
  (http://www.acs.psu.edu/drussell/bats/batvibes.html)
  This site has lots of nice animations of vibrating bats as well as the "hoop modes" of aluminum bats.

- Richard Ehrgott has this cool animation of the vibration of a wood bat.
  (http://www.csun.edu/~ehrgott/wood.gif)

- VSI Baseball with Coach Preston Peavy.
  (http://www.peavynet.com/ballbatcoll.htm)
  This page has some wonderful vidoes of the vibrations caused by real world ball-bat collisions.