Maple Bats Changed the Game

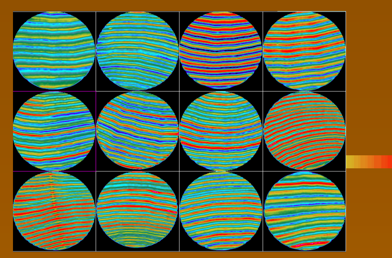
A comparative study on the composition of ash and maple wood bats

By Dr. Avrami S. Grader, Dr. Phillip M. Halleck, Penn State Center for Quantitative X-ray Imaging, and David Zavagno, Universal Medical Systems, Inc.

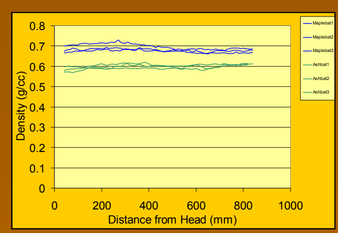
<u>Background</u>: Maple Bats have largely replaced ash bats in recent years. **What has been the effect on the game?** Lab tests suggest there is no difference in bat performance. Game results and players believe otherwise. A recent rash of "exploding" maple bats have led to calls for banning them? Why do players like them so much?Why do they appear to break more violently? We used quantitative X-ray Cat Scan (CT) to find out.

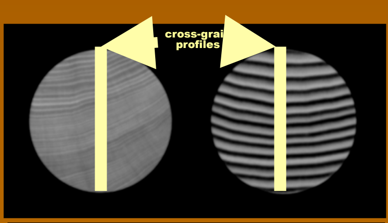
<u>How does X-ray CT work</u>? In a one-material object, X-rays absorption depends on density. A computed tomography (or CT) image is thus a three-dimensional map of the internal density of an object displayed as a "slice". In this case, we used it to measure the grain density and orientation of ash and maple bats. Here's what we found:

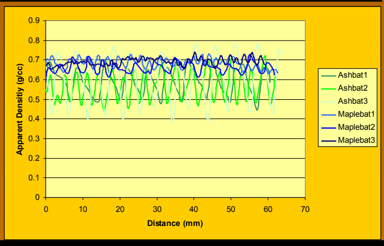
<u>Grain Density and Orientation</u> vary greatly from Bat to Bat. We scanned ten MLB ash bats, each with trademark up. Grain curvature, spacing and orientation are very different. Orientation of impact with the grain thus also varies. Since stiffness of wood depends on grain orientation, flex of the bat and perhaps COR will too. The scale is from 0.5 g/cc on (blue) to 0.7 g/cc (red)



<u>Maple is denser than ash.</u> CT data can be interpreted directly in density units. Three maple bats were 10 – 15% denser than three corresponding ash bats. We found little variation along the length of the bats. For a given bat length and weight, the maple bats are thus slightly smaller in barrel diameter.







<u>Maple grain structure is more uniform than ash</u>, likely affecting several important mechanical properties. Profiles of CT data taken across the grain shows that the high density bands in ash and maple are nearly the same, but the intervening wood is much lower density in ash than in maple.

<u>Recommendations</u>:

1. Inspect bats to find structure problems and fatigue with X-ray CT. Note low-density hidden layer curving through handle in maple bat at right.
2. Instrumented batting tests to determine handle flex and barrel speed while batting

<u>Properties that affect bat performance</u>:

- Compressive Modulus: Affects COR between ball and bat. Denser wood likely has higher modulus. Low-velocity testing has shown no difference in COR, but neither wood nor ball are linearly elastic. Laboratory tests do not replicate playing conditions.
- Bending Modulus: Affects barrel speed through hitting zone through "whipping" action. Optimum modulus depends on batter strength and mechanics. Modulus is different parallel and perpendicular to grain. Maple and ash grain structures clearly result in different bending modulii.
- Strength: Bat life depends on ability to resist fracture. Fractures initiate by tensile failure at point of maximum flexure in the handle and grow along grain toward the barrel. Cumulative fatigue failure after many uses is likely a contributor. Denser, more uniform wood grain likely contributes to longer bat life.
- Fracture Toughness: Once initiated, crack growth is controlled by fracture toughness, a measure of "brittleness". Low-density (presumably softer) layers in ash can absorb energy without contributing to crack growth, making it tougher to create violent breaks, although probably weaker, than maple.