Wood versus Aluminum Bats
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Aluminum bats are hollow, wood bats are solid. That has important consequences for bat construction. For a wood bat, if you want to make the bat longer (to protect the outside part of the plate) or fatter (to improve your chances of a solid hit), that means the bat must necessarily be heavier, which might be a disadvantage. Not so for an aluminum bat, because you can always compensate for the length or diameter by making the aluminum shell thinner, at least up to a point. This flexibility in construction means that for a given length bat, both the weight and the balance point of an aluminum bat can be made nearly whatever you like. This is a definite advantage for aluminum.

For a wood bat, since it is solid, most of the weight is concentrated in the barrel, which means the center of gravity is further from the hands. For an aluminum bat, because it is a thin shell, the weight is more uniformly distributed and less concentrated in the barrel. This has two important and partially compensating effects, which I now describe in the next three paragraphs.

Because of the way the weight is distributed, the balance point (sometimes called the center of gravity: the place where you can balance the bat on your finger) is closer to the handle for an aluminum bat than for a wood bat. Therefore an aluminum bat has a lower "swing weight" even though its actual weight may be the same as a wood bat. The effect is easy to understand: It is much easier to swing something when the weight is concentrated closer your hands than when it is concentrated far from your hands. You can try such an experiment yourself. Simply take a bat by the handle and swing it. Then turn the bat around, holding the barrel, and swing it. You should find that it is easier to swing it in the 2nd case because the balance point is closer to your hands. Therefore, a batter can often get a higher bat speed with an aluminum bat than for a wood bat of comparable weight and dimensions. Higher bat speed generally means the ball comes off the bat faster, all other things being equal, so is a definite advantage for aluminum. Moreover, the batter can propel the bat to high speed more quickly for aluminum than for wood, allowing the batter to react to the pitch more quickly and even wait longer before committing on the swing. This particular feature is a definite advantage for aluminum over wood, especially for baseball and fast-pitch softball, where reaction time is very important.

The more uniform distribution of mass for an aluminum bat has a compensating disadvantageous effect. Because there is less mass on the fat part of an aluminum bat than for a comparable wood bat, the bat produces a less effective collision with the ball. Once again, this is easy to understand. For a given bat speed, the ball will leave the bat faster for a heavy bat than for a light bat. Even thought the total weight of a wood an aluminum bat may be the same, only the weight of the bat in the vicinity of the impact point (i.e., the weight in the barrel) is effective at turning the ball around and propelling it off the bat at high speed. A typical aluminum bat has less weight in the barrel than a typical wood bat and is therefore less effective.

Therefore, the fact that the mass of the aluminum bat is less concentrated in the barrel than for a wood bat allows the batter to get higher bat speed but at the cost of a less effective collision with

the ball. Which effect is larger? That is not an easy question to answer, since bat speed depends on lots of things that are not easily subjected to scientific analysis. Nevertheless, it is safe to say that the two effects (higher bat speed; less effective collision) at least partially compensate for each other.

An aluminum bat has a "trampoline" effect. That is, the thin shell actually compresses during the collision with the ball and springs back, much like a trampoline, resulting is much less loss of energy (and therefore a higher batter ball speed) than would be the case if the ball hit a completely rigid surface. A wood bat is almost incompressible and produces very little trampoline effect. This gives a definite and noticeable advantage to the aluminum bat. The loss of energy that I referred to comes mostly from the ball. During the collision, the ball compresses and sort of wraps itself around the bat. It then expands back out again, pushing against the bat. This is a very inefficient process resulting in much loss of energy. You can see this for yourself. Drop a baseball onto a hard rigid surface, such as a solid wood floor. The ball bounces back up to only a small fraction of its initial height because energy was lost in the collision of the ball with the floor. The loss mainly came from the compressing of the ball. When a ball collides with a flexible surface, like the thin wall of an aluminum bat, the ball compresses less than it does when colliding with a rigid surface, since the thin wall does some of the compressing instead. There is therefore less energy lost in the ball. By the way, the trampoline effect is well known to tennis players, where the effect comes from the strings of the racket. All tennis players know that to hit the ball harder, you should decrease the tension on the strings, NOT increase the tension. Many people who do not play tennis find this counterintuitive, but it really is true. The smaller tension makes the strings “give” more, just like a trampoline. You can even try the following experiment. Drop a baseball from the floor and measure the ratio of final height to initial height. Now drop a baseball from the strings of a tennis racket, making sure that the frame of the racket is clamped down so it does not vibrate. You should find that the ratio of final to initial height is higher than when the ball is dropped onto the floor. That is the trampoline effect in action.

Because of the way the weight is distributed, an aluminum bat is more efficient at hitting an inside pitch. Another way to say this is that the "sweet spot" of an aluminum bat is longer than for a wood bat. This has definite advantages for mis-hit balls, that is, for balls hit off the main part of the sweet spot. An aluminum bat is more "forgiving"; that is, you can still make good contact. A wood bat is likely to break if you hit it too close to the handle. This is another advantage for aluminum. By the way, it has been said that college players, who almost exclusively use aluminum bats, have big problems making the transition to professional baseball, where wood bats are used, because of the advantage that aluminum bats have in hitting the inside pitch. In effect, college players making that transition have to relearn the proper way to hit an inside pitch.

And, of course, aluminum bats do not easily break, although they can be dented.