Playing the right 'tune'

Kettering professor develops research on baseball, softball bats.

When Daniel Russell visited Roush Anatrol, a company that seeks to solve complex noise and vibration problems, in 1996, engineers there showed him a youth baseball bat with a dynamic absorber inside to reduce vibration. At the time, Russell wasn't thinking about optimizing the performance of baseball bats. Nor was he contemplating ground-breaking research that could have a big payoff for baseball bat manufacturers. Instead, the associate professor of Applied Physics at Kettering University just wanted to develop some advanced laboratory experiments for his students to perform while developing laboratory research skills, and baseball bats seemed like an interesting idea.

But that simple task turned out to be the gateway to Russell's current undertaking – researching the physics of composite baseball and softball bats. Examining their two different types of vibration – bending modes and hoop modes – and their frequencies, Russell has theorized that composite bats can be "tuned" for better performance. Because composite bats have a trampoline effect that can increase the amount of energy transferred to the ball when it is hit, Russell believes a well-designed bat can enable its natural vibration shape to coincide with optimal transference of energy to the ball.

"Composite bats are quite different from aluminum bats in that the material from which the bat is made is anisotropic, which

Kettering University Professor Daniel Russell's research could some day help manufacturers design the "perfect bat."

circumference," he says. "This means that you can design the stiffness – and thus the frequencies – of the bending and hoop modes independently. The experiments I've been conducting appear to suggest that the performance of a bat is strongly linked to the frequency of its lowest hoop mode.

"Unlike metal bats, for which the hoop stiffness and frequency can only be changed by changing the barrel wall thickness, the frequency of the hoop mode for a composite bat can be tuned to almost any desired value."

Scientific jargon aside, the bottom line is that Russell's research could have huge implications for baseball bat manufacturers hoping to some day design the "perfect bat." But if that potential is ever realized and actuated, the result might be a bat that violates certain regulations and standards set by several baseball and softball governing bodies. And though he hopes that using physics and acoustics will lead to the design of the ultimate bat, Russell also acknowledges converse possibilities.

"As good as the best bats are, I don't think they have reached the maximum performance possible," he says. "Of course, as was the case for titanium and several recent composite models, bats which perform too well are quickly banned. So, the quest for the perfect bat may not be the best direction for the industry as long as governing bodies place limits on performance. But, understanding why good bats perform so well may help in the design of bats that must meet certain performance limits."

To help bring baseball bat manufacturers up to speed on his research and its potential implications, Russell will host a short course in July at Washington State University with Alan Nathan, University of Illinois, and Lloyd Smith, Washington State University. The course will cover the physics behind bat-ball collision. TD