

Sports Acoustics

Alex Scheiwe
Blythe Lasher
Jordan Garcia
Sarah Beeman
Scott Payton

INTRODUCTION

- National Anthem
- Aluminum and Composite Bats
- Basketball
- Home Field Advantage

National Anthem: **Outdoors**



Outdoors Continued

◎ Pros

- > Larger crowd, better atmosphere
- > Performer satisfaction
- > Speakers face audience

◎ Cons

- > Venue not suited for performance
- > Outside factors
- > Unpredictability of speakers
- > Lack of smoothness

National Anthem: **Indoors**



Indoors Continued

◎ Pros

- > Structure
- > Clarity and smoothness
- > Envelopment
- > Microphone sensitivity

◎ Cons

- > Performance satisfaction
- > Speaker deficiency

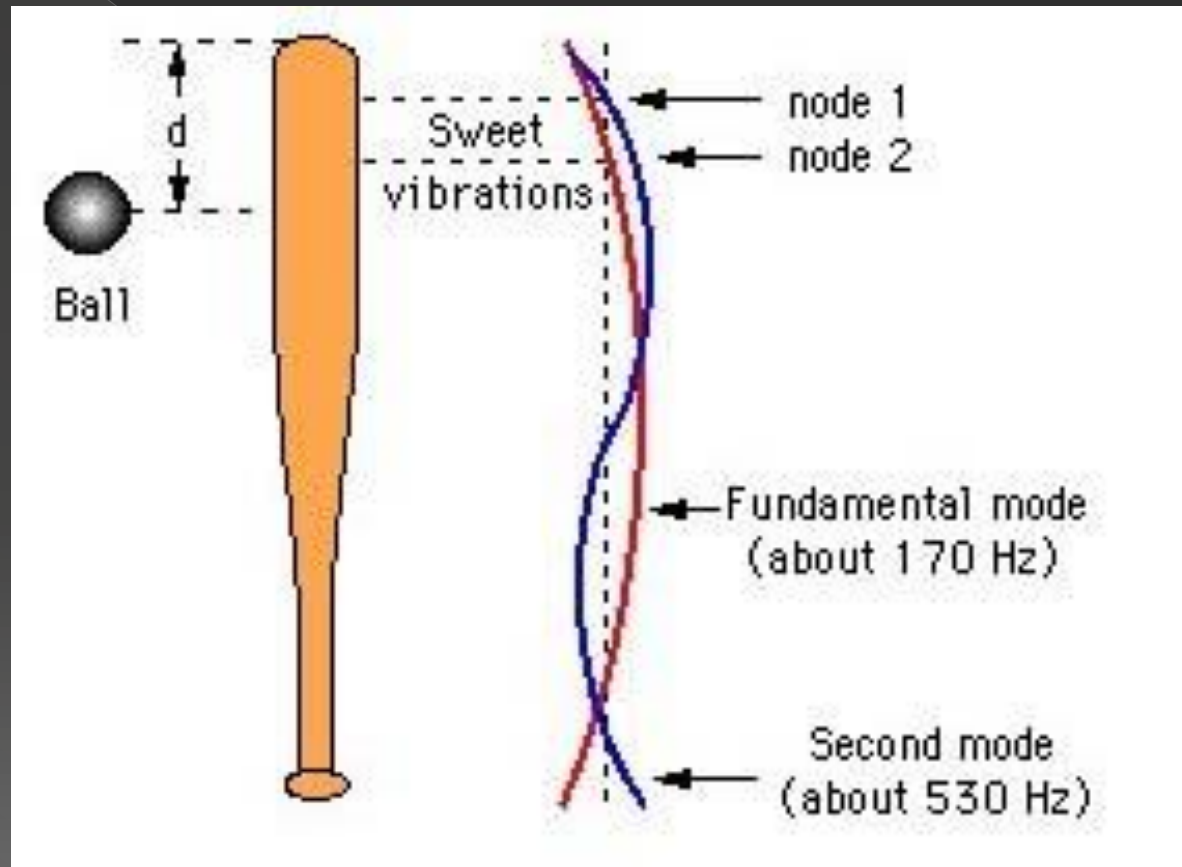
Aluminum and Composite Bats

Aluminum Bats

- Aka: metal, alloy bats
- Make a “ping” sound



Aluminum Bat



Composite Bats

- Interconnected, woven fibers

Expert Advice: **Composite Bats**

[Find Approved Bats](#)

Brand New Bat

Tightly Woven Carbon Fiber
Strong Glue or Resin

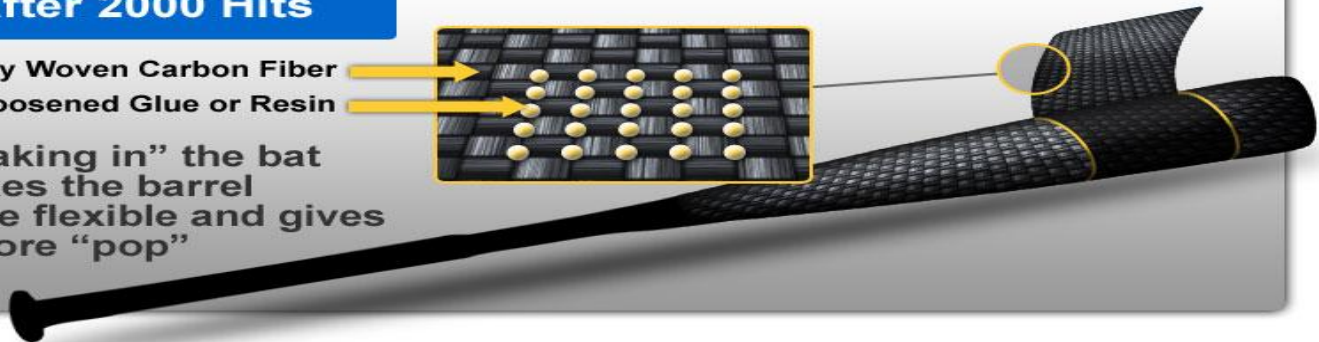
Fresh from the factory,
the resin is still
strong and intact.



After 2000 Hits

Tightly Woven Carbon Fiber
Loosened Glue or Resin

“Breaking in” the bat
makes the barrel
more flexible and gives
it more “pop”



Composite Bats

- Sales have taken off in the last five years
- Produce a trampoline effect
 - > Like a spring that compresses
- Don't have modes or nodes
- Make virtually the same sound up and down the bat, as long as the ball is squared up
 - > Any difference in sound is from how straight on the ball hits the bat
 - > Makes a "thud" sound
- Some are now illegal to use

Video

- ◎ <http://www.youtube.com/watch?v=YIHKOPeWFg0>

Sound Decibels Affecting Shooting Accuracy?



What is a decibel, and How is it Measured?

- The **decibel** is the unit used to measure the intensity of a sound.
 - > Your ears can hear everything from your fingertip brushing lightly over your skin to a loud jet engine.
 - > In terms of power, the sound of the jet engine is about 1,000,000,000,000 times more powerful than the smallest audible sound.

Source	Intensity	Intensity Level	# of Times Greater Than TOH
Threshold of Hearing (TOH)	$1 \times 10^{-12} \text{ W/m}^2$	0 dB	10^0
Rustling Leaves	$1 \times 10^{-11} \text{ W/m}^2$	10 dB	10^1
Whisper	$1 \times 10^{-10} \text{ W/m}^2$	20 dB	10^2
Normal Conversation	$1 \times 10^{-6} \text{ W/m}^2$	60 dB	10^6
Busy Street Traffic	$1 \times 10^{-5} \text{ W/m}^2$	70 dB	10^7
Vacuum Cleaner	$1 \times 10^{-4} \text{ W/m}^2$	80 dB	10^8
Large Orchestra	$6.3 \times 10^{-3} \text{ W/m}^2$	98 dB	$10^{9.8}$
Walkman at Maximum Level	$1 \times 10^{-2} \text{ W/m}^2$	100 dB	10^{10}
Front Rows of Rock Concert	$1 \times 10^{-1} \text{ W/m}^2$	110 dB	10^{11}
Threshold of Pain	$1 \times 10^1 \text{ W/m}^2$	130 dB	10^{13}
Military Jet Takeoff	$1 \times 10^2 \text{ W/m}^2$	140 dB	10^{14}
Instant Perforation of Eardrum	$1 \times 10^4 \text{ W/m}^2$	160 dB	10^{16}

Overview of Intensity

- The amount of energy that is transported past a given area of the medium per unit of time is known as the **intensity** of the sound wave.
- The **greater** the amplitude of vibrations of the particles of the medium, the **greater** the rate at which energy is transported through it, and the more intense that the sound wave is.

$$\text{Intensity} = \frac{\text{Energy}}{\text{Time} \times \text{Area}} \quad \text{or} \quad \text{Intensity} = \frac{\text{Power}}{\text{Area}}$$

Can College Fans Impact Free-Throw %

- Many fans believe that while the visiting team is shooting free throws they can have a great impact in the outcome of the game.
- Many games are lost by just a few points. It is during the free throws that visiting players can hear the fans the most. Some studies have been done to research if certain variables such as point margins, pre-shot routines, and audience participation affect free throw accuracy.



Decibel Levels During Game: Study at Brigham Young University

- **POSES TWO QUESTIONS:**

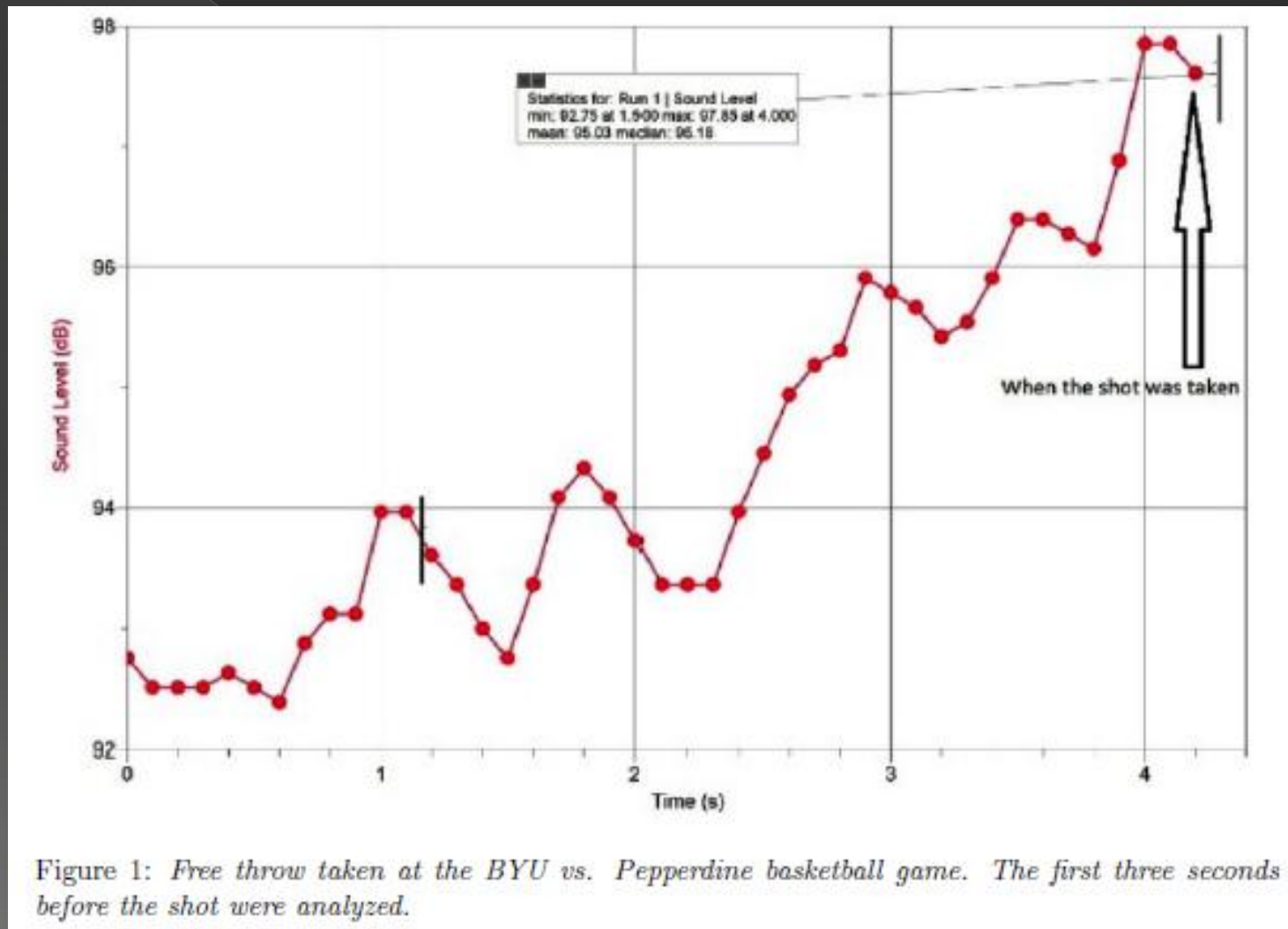
- Does decibel level affect the free throw accuracy of visiting teams?
- Does the maximum decibel level before the shot or the average decibel level before the shot matter most?

- Method to the Study:

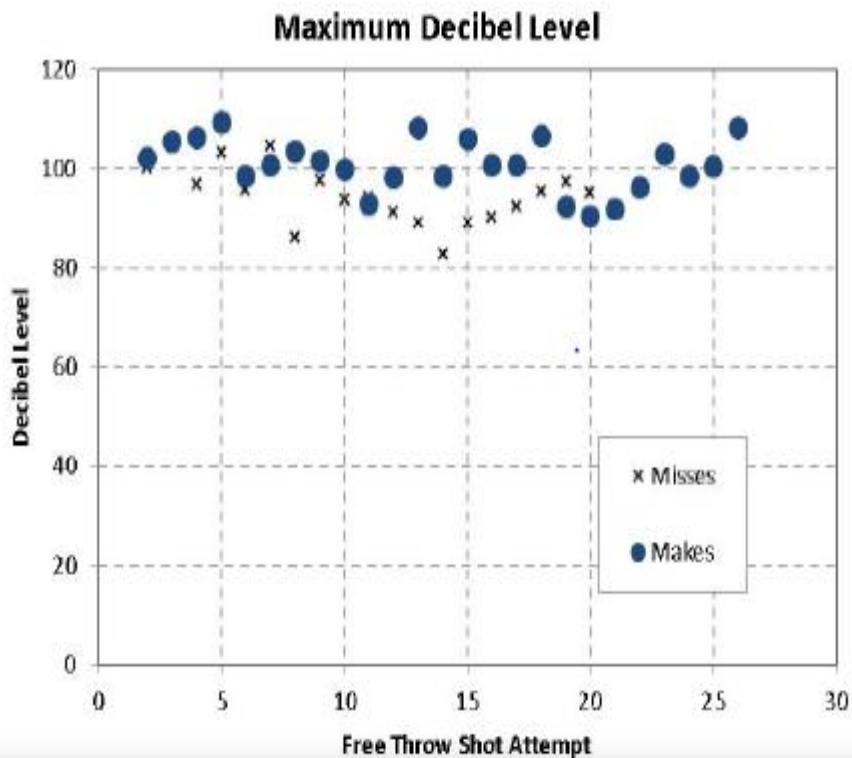
- A LabQuest handheld device with a sound level meter attached was used to record these measurements.(3 games all at BYU Marriot Center)
 - BYU vs. Gonzaga
 - BYU vs. Pepperdine
 - BYU vs. Portland
- All measurements were recorded from center court- 28 rows up in the student section

Decibel Level Analysis

Maximum dB reading of 97



RESULTS OF THE STUDY



- The data shows that the average of the maximum and mean decibel levels for the **made shots** was about six decibels **higher** than that of the missed shots.
- The results were the opposite of what I had expected:
 - > that a visiting player is more likely to score a free throw if either the max or mean decibel level is **increased** before he takes the shot.

	Misses		Makes		Team Free Throw %
	Max dB	Mean dB	Max dB	Mean dB	
Gonzaga	98.78	95.09	102.32	98.64	71.43%
Pepperdine	91.22	86.26	92.85	86.85	30.77%
Portland	95.46	89.28	100.45	92.73	55.56%

*dB = decibels

- **Why these results?**

Possible Explanation: Kansas vs. Georgia Tech Game



- During the game: Kansas fans sound levels reach 122 dB
 - > As we have learned exposure to a decibel level of 110 for more than a minute and a half can cause damage to someone's hearing
 - > Throughout the game, Allen Fieldhouse consistently hit noise levels of 90-100.
- "I would have to say that I've played a lot of places and this is one of the loudest. They have great fans and it seems to give us an extra boost," Georgia Tech junior guard Jarrett Jack said.
 - > With so much noise the players, the opposing team can't distinguish the different insults or chants against them.
 - > It's as if they have headphones on playing "white noise" at a high volume.

Effects Of Exposure During College Basketball Game

- Exposure to high levels of noise like at a College basketball game may cause hearing loss, create physical and psychological stress, reduce productivity, interfere with communication, and contribute to accidents and injuries by making it difficult to hear warning signals.
- Exposure to loud noise will inevitably cause hearing loss over time.
- Loud noise damages or destroys the hair cells in the inner ear.
- Another effect can be “tinnitus” or permanent ringing in the ear.

Daily Allowable Exposure to Noise

The table below shows noise levels and how long a person can be exposed without hearing protection before there is damage to the ear.

<u>Noise Level</u>	<u>Allowable Exposure Time</u>	
85 decibels	8 hours	
90 decibels	4 hours	The average basketball game is around 2 hours long (accounting for timeouts, quarter breaks and half time) → → →
100 decibels	1 hour	Based off the study, the average decibel reading was in between 90 and 100 dB.
105 decibels	30 minutes	
110 decibels	15 minutes	
115 decibels	0 minutes	As proved in the study at BYU, the loudness of the fans throughout the game does not impact the shooting percentage → however, does increase the probability of everyone in the arena to leave the game with hearing loss.

Final Assessment

- From small gymnasiums to large arenas, almost inadvertently they are designed to amplify sound.
- They are reverberation chambers. Therefore they amplify sound more than they might have otherwise.
 - **The problem is that the intensity level at some basketball games can permanently damage hearing.**
- "When you combine all the noise that we listen to during a basketball game, the intensity of that noise - - from the pep band to the crowd, the PA system -- can reach levels that are damaging to our hearing up to around 115 decibels. At that intensity level, we can stand that noise without permanent damage to our hearing for approximately seven and a half minutes." –

Home Field Advantage

- ⦿ <http://www.youtube.com/watch?v=iaWJ6Np4a00>

Sources

- <http://www.physics.usyd.edu.au/~cross/baseball.html>
- <http://www.acs.psu.edu/drussell/bats/compalum.html>
- <http://www.cstv.com/sports/m-baskbl/uwire/010305aaj.html>
- <http://www.wichita.edu/thisis/wsunews/news/?nid=1972>
- <http://www.et.byu.edu/~kuhndog/JournalArticle.pdf>