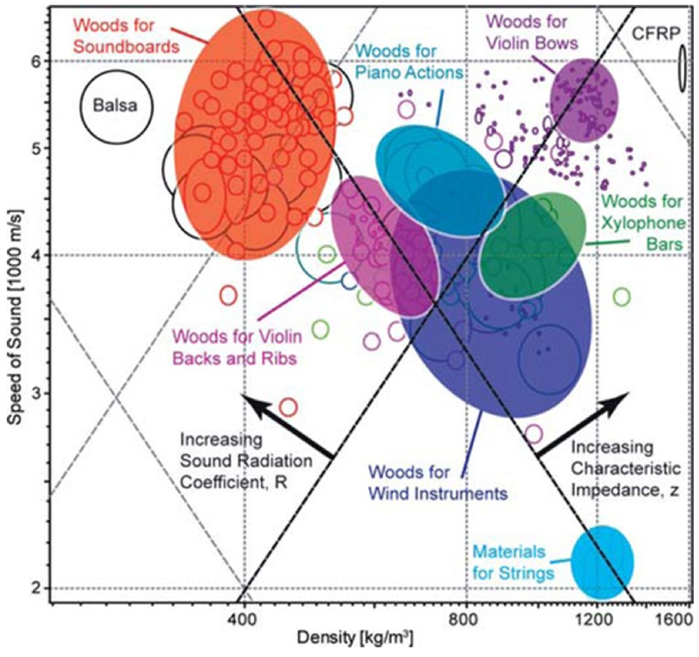
Developing Synthetic Materials for Percussion Instruments

Sarena Bemis[1], Dr. Joseph Biernacki[1], Dr. Holly Stretz[1], Dr. Steven Anton[2], Dr. Mohammd Albakri[2]
[1]Chemical Engineering, Tennessee Technological University
[2]Mechanical Engineering, Tennessee Technological University

Background

Most musical instruments are wooden, exotic or precious woods. These woods have substandard environmental standings. Due to this, there is a need for synthetic materials to replace wood usage.

- The most desired woods are endangered and have limited availability[1]: Rosewood, Mahogany, and Ebony
- Most important qualities these tone woods are the sound qualities: resonance and color(tone)
  - Qualities determined by Young's Modulus, density, hardness, moisture, temperature adaptability, and grain direction
- Few companies produce instruments from synthetic materials because they lack desired sound qualities



[2]

Data Acquisition

- **Interview with a Percussion Educator and Instrument Builder**: acquire knowledge on instrument building and materials
- **Percussionists Survey:** obtain information on the most sought-after qualities in the various percussion instruments
- **Lab:** Use of sound recording software to view sound waves off different instruments

References

1 Meier, J. "Restricted and Endangered Wood Species." *wood-database.com*. 3 Mar 2021.
2 Wegst, Ulrike G. K. 2006. "Wood for Sound." American Journal of Botany. 93(10):1439-1448. 24 Jan. 2021.

Method

- In lab:
  - The same key will be struck on each instrument
  - Each key will be struck approximately 9 inches from the surface of the instrument
    - Struck with same mallet (2 types of mallets)
    - Matching stroke style

Results

Interview Data

- Essential to use a hard, dense wood when making marimba which possesses percussionist's desired qualities
- When making marimba, carefully assess the grain direction and hardness of wood to properly sand and cut the bar into pitch

Survey Results

- Surveyed 10 percussionist ranging from percussion educator, performer, and student

Sought-after Qualities

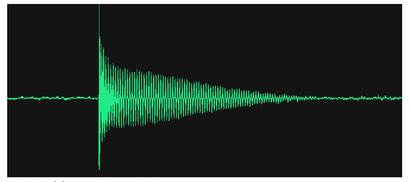
Qualities	Drums	Mallet Instruments	Auxiliary	Heads and Sticks
Durability	X	X	X	X
Resonance	X	X	X	X
Quality Sound	X	X	X	X
Response	X	X	X	X
Tunability	X	X		X
Weight	X			X
Transportability		X		
Pitch Match		X		X
Appearance		X	X	X

Number of Responses to Each Quality

Qualities	Drums	Mallet Instruments	Auxiliary	Heads and Sticks
Durability	5	5	1	6
Resonance	4	9	4	1
Quality Sound	6	4	7	4
Response	1	1	1	4
Tunability	4	1		1
Weight	4			7
Transportability		2		
Pitch Match		1		2
Appearance		1	1	1

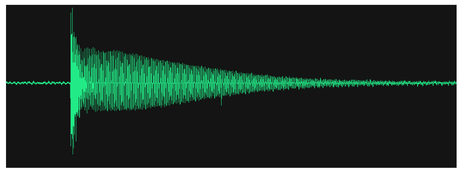
Lab Vibration Results

Sound Waves Low C Marimba

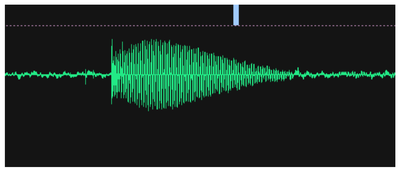


Mallet IP275

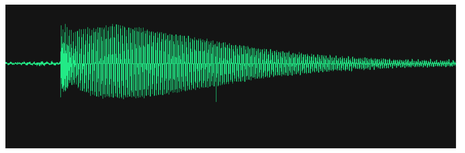
Sound Waves Low C Synthetic Marimba



Mallet IP275

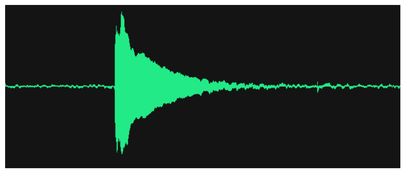


Mallet IP100



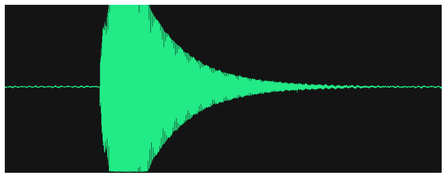
Mallet IP100

Sound Waves Middle C Marimba

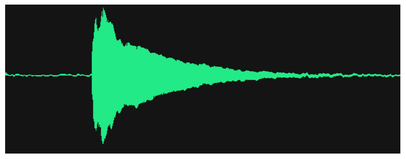


Mallet IP275

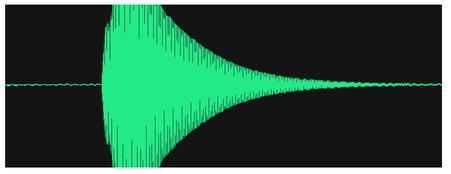
Sound Waves Middle C Synthetic Marimba



Mallet IP275



Mallet IP100



Mallet IP100

- Visibly sound waves are different and the sustain on synthetics are far greater

Conclusions

- The vibrational analysis of sound recorded waves shows the difference in wooden marimbas and marimbas made of synthetic materials:
  - Sound waves are visually different
  - Sound waves are more resonant on synthetics
- These results provide a basis for identifying and characterizing new materials for instrument construction.

Acknowledgments

I would like to thank Dr. Joseph Biernacki, my research advisor, Dr. Cynthia Rice, Dr. Holly Stretz, Dr. Steven Anton, Dr. Mohammad Albakri, Dr. Collin Hill, Professor Jayce Clemons, and my survey participants.