

Acoustics and Musical Instrument Design to Create a Robust, Stable, Flexible Berimbau Instrument

Team 35

Clayton Smith, Matthew Hasto, Michael Abukhader
Mechanical Engineering Department, Dr. Hasan Ferdowsi
Northern Illinois University
DeKalb, IL

Abstract— The Afro- Brazilian berimbau is an instrument with a rich history and unfortunately a limited potential. The single string instrument requires multiple players to create complex compositions. Dr. Gregory Beyer, along with his non-profit organization called Arcomusical, dedicated to the spread of knowledge and enjoyment of the instrument, have commissioned through the School of Engineering at Northern Illinois University to create a stable multistring instrument that solves some of the most common issues with the berimbau, while expanding the potential for a single instrumentalist. The final design that has been completed contains a modified berimbau staff that contains a second string and tuning mechanism as well as a bridge clamp mechanism meant to be able to slide along the staff of the instrument, as well as acting as the bridge for the strings and the gourd connection. This design utilizes hooks to bridge the strings and allows the use of multiple clamp mechanisms to bridge the strings at different locations along the staff.

I. INTRODUCTION

A. History of the Berimbau

The berimbau is an African-Brazilian instrument strongly linked to the dance fighting technique of Capoeira. Capoeira is a martial art that focuses on fluidity and elegance and it is extremely common for those who practice it to own and play the berimbau, as is traditional to the art. In its root this instrument was used to muffle the sounds of slaves learning martial arts so the owners would not be able to hear and find out that the slaves were learning combat. The berimbau is traditionally formed with a staff of hardwood, with a string being brought from one side of the staff to the other where typically there is a tuning mechanism to adjust the tightness of the string. It bows not unlike a hunting bow. Then a dry hollow gourd, acting as a resonance chamber, is attached to the staff using cord. The cord is also tied around the string to bridge the instrument into two separate lengths. It is played by pressing a key usually made of stone or brass into the string right above the location the string is bridged, and the string is struck with a wooden stick to create the sound. Because of how it is played it is considered a percussion instrument.

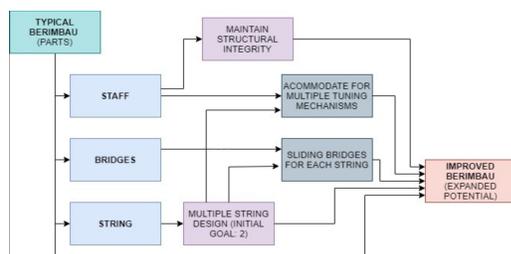


Figure 1: Block Diagram

B. Project Goal

The berimbau's one stringed design causes limited ability for a single instrumentalist. The goal is to expand the melodic potential of a single player by creating a stable multi-stringed berimbau instrument, as well as to address common issues with the berimbau to improve it overall. The addition of a second string as one can assume will at the very least double the ability of a single instrumentalist allowing for much fewer musicians to play much more difficult and complex pieces. Other issues that must be addressed are that of the uncomfortable hold of the instrument, as well as the tendency of the bridge to slip while playing.



Figure 2: Dr. Beyer's 2-String Prototype

II. OPTIMAL DESIGN

A. Improved Staff

The solution includes a new berimbau staff with a larger bulb to account for a second tuning mechanism as well as modified bridges on each end to set the lengths of the playable string for each string.

B. Clamp Mechanism

Also, the addition of a new mechanism has been added to the instrument to replace the cord originally used. This is called the bridge clamp mechanism and it contains many vital improvements to the original instrument. There are two functional clamp mechanisms, one more suited to holding the gourd utilizing an improved cord configuration in which a housing allows for the cord to be easily tightened by a wing screw mechanism.

The alternate design is better suited as a secondary clamp for if an instrumentalist would prefer to bridge the strings at different locations along the berimbau. This clamp is more robust and most resistant to movement along the staff, which was one of the desired improvements of the instrument.

C. Bridge and Hooks

Both clamp mechanisms contain a bridge slot for the string hooks to enter and a set screw that is meant to pin the hooks in place. The hooks themselves are an improvement to the original design as they are made from steel making them much more robust than the cord originally used. The hooks have also been coated in a flexible plastic providing more friction and reducing the ability of the bridge to slip, as the former bridge is prone to in the original instrument.

These hooks have two different

forms, a single

hook form for use with two clamp mechanisms allowing the strings to be bridged at two different locations, as well as a double hook permutation in which only one bridge clamp mechanism is required. This version allows the strings to be bridged at the same location on both strings.

D. Handhold

Both bridge clamp designs also have been modified in that they both contain an ergonomic hand hold which the original instrument lacked. This is built directly around the slot for the hook and is made for the comfort of the players finger, as the instrument is typically held up by a single finger. This part is made of hardwood similar to what is used to make the staff to ensure that it is robust enough to handle the weight of the instrument being carried by it as well as the tension of pulling the strings back.



Figure 3: New Prototype-Clamp Mechanism and Hook insert

III. SUSTAINABILITY AND MAINTAINANCE

The berimbau itself requires slight maintenance to increase its longevity as any instrument does. As the instrument is prone to bowing farther and farther as time goes on, it is important to relieve tension as much as possible when not playing the instrument. This includes removing the bridge mechanism and relieving the tension on the string by loosening the tuning mechanism.

It is important not to overtighten or strip any of the twisting components including the set screw or the gourd tightening housing.

IV. RESULTS AND DISCUSSION

Due to the original limitations of the berimbau a second string drastically increases the functionality for a single player. The ability to bridge the string in multiple locations along with the use of an additional string means that much more complex compositions may be played by fewer musicians. This includes different positioning on either string completely changing the functionality of the original instrument. The original instrument could change the tension point on a singular string allowing for two different notes to be available to a player separate from using the coin. Additionally, with the double hook in place, the instrument now has two strings being tensioned at one point

allowing for four notes. The incorporation of the mount makes moving the double hook up and down the staff extremely efficient and easy to do in the middle of a composition. Now, the two mounts using two separate hooks expands the potential even more allowing off set notes on either string. If the musician wishes to keep one string in tension, they can move the other tension without interrupting the initial string. This adds an infinite number of notes that can be played with easy movements. With the robustness of the hook mechanism the slipping of the during use of the instrument has been addressed, as well as the uncomfortable handhold of the instrument being significantly improved according to client feedback.

V. CONCLUSION

The addition and design of a clamp capable of holding two strings rather than one is increasing the melodic potential of the instrument by more than double. Also, the option of having two clamps applying tension at different areas on either string allows musicians to change playing styles fluidly in the middle of a composition and have access to a plethora of different playable notes.

ACKNOWLEDGMENTS

Dr. Gregory Beyer – Founder, President, and Artistic Director of Arcomusical

Dave "Snappy" White – Arcomusical's personal woodworker handcrafting musical bows.

Dr. Hasan Ferdowsi – Faculty Advisor Team 35

German Ibarra - Teaching Assistant Team 35

REFERENCES

[1] Beyer, Gregory, 2020, Arcomusical. [online]. 2020. [Accessed 4 November 2020]. Available from: <https://www.arcomusical.com/about-arcomusical/#>

[2] Lyra, Claudia, 2020, Center for World of Music. [online]. 2020. [Accessed 20 October 2020]. Available from: <https://centerforworldmusic.org/2015/06/world-music-instruments-the-berimbau>

[3] Beyer, Gregory, 2020, Northern Illinois University College of Visual and Performing Arts. [In Person].

[4] Watson, Nathan W., 2017, Miami University [online]. 2017. [Accessed 20 November 2020]. Key Factors In The Evolution and Globalization of The Berimbau. Available from: https://scholarship.miami.edu/discovery/fulldisplay/alma991031447354202976/01UOML_INST:ResearchRepository/