Cicada Sound Model: An Interactive Model to Replicate Cicada Sound Production

Mehmet Guvenilir, Alejandro Montero,
Tony Nunn, Sanjeev Chauhan

Motivation

The Duke Gardens hosts many presentations and tours throughout the year where they teach their guests how different animals make sounds. This is often very difficult to do with a verbal description, and animals often flee from large groups of people. **The lack of an interactive visual model to teach Duke Garden visitors about a complex sound making process is the motivation for this project.** A cicada was chosen because of its fascinating sound making process.

Objectives

An interactive model should be designed to clearly **convey cicadas' sound making process.** The model must be:

- **Safe and durable** enough to be used in the Duke Gardens and around children
- **Easy to use** in every aspect (interaction, transportation, maintenance, etc.)
- **Accurate** in terms of appearance and sound
- **Interactive** in terms of how the sound is made

Design Solution

- **Sound Production System**: MKR Zero (3.3v LiPo battery powered Arduino), I2S amp, power switch, change sound button, play sound button, reset button (*Figure 3*)
- Laser cut **Acrylic Wings** with engraved sections to show texture (shown in *Figure 1*)
- **3D Printed body:** Durable, modular and easy to replace (*Figure 1*). Spray painted to make the model visually accurate.
- Mesh cable guides overlayed on a custom 3D-printed piece to simulate the flexing of the **Tympanic Muscles** (*Figure 4*)
- **Zip-ties** to emulate the movement of the **Tymbal**, which causes the vibrations (*Figure 4*)
- A **Crank** to allow users to interact and manually control the tymbal movement
- **Head Hinges open:** to easily show a cutaway view of how the cicada anatomy contributes to its sound: the tympanic muscles, tymbal, and air chambers (hollow abdomen)

Figure 1: Cicada Model on a bush

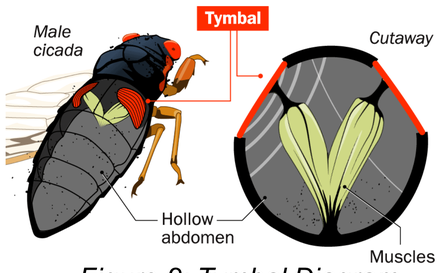


Figure 2: Tymbal Diagram

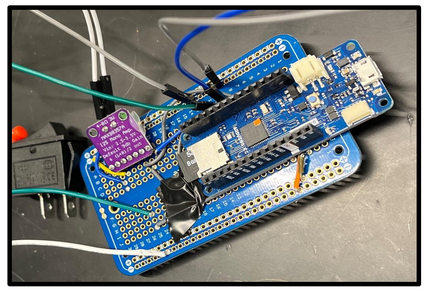


Figure 3: MKR Zero + I2S Amp

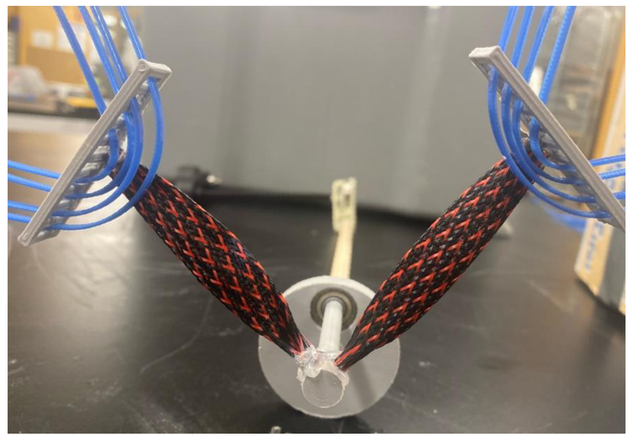


Figure 4: Crank powered tymbal design for the cicada model

Design Criteria and Testing

Design Criteria	Goal of Test	Method of Test	Results	
Accuracy	**Replicates cicada sound** production as accurately as possible	Expert Consultation: **Asking the Duke Gardens team** if they approve of the mechanics	To be determined in further testing	
Portability	The model can be easily held and **transported >3 km**	User-testing where people will be selected to **attempt to carry the model >3 km**	Successful with current prototypes, but more tests needed for others.	✓
Interactivity	A person has **>7** instantaneous or **>2** prolonged **interactions** with the model	User-testing where the **person will be asked to interact with the model** with no further prompts	Users had 3 prolonged interactions with the crank, body, and sound systems	✓
Durability	The product can **withstand a pressure of 50 pounds** for **>5 seconds** to display the model's durability	Placing various weights on the model to observe how much **pressure the product can withstand** without displaying any damage. Additional **drop tests** were conducted to better understand the product's overall durability	Successfully completed both tests without any damage	✓
Ease of Use	A person can correctly **use the model within 2 minutes** of receiving the instructions	User-testing **where a person is given simple instructions and asked to operate the model**	Users understand how to interact with it in under 2 min.	✓
Aesthetics	The model **looks and sounds like a cicada** in terms of exterior design, sound volume, and sound clarity	Asking the client and experts if the **appearance is detailed and accurate**	To be determined in further testing	

Future Plans

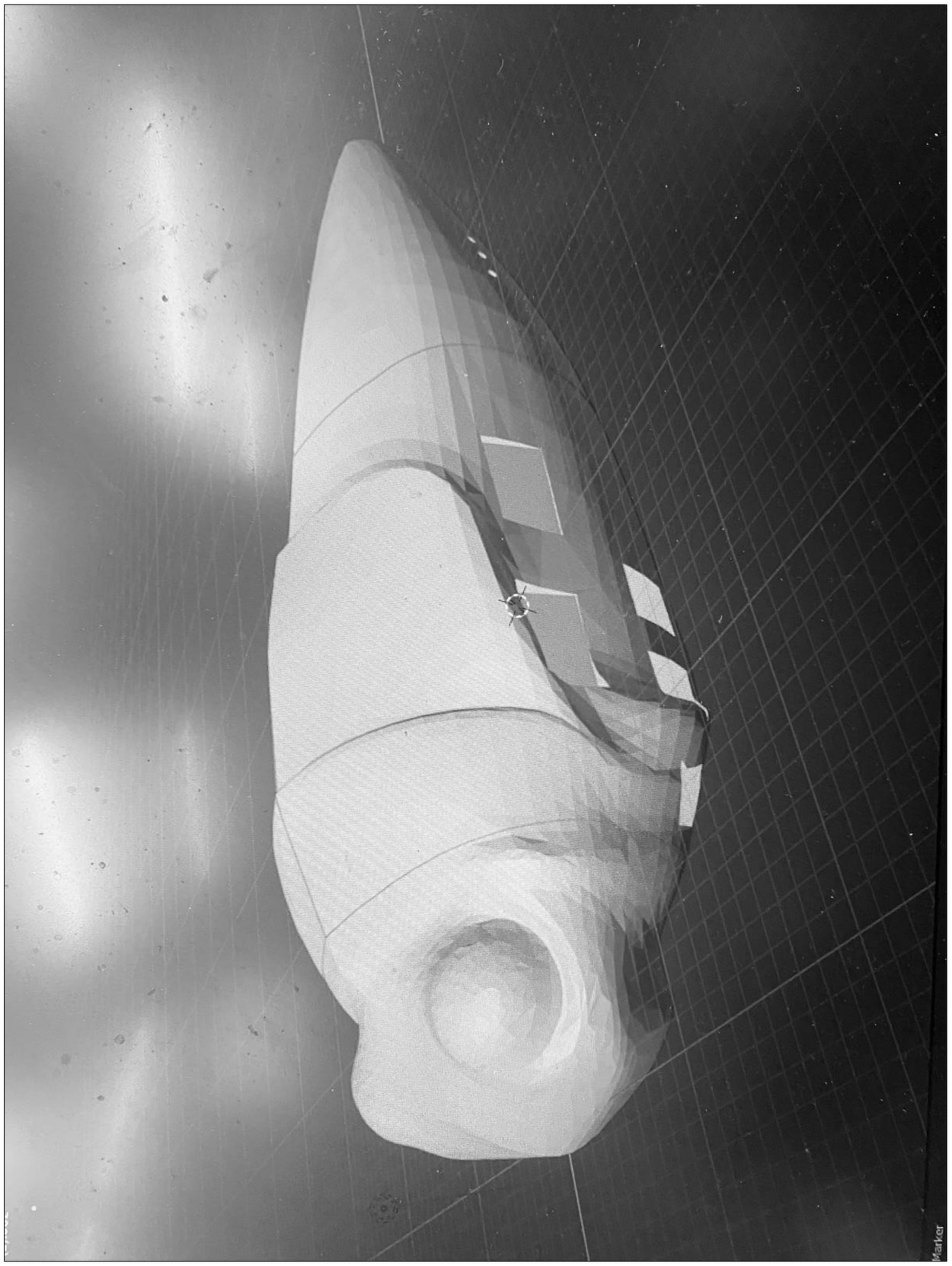
The final cicada sound model was successful in satisfying the determined criteria of portability, interactivity, durability and ease of use. This model will allow the Duke Gardens to educate people on the unique sound-making process of cicadas with an interactive and visual model.

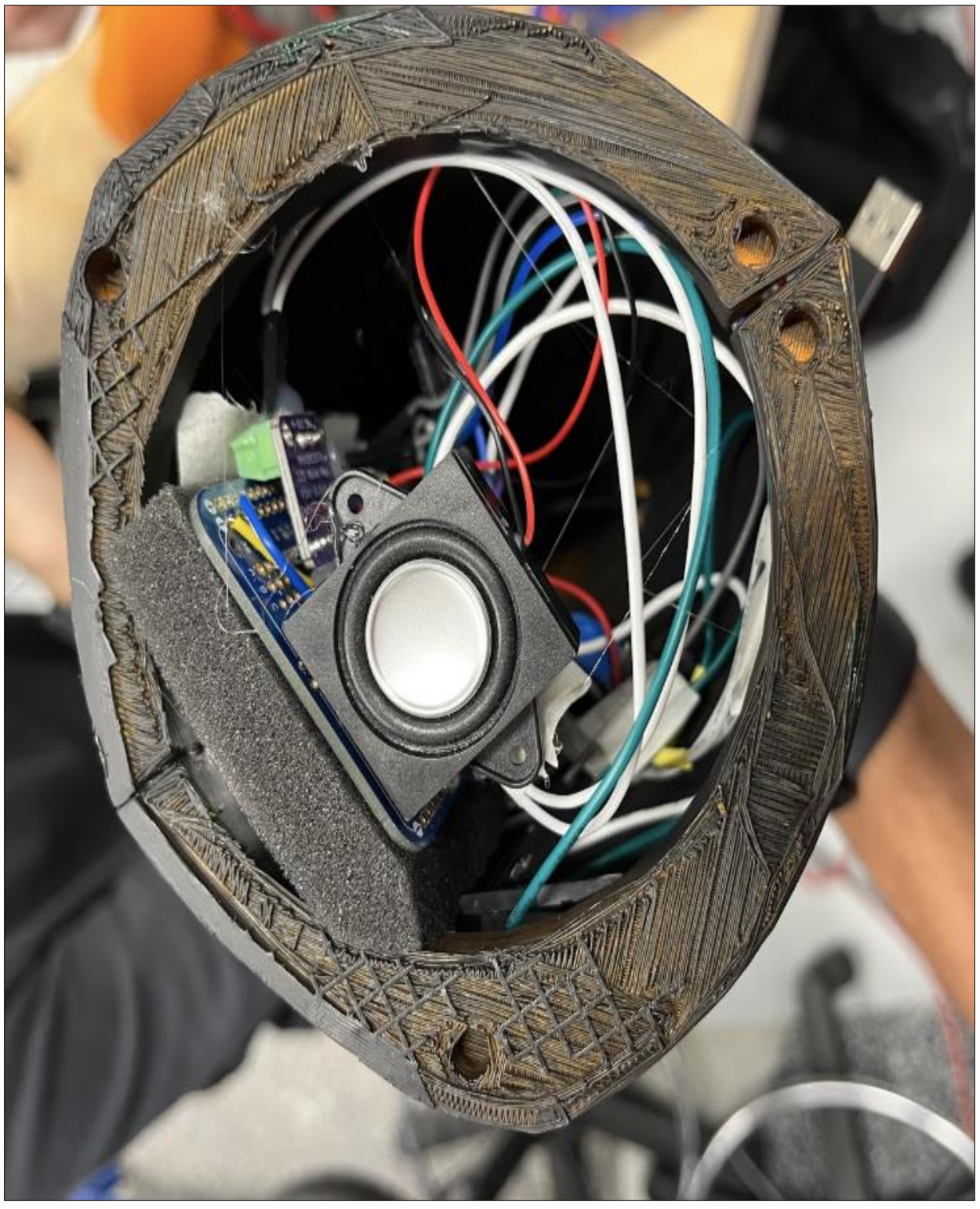
Future plans for the final product:

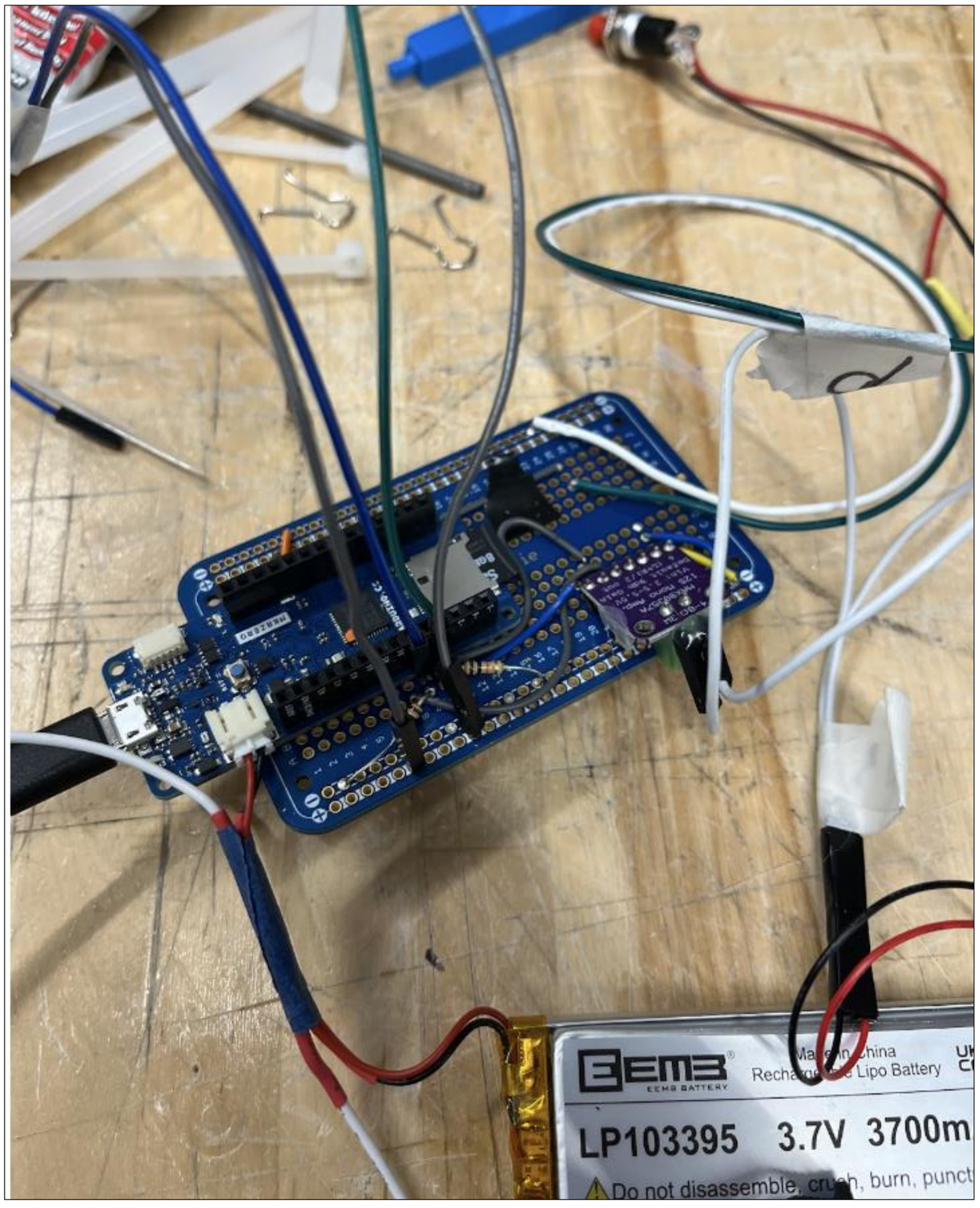
- **Finalize remaining tests** that require the Duke Gardens team's participation
- **Adjustable sound** volume via controller
- A **Stand** to hold the cicada model in place
- **Case** to safely carry the model

Acknowledgments

- Dr. Schaad, Dr. Tantum, Dagan Trnka, Ali Stocks
- Adam Davidson – Technical Mentor
- Kavanah Anderson – Director of Learning and Engagement at the Duke Gardens
- Kati Henderson – University Partnerships and Community Engagement Program Coordinator at the Duke Gardens






LP103395 3.7V 3700m


Duke
CICADA SOUND MODEL
HOW DOES IT WORK?


Duke
CICADA SOUND MODEL