Interactive Water Vortex Exhibit

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Mechanical Engineering CAL POLY

Acknowledgements:

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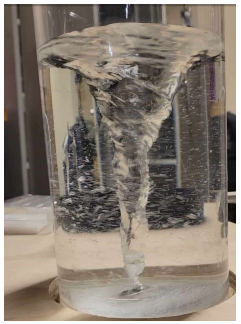
SPONSOR

SAN LUIS OBISPO CHILDREN'S MUSEUM

SCOPE

The San Luis Obispo Children's Museum has a variety of scientific displays educating children about a variety of topics; however, they do not have an interactive water vortex exhibit. This absence sparked our team's initiative to develop and introduce this exhibit, aiming to enlighten children about the fascinating fluid mechanics of water vortices. Our goal is to nurture their curiosity in science from an early age.

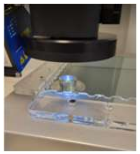


Our objective was to:

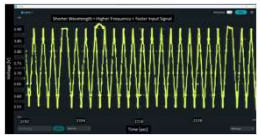
- Create a fun interactive water vortex exhibit.
- Design for minimal maintenance.
- Design for children ages 2 to 8
- Follow a $1000 budget cap for both testing and full design phases.

ANALYSIS

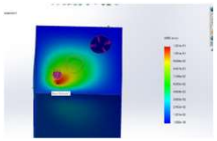
- Using the MicroVu and CMM machines, parts were analyzed to determine the hole size and circularity of the shaft and bushing.
- Using Arduino, we implemented code to read the encoder and output signals to power the motor. Shown in the second figure was the sine output proving that the software could read the input from the steering wheel.
- Performed FEA on the input frame assembly to ensure deflection and stress were within acceptable limits. The frame manufactured with selected materials was found to deflect less than the specified objective of 15 millimeters.
- Calculated the required RPM of 650 and voltage to power the system.



MicroVu Analysis of Manufactured Part



Frequency Plots proving Encoder/Arduino Communication



Finite Element Analysis of Input Shaft (FEA)

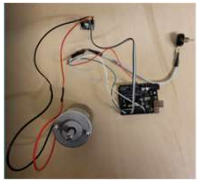
MANUFACTURING PROCESS

- Constructed wood panels out of ½" plywood.
- Welded square aluminum tubing into metal frame.
- Machined bushing and welded input shaft to steering wheel.
- Wired the drive system and uploaded code using Arduino IDE.
- 3-D printed propeller, vase cap, and magnet plate. using the 3-D printers in Mustang 60.

Magnet Plate (Left)

Propeller with Magnet (Right)

Metal Frame being Welded



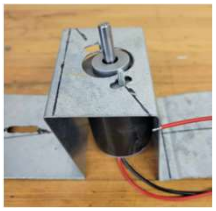
Drive System

Encoder Mounting Plate

Final Design for Output System

Steering Wheel, Bushing, and Input Shaft

Internal Bracing and Side Shell Panels



Motor Mounting Bracket

Assembled Top Shell Panel and Side Shell Panel over Metal Frame

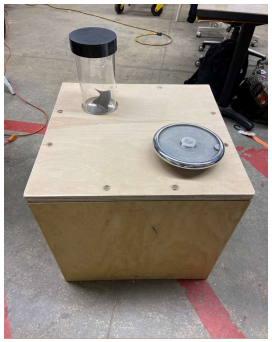
TESTING/VERIFICATION

- The metal frame and top shell panel were subjected to load testing of 118.8 pounds. The requirement was to hold up to 100 pounds, so the frame passed.
- The side shell panel was subjected to a 78-pound impact force. The requirement was to withstand 60 pounds of impact, so the side panel assembly passed.
- The encoder within the drive system underwent a manual rotation to showcase the power and the response to the motor. The encoder was spun both ways and the system responded accordingly.
- The RPM of the system was tested and adjusted to support the rotation of the propeller to showcase a working water vortex.
- The vase underwent a leakage test using a moisture sensor to guarantee its leak-proof quality and it passed this requirement with no leakage detected.
- The magnets experienced a test to ensure they recouple in 5 seconds in the event that they decouple. After running the test, it passed.

118.8 Pound Load on Metal Frame and Top Shell Panel

Magnet Coupling Test

CONCLUSION



Final Water Vortex Build

FUTURE WORK

- The top panel will undergo staining to blend with the birch wood used on the other exhibits at the museum.
- The side panels will showcase wraparound designs intended to enhance its aesthetic appeal.
- Signage will be placed near/on the exhibit that will aim to educate children about the science behind water vortices.