Sight & Sound Remote Latching System

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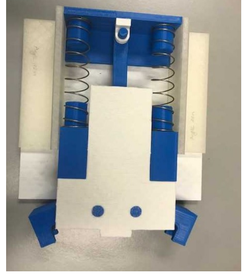
S&S BUG LATCH

The Problem

Sight and Sound Theatres is a theater company that performs well-known Biblical stories as plays. In order to immerse viewers in the story, they use special effects, live animals, and elaborate sets. The latter of these can be challenging, however. Large set pieces must be latched together to ensure actor safety, and the latching mechanisms can only be operated by hand. This requires either stage hands or even actors to activate these latches, and results in unwanted stress upon the whole production team, especially the actors that need to focus on their primary responsibilities. The Lancaster S&S troupe reached out to the Collab with a request for a latch that can be operated remotely and consistently connects the set pieces together.



3D-printed prototype

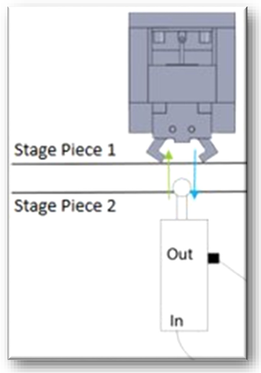
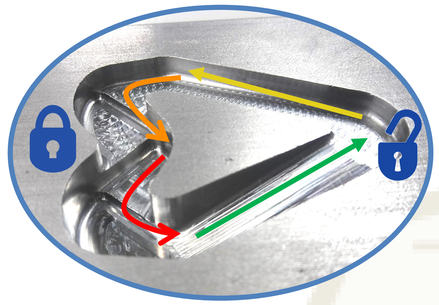


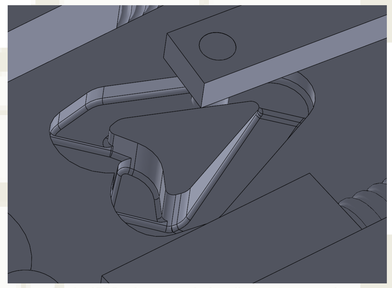
Illustration of latching process



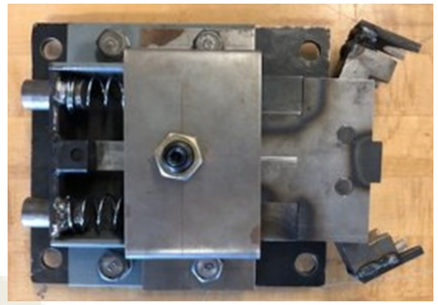
Detailed view of the track & pin travel path

Functionality

- Our design uses a pneumatic cylinder on one set piece and our latching mechanism on the other. The latch works in tandem with a pneumatic piston. When the piston presses into the latch, the jaws close around it and locks. The piston retracts and pulls the set pieces together. Once the scene is done, the piston is pressed into the latch again to unlock it and retracts, allowing the set pieces to separate.
- The Latch uses a pin-and-track system to operate. A guide pin moves along a heart-shaped track to guide the latch's motions. The latch starts unlocked in the bottom of the heart and slides up and into the top when pressed. This locks the latch in place. When the latch is pressed again, the pin slides out and over the top back into its original, unlocked position.



SolidWorks model of pin in track



The completed latch prototype

Latch installed in sample set piece

Testing

- Our first test was lifecycle testing. We built a rig to perform stationary tests, and repeatedly tested the latch 2000 times to look for signs of wear or fatigue. The latch showed minimal signs of wear during the testing.
- We performed alignment testing using actual set pieces from Sight and Sound. We tested to find the maximum offset distance in each direction, as well as the maximum angle offset. We found that the latch had a tolerance of about 1/2 in. horizontally, 1/16 in. vertically, and 4° angularly.
- To perform the maximum force test, we used a tensile testing machine to pull on the latch. The latch withstood the required minimum of 500 lbs. The most critical area, the pin, took minimal strain during the test.

Latch prototype in the tensile tester

The set piece we were loaned for testing

Specifications

- Remotely controlled and indexes automatically.
- The latch would need to attach set pieces ranging from **200-20,000 lbs.**
- Pulling force of the first prototype should be **500lbs.**
- Must operate at **40 decibels** or lower.
- Dimensions should be less than or equal to **18 inches tall, 24 inches wide and 12 inches deep**.
- The latch must fit completely within the frame of the set pieces, hidden from the audience.
- Ideally, the latch should be **less than $300**.

Design History

- The initial latch design was based on a common kind of cabinet latch. Pressing in the door locks the cabinet and unlocks it when pressed again.
- Our Team used rapid prototyping to create 3D models of the latch parts in SolidWorks. We printed out numerous prototypes to test for functionality.
- Once we had our design, we set about fabricating the latch from metal. We made minor design changes as we went, such as switching a spring with a bushing.

Conclusions

This year we were successfully able to complete the final prototype of the latch and deliver a working latch prototype, manufacturing and operation instructions, and scale drawings for other models of this latch design. This prototype has undergone various amounts of testing, observing forces that it can take, amount of cycles undergone before wearing, and alignment specifications when in use with actual set pieces. The team is confident in the work that has been delivered to Sight & Sound and has been rewarded in the satisfaction of seeing the completion of this project.

Acknowledgements

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