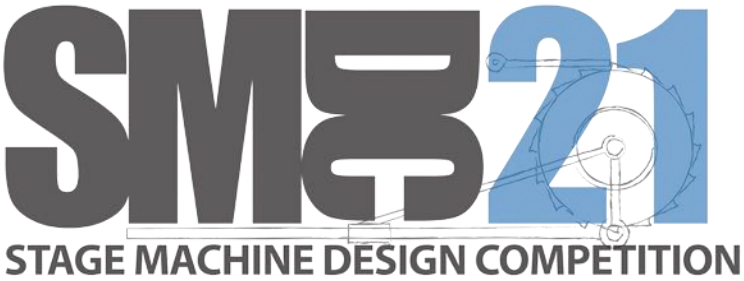

2021 Stage Machine Design Competition

Design Proposal

Maris Keller

Collin Schy

Samantha Pietrinferno

Faculty Advisor: Mark Willoughby

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*Modes of safety and operation are subject to change with commencement of construction.

Design Specification

The design was created as a pop-up dart trap mechanism for a new, immersive escape room experience opening in our hometown. Specifically, for the room following a Wisconsin Johnson theme. The machine must have two elements: a mechanism to lift the "head" a total of 18 inches and a mechanism to propel the "dart". The head must be 18 inches in diameter and 18 inches tall, with the mouth in which the dart will shoot from located 6 inches from the bottom of the head. The pop-up, launch, and drop-down sequence should be triggered as one singular sequence. The head must rise to its full height in less than 2 seconds, and after launch, lower in no less than 10 seconds. The dart should only launch from the mouth when the head has reached its maximum height. Once installed, the device should be able to repeat its sequence 10 consecutive times without failure, allowing for reloading of darts in between. In addition, the device should propel the darts at least five feet but no more than ten feet. The distance traveled should be consistent upon each time of operation. Amongst a consistent operation level, the device must include safety interlocks for loading and unloading the darts, including a safety switch which ensures that the dart will NOT fire during reloading. Lastly, the machine should require only a single trigger to operate.

Research

Our concept design portion began with us looking up the movie scene referenced in the design specifications. As each of us began coming up with ideas, we started researching other firing devices and counterweighted systems. Some of the systems/devices we evaluated were:

- Medieval catapult
- Nerf Gun Crossbow
- Pulley systems
- Bungee corded systems

Concept Generation

Initial brainstorming resulted in a few separate rough concept designs. We organized our concepts by modes of operation: mechanical, pneumatic, and electrical. For mechanical, we came up with a system involving a 18inch cylinder shaped piston, a seesaw-like counterweight system for the raising of the head, and a crossbow mechanism for the propelling of the dart (see Figure 1). Concerning the operational specifics of the mechanical system: the idea is that the device will be set up so that the base of the cylindrical piston, in which the head is attached, is rested on a counterweighted seesaw-like plate set to operate on a centered pivot point. Once the weight is released from its initial position, it will trigger the seesaw to push down, propelling the piston upwards, and raising the head of the device. Once it reaches full height, it will lock in place for the propelling of the dart. That same locking mechanism will also trigger the crossbow, which is pre-set at the mouth of the head with a dart. Once the dart is released, the counterweight will unlock and slowly slide the seesaw plate back down to its original position. To clarify, the mechanical version involves the use of a pneumatic piston, but we will not be pushing air through it. The pneumatic and electronic methods are similar in physical form but differ in trigger operation. The pneumatic device would simply use air pressure to operate instead of a counterweight system alone to trigger the movement sequence (see Figure 2). As for the

electronic device, it would use an electronic arm with a trigger in the form of an electronic signal to operate in a similar fashion. We decided to pursue the mechanical method because we agreed that it would offer the most challenges and allow us to test ourselves.

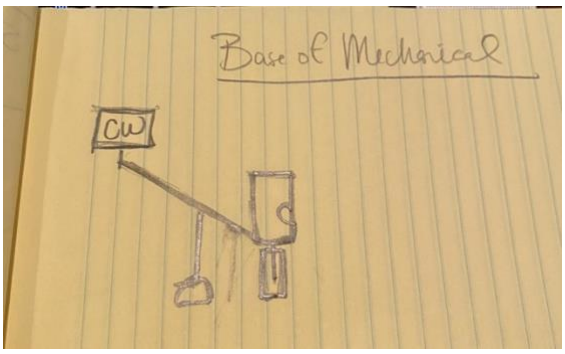

Figure 1: Base Drawing of Mechanical Method

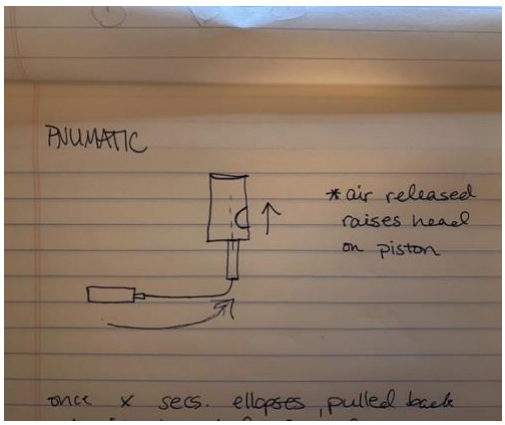

Figure 2: Pneumatic Base Drawing

User Manual

Introduction

The device is intended to be loaded at ground level, pre-operation, with the intended darts. As of now, this device allows for the loading of a single dart and requires reloading in between each use. The device consists of a few main components: the head, the see-saw counterweight lifting mechanism, and the crossbow dart firing piece.

Safety

Prior to any operation of the device, loading, or reloading of the device, all operators must be sure the space in front of the device is clear of people and other obstacles.

- On the side of the device will be a pin-locking point in which a pin will be inserted to lock the device in place to avoid unwanted triggering of the device while loading/ reloading.
  - Anytime the operator wills to reload the device, the pin must be inserted.
  - Vice Versa- anytime the operator wishes to trigger the device, they must be sure the pin is removed.
- After the triggering of the device, all people present are prohibited from walking into the firing path and must remain behind the device in order to prevent injury.
- When not in use, be sure that the pin stays inserted, and the machine is free of darts.
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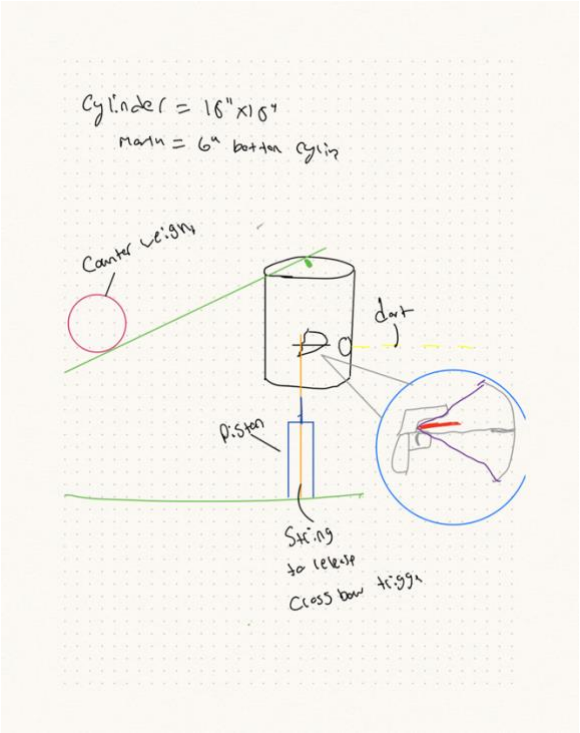
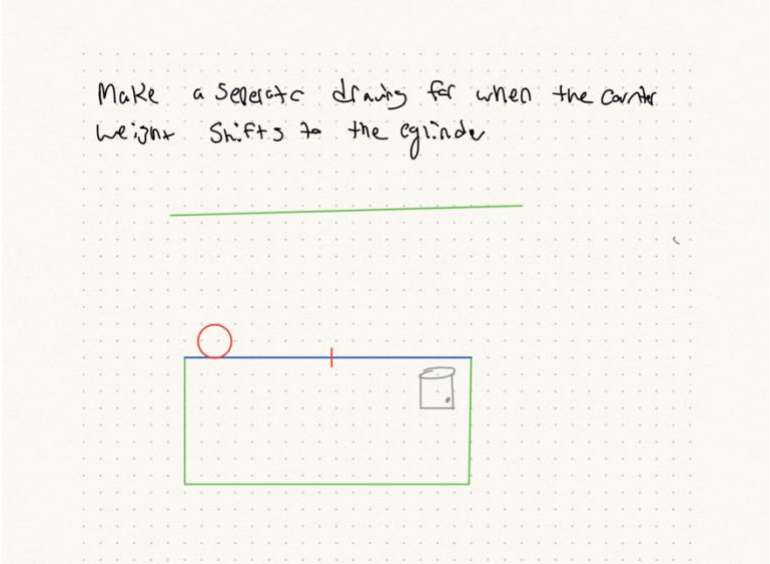
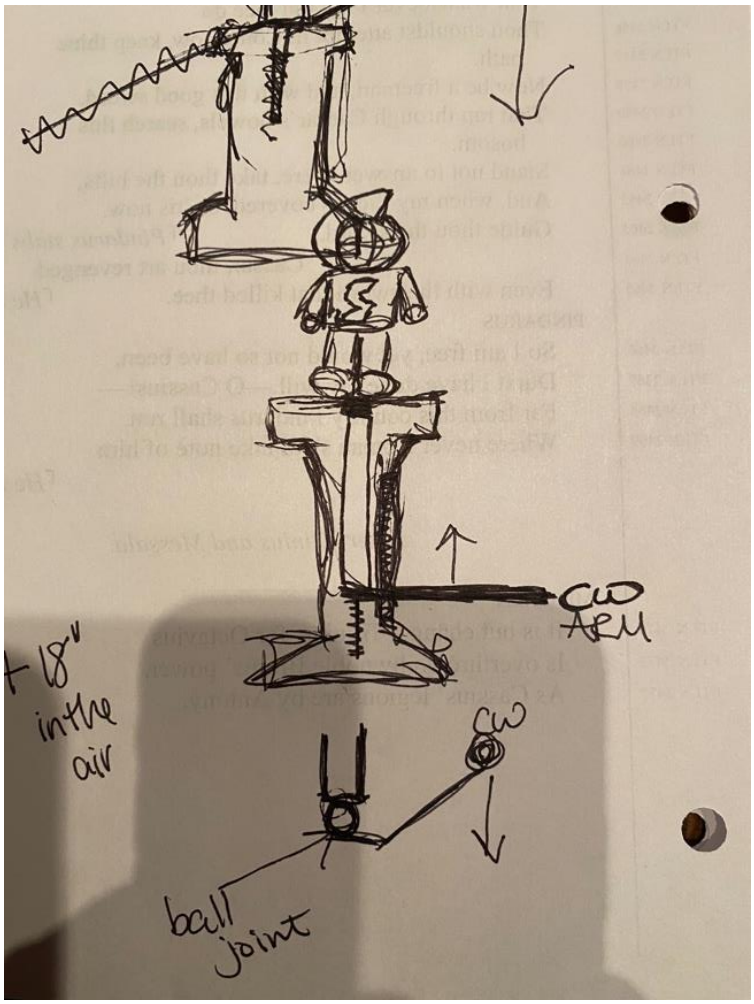
Setup and Instructions for Use

1. Be sure safety pin is inserted while loading.
2. Locate the crossbow mechanism at the top of the head of the device, and place one of the darts in position to fire. (Be sure dart is pulled back and ready to fire)
3. Set up counterweight so it is ready to trigger
4. Remove safety pin and trigger mechanism.


Cylinder = 16"x16"
main = 6" bottom cylin
Counter weight
dart
piston
String
to release
Cross bow trigger


Make a separate drawing for when the counter
weight shifts to the cylinder


CW
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+ 18"
in the
air
CW
ball
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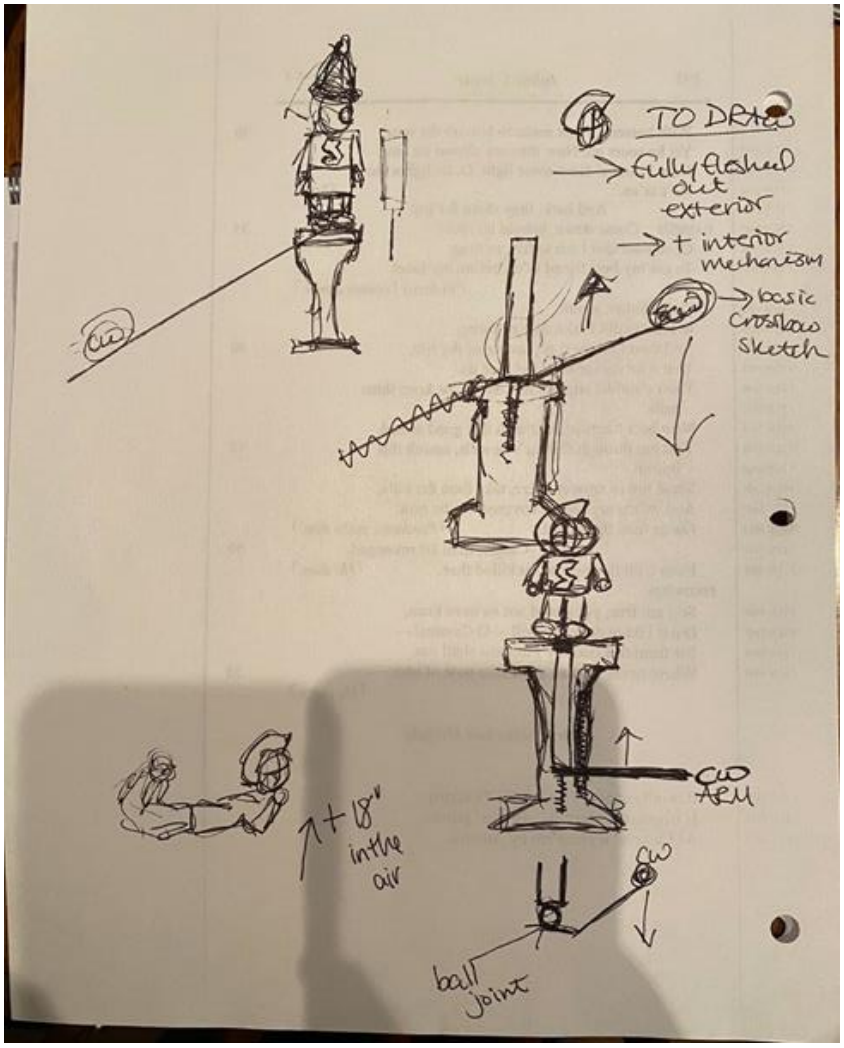
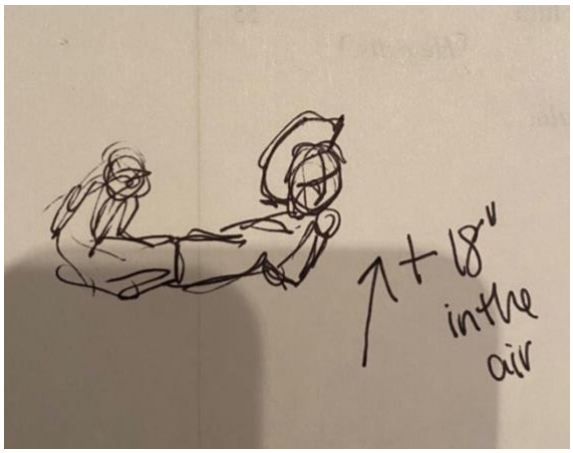
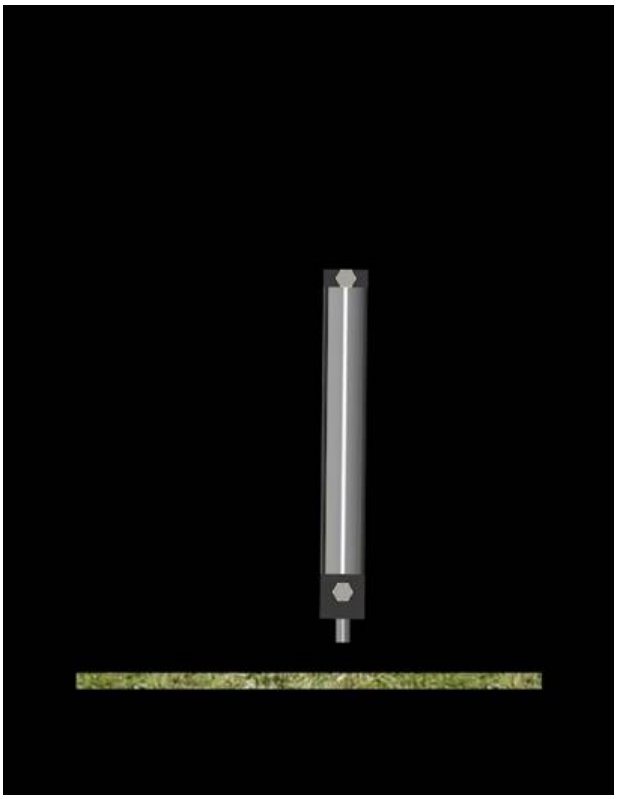
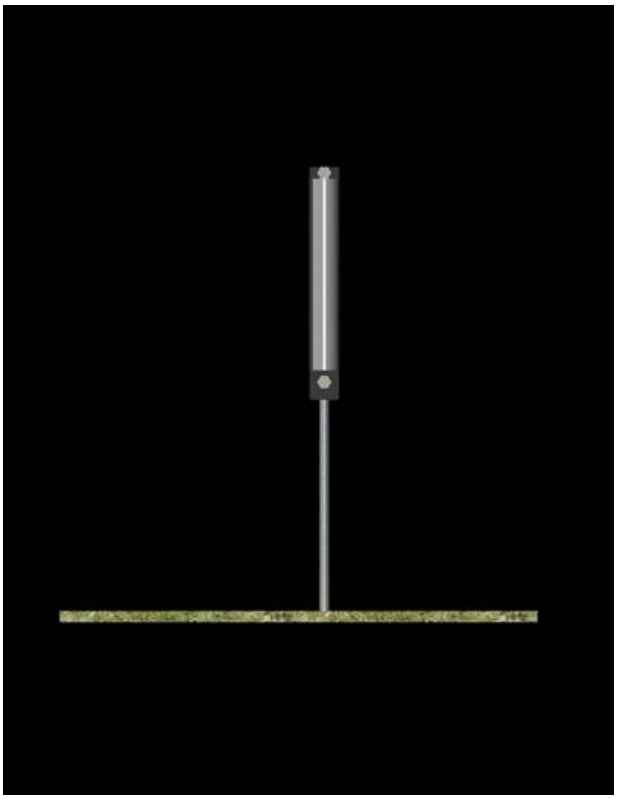
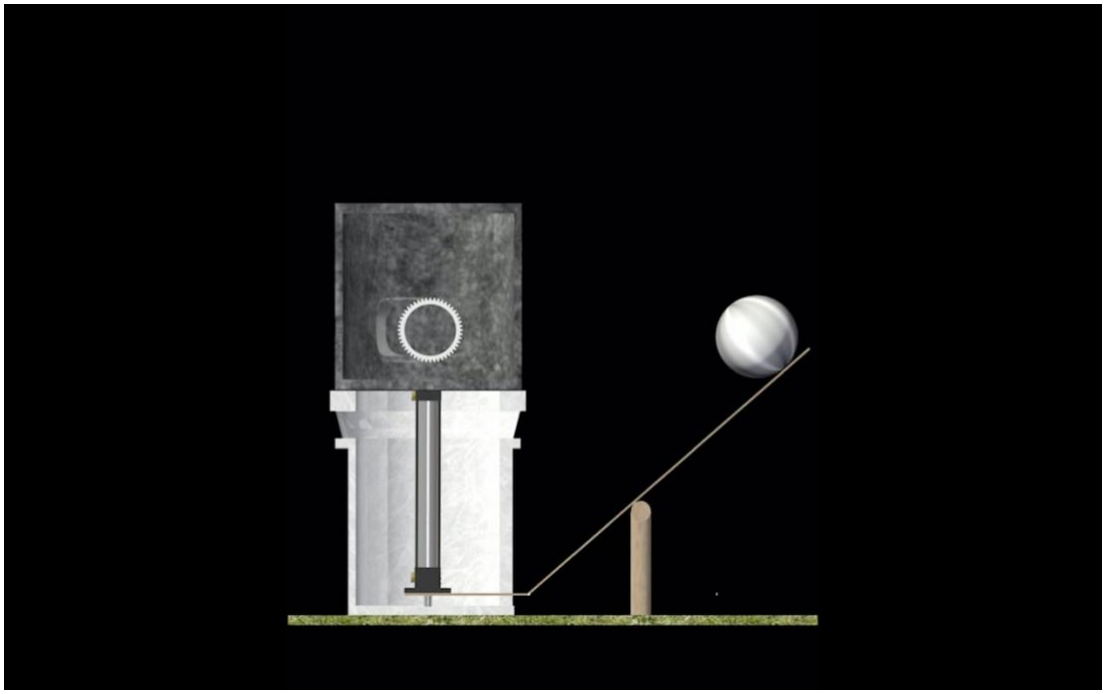


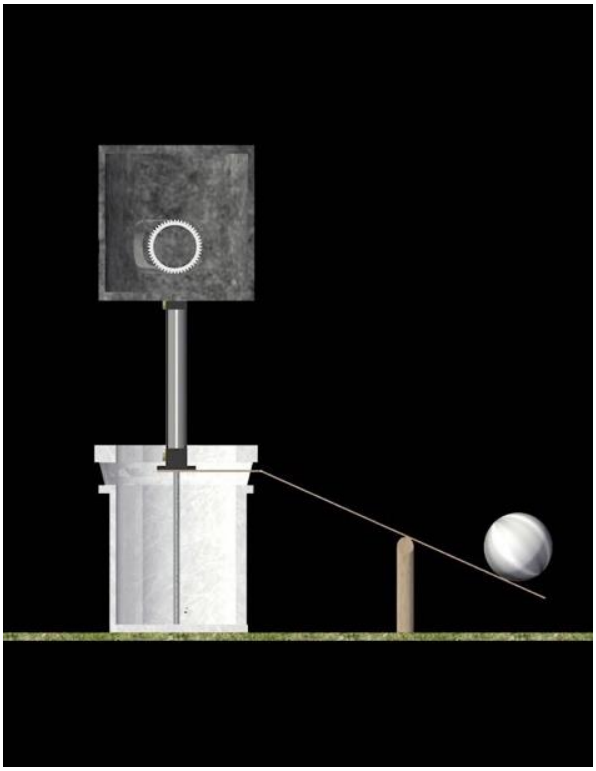


*dart mechanism referenced to with white gear









*white gear referencing dart mechanism