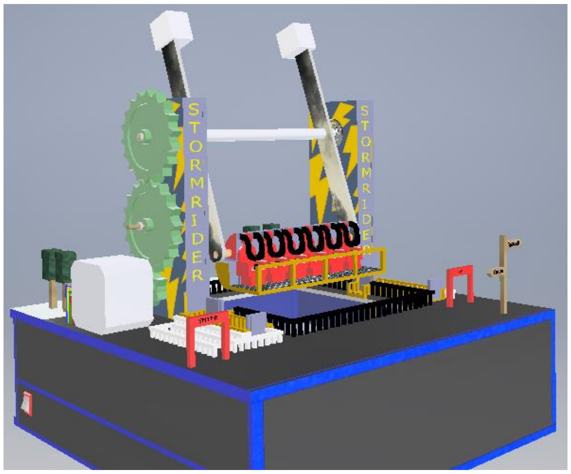
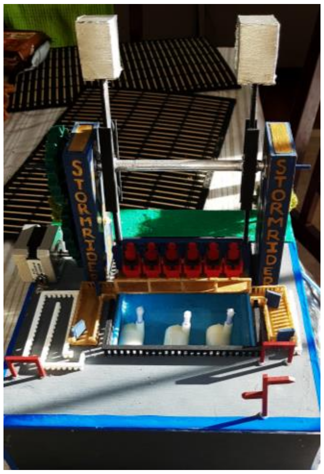
Theme Park Ride

StormRider





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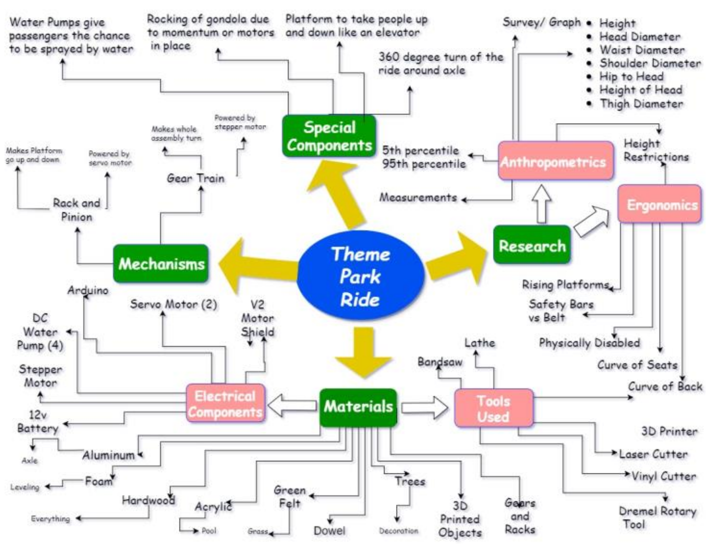
The Situation

Problem

AW Enterprises was invited to participate in a bid for a contract to design and create a ride driven by mechanisms that would be constructed for a theme park in Chinguacousy Park. This event is hosted by city of Brampton and many other engineering consulting organizations have been asked to design and present an idea for the ride. The ride must have an independent power source and work with the use of mechanisms, pneumatic power, electronics, or hydraulics. At least, one accommodation for a physical disability must be made as well. The ride will have a potential earning of $100 000 monthly. Seeing that the city is veering off a recession, the contract will provide AW Enterprises with a major part of the revenue that is needed to continue the company.

Brainstorm and Ideas

Bubble Diagram



. The bubble diagram was created during the initial stages of designing the StormRider. This diagram was created to organize and brainstorm how the ride would be created. It includes the resources and materials available for use and what they could be used for. It also included the anthropometric and ergonomic research that has to be conducts in order to design the ride. Potential mechanisms and what they could be used for were displayed in the diagram as well so, when deciding what ride to make, the mechanisms would help decide which ideas are realistic and achievable. The graph was altered throughout the next stages of the design process so it showed more specific information in regards to the ride being designed. A new section was added to show the special features that would be added to the ride, the features that would make passengers want to ride this ride instead of any other ride.

Idea List

+ Fast, exciting, enjoyable
+ Based on gravity and/or magnets
+ Camera that takes times photos
+ Can have a theme
+ Custom designs (cave, water, underground, can have things pop up)

- Cart might fall off
- Takes up a lot of space
- Loops are not possible

+ Interesting ride
+ Different types of mechanisms
- Similar project has been done before
- Difficult coding is required

+ Interesting (Spinning cart, roller coaster)
+ Doesn't take up much space
+ Has a theme
- Difficult coding is required

+ Doesn't take up much space
- Not too visibly appealing
- Not much creativity can be applied in terms of what it does
- Simple mechanisms

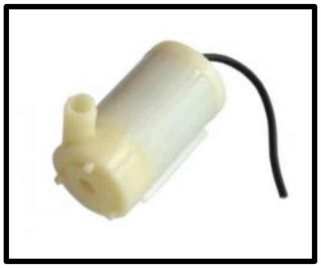
+ Can have a theme
+ Rising and falling of carts, can alternate
+ Doesn't take up much space
+ Add-ons include light and theme related music
- Complex 3D printing carts (depending on theme)

+ Doesn't take up much space
+ Visibly appealing add-ons (lights, designs etc)
+ Extra features include top moving up and down, side to side, tilting etc
- Difficult to achieve different movements
- Hard to make carriages - 3D print

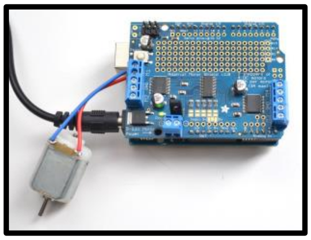
+ Minimal mechanisms, simple to build
+ Can have a theme
- Simple to build
- Not to interesting or complex, boring
- Not much creativity can be applied in terms of what it does

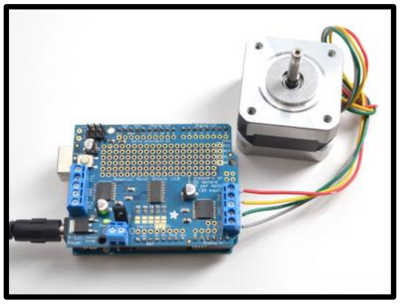
Research

Motors

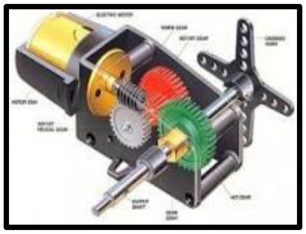


A DC powered water pump was chosen because it is small and requires a small and simple circuit. This way, it could easily be placed under the base and still achieve the task that it is required to do.

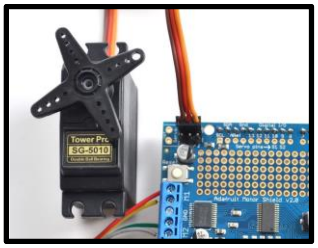




A stepper motor was used to rotate the gondola around the axle. A stepper motor was chosen because it has high torque. This will allow the ride to move smoothly without stalling. The bipolar stepper motor also has a simpler circuit than a unipolar stepper motor. Although the bipolar stepper motor has a more complicated code, the V2 motor shield provides a library so that the code is easier to write up.

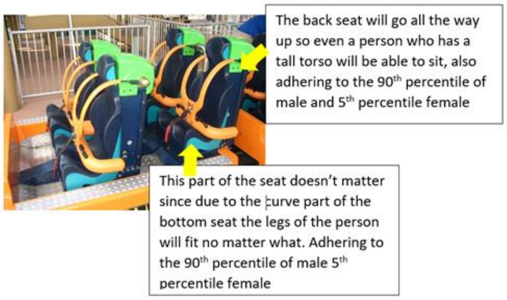


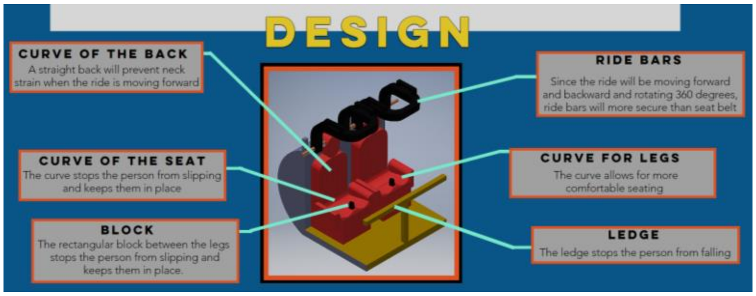
A servo motor was used to move the platform up and down. This motor was chosen because of its small size and simple circuit. The low torque was not a problem because the platform is lightweight.



Ergonomic Research

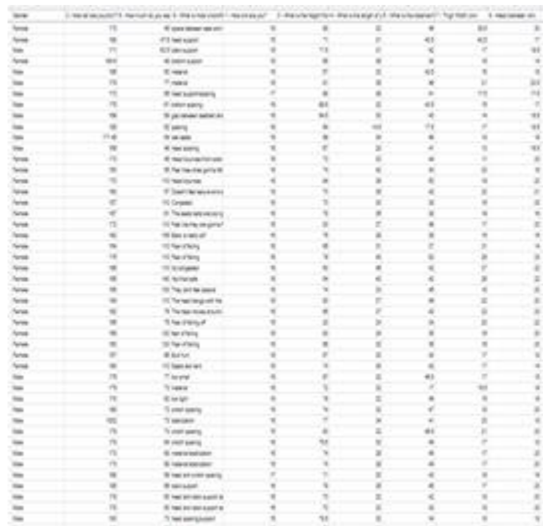
Research has shown that the seats of a theme park ride should not be curved. A curved ride seat can lead to neck and back pain due to the fast and continuous movements of the ride. An overhead safety bar would also be better than a belt because it would better protect the passengers with the turning motions of the gondola





The bottom part of a ride is generally curved at the bottom to avoid people sliding off. Another safety measure added to prevent people from slipping off is a block put between the legs. The StormRider rotates many times so it was important to add these details to make sure that the passenger does not slip off.

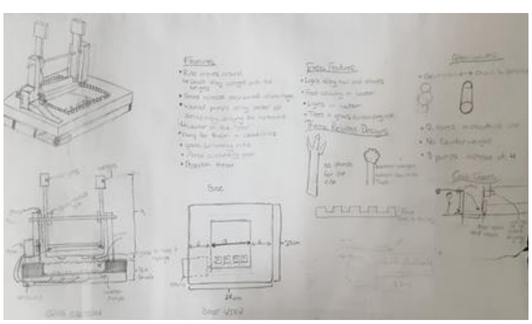
Surveys



This creation of StormRider requires anthropometric data, measurements of potential passengers to determine the size of all the size of the ride as well as the safety features. Information found online conducted by researchers or Human Factors Engineers provides more accurate and unbiased data but not all information was available easily. A survey was conducted of those who were available to determine the relevancy of the data found online as well as measurements that could not be obtained through secondary research. The survey was calculated to find the 5th percentile female and the 95th percentile male (Graphs found in appendix). Using the information found through the survey as well as the data online, the seats and other aspects of the ride were determined so 90% of the population would be able to ride StormRider comfortably with no safety hazards.

Designs

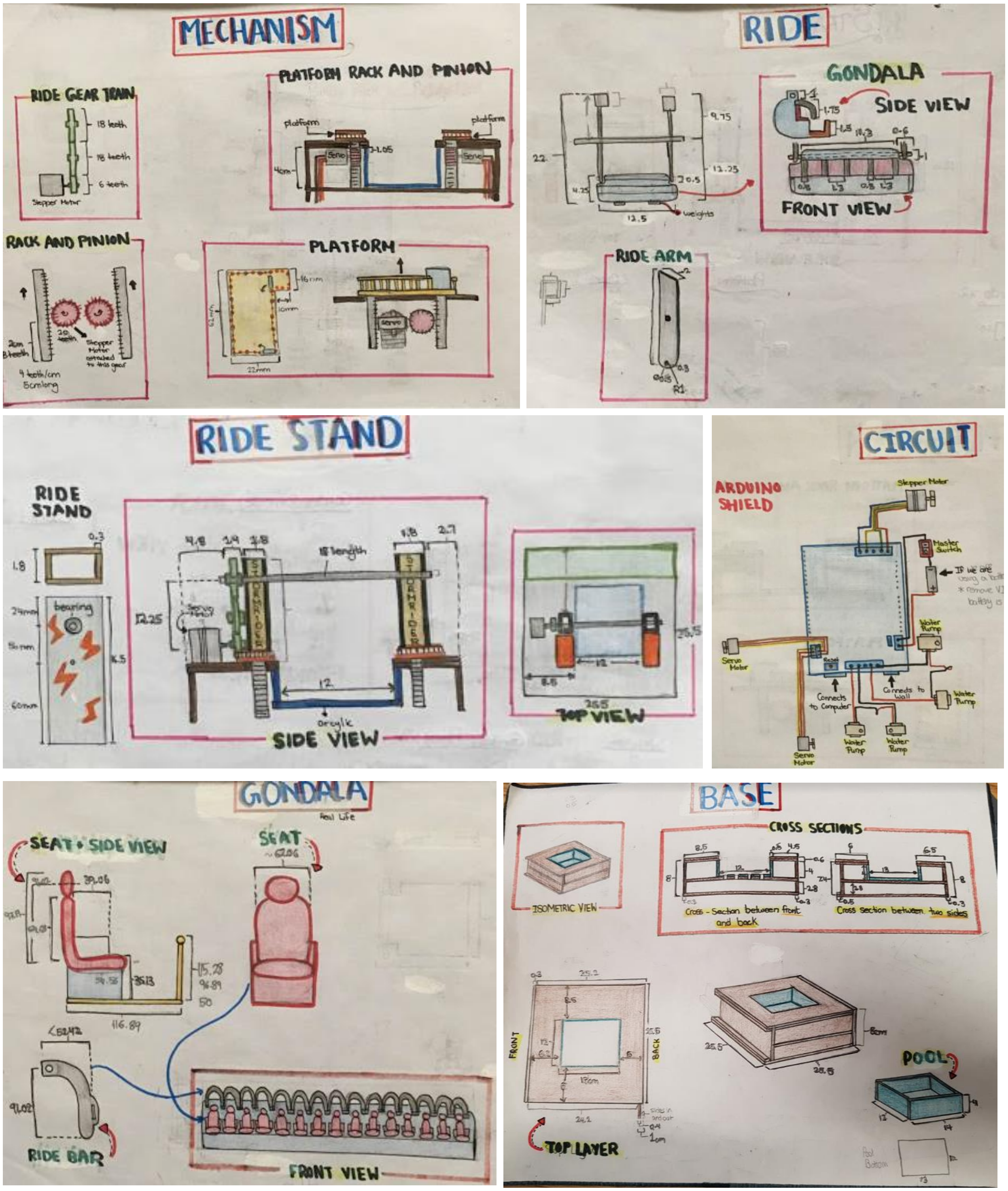
Initial Sketches



While keeping the constraints and criteria in mind, a design was chosen from the top idea choices. After discussing it with the partners, StormRider, a unique take on the ride Riptide from Canada's Wonderland, was what AW Enterprises had decided to make. The model of this ride was to be created in a space of 10" x 10" x 12" using only $50 of personal expenses and using the materials/tools provided in the workshop. This model was to be shown to the City of Brampton 4 week after the design was chosen.

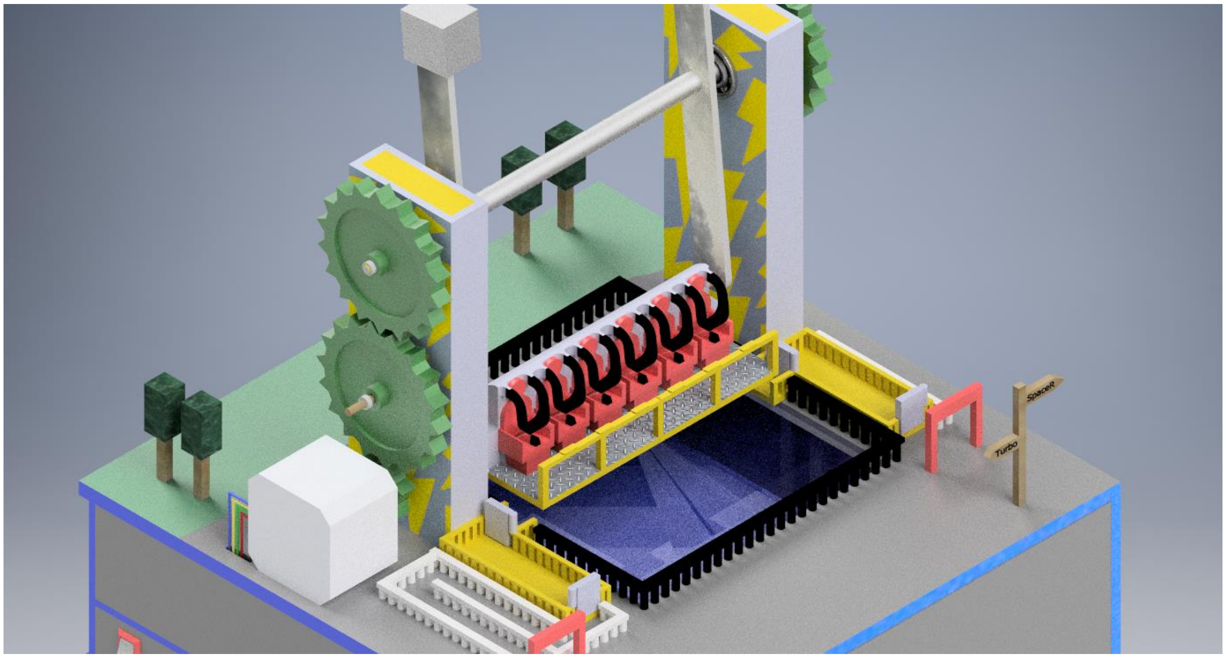
Final Designs

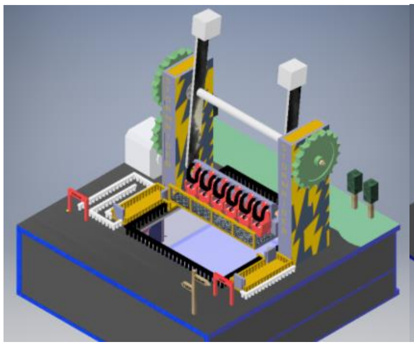
Final Sketch

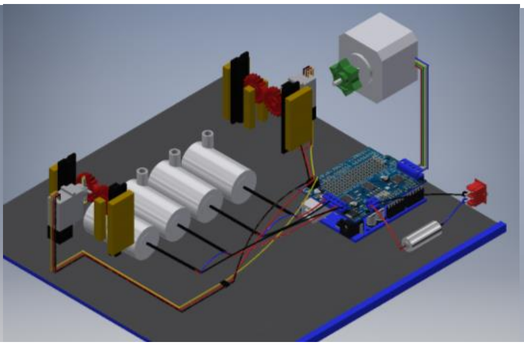


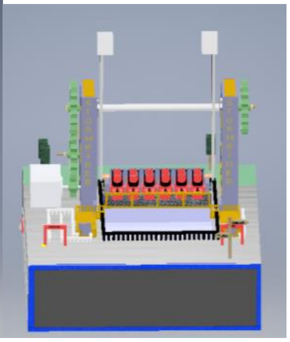
Prototype

Inventor Cad



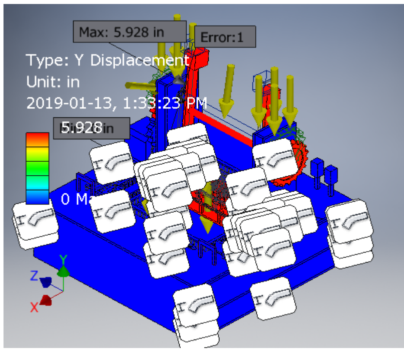


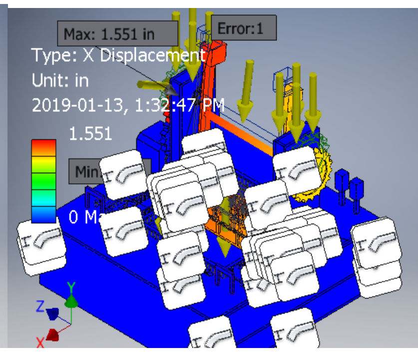


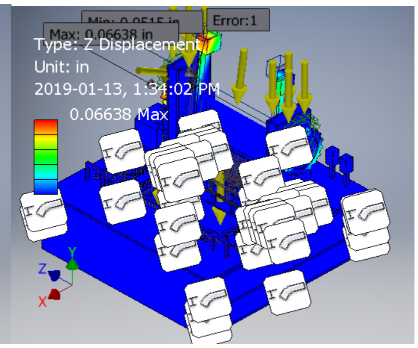


Stress Analysis

A stress analysis was conducted to display the weak points of the design that was created. Most of the results showed that, with all the constraints in place, it was a stable structure. Some of the results did show that the axle, gondola and weights were weak. This was true because those would be the potions rotating around the axle and they would need to be moving with the weights put on it. This stress analysis shows that the arms holding the weights and gondola might be weak too so layers were added to it to make sure it does not break during the rotations of the ride.

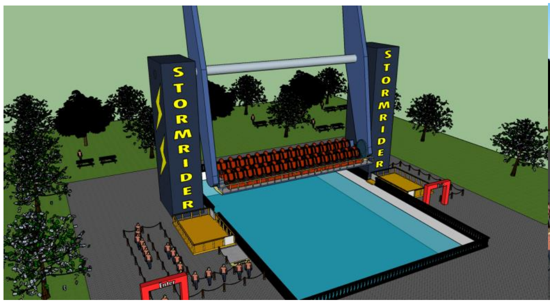


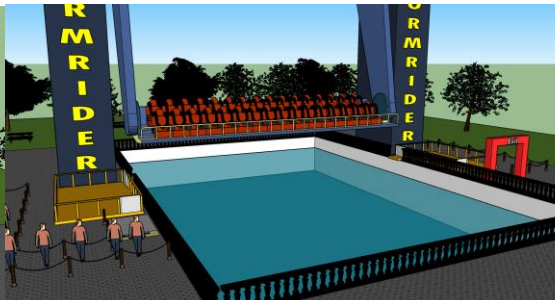




SketchUp Model

The SketchUp model was created to show more realistic images and measurements of the ride.






Construction

Materials Used

- Hardwood was used because it is a strong and sturdy material.
- Acrylic is being used for the pool because it is waterproof and will be able to hold the water while still being aesthetically pleasing. Silicon was added to prevent water from leaking.
- Foam was used because it is easy to adjust to the needed size. It was used as a placement holder for the motors, gears, or electronics
- 3D printed objects were designed to look a specific way with certain details that were essential for the model
- Vinyl was used to add a striking colour and aesthetic value to an otherwise dull base
- Trees, Felt (grass), signs were put in to add aesthetic value and details

- Aluminum was used because it could be machines to the size needed to fit bearing through it. It is also a strong material to be able to handle the weight of the gondola being placed on it.
- Stepper Motor was used because it has a lot of torque
- Servo Motor because it is easy to control and small
- Rack and pinion was used to move the platform up
- V2 Motor Shield was used because it simplified the circuit
- Vex Gears were used to connect the axle to the stepper motor
- 2 1.5 Volt batteries and a breadboard were used to power the water pumps
- DC water pump was used to spray water from the pool into the air

Problems faced

The creation of StormRider involved many different components which resulted in many things going wrong, no matter how much panning had been done beforehand.

The pool leaking had been a big problem. The acrylic used for the pool was not cut with straight edges and there were holes that allowed water to leak. This problem was solved by using silicon to cover up the holes. We had also realized that the water pumps might not be completely waterproof so, in order to solve this problem, tubing was added to the motor to prevent water from getting in.

The weight of the gondola had also created a weight problem in our design. The gondola was too strong and the motor was not strong enough to turn it without stalling. To fix this problem, counterweights made out of clay were added to the ends. This made it easier for the motor to turn the gondola. The gondola also had a natural tilt to it because of the way it was designed. The tilt was designed so the gondola would be facing downwards when coming in face with the water shooting up from the water pumps but this becomes a problem when passengers are trying to get onto the ride. The tilt makes it unsafe for people to board the gondola. This problem was solved but constraining the gondola to the ride arms. This constraint stopped the gondola from tilting which lowered the thrill factor of the ride, but not by much.

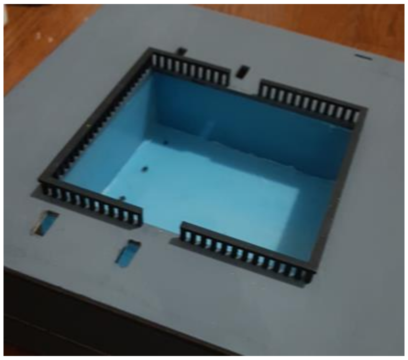
The motors itself were a problem too. The motors that were decided upon had complicated circuitry. Too many wires under the base would make the possibility of loose connections or something going wrong more. This problem was solved after consulting other members of the same profession. They recommended using a v2 motor shield which was designed specifically for motors. This made the circuitry more simple easy to follow.

Evaluate

Special Features

Pool

This ride is unique because it mixes the two elements of a land ride as well as a water ride. The pool is able to spray water up at the passengers on the ride.



Platform

The platform for this ride was designed to act as a lift. This lift would take people up to the level of the gondola. Originally, the ride was designed to have a ramp that would take the passengers to the gondola but that introduced many problems. The space between the gondola and the ramp would be too large for passengers to get on safely. If the ramp was extended, it would get in the way when the gondola was turning. This is way a platform that moved up and down was the best solution.

Gondola

The gondola itself is a unique feature that was made for the ride. The gondola allows more people to sit on the ride because it has two floors or levels to it. The gondola was also designed by taking in account the anthropometric and ergonomic research. The seats were curved and at in incline. The measurements used for seats were also made to accommodate for the 90 percent of the population; 90th percentile male, 5th percentile female.

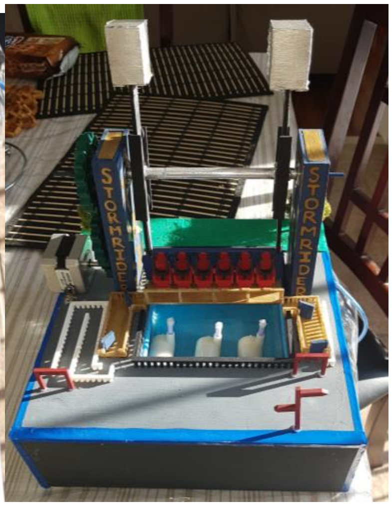
Reflection

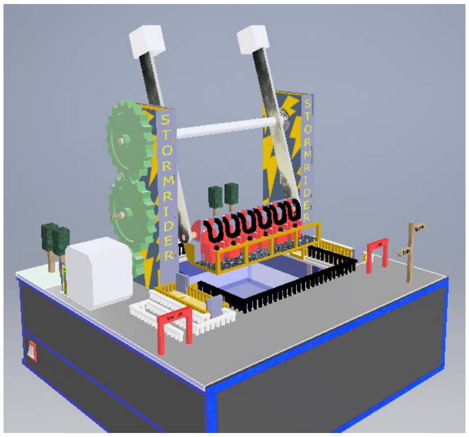
The design and application of this ride is a success because it fulfills the required criteria. The model of this ride is created in a 10” x 10” x 12” scale and is powered through an independent power source. The ride also uses mechanisms to function. The stepper motor moves the gondola 360 degrees around the axle with the help of gears. The gear train provides a mechanical advantage of 3. The ride also used a rack and pinion mechanism powered through a servo motor to move the platform up and down.

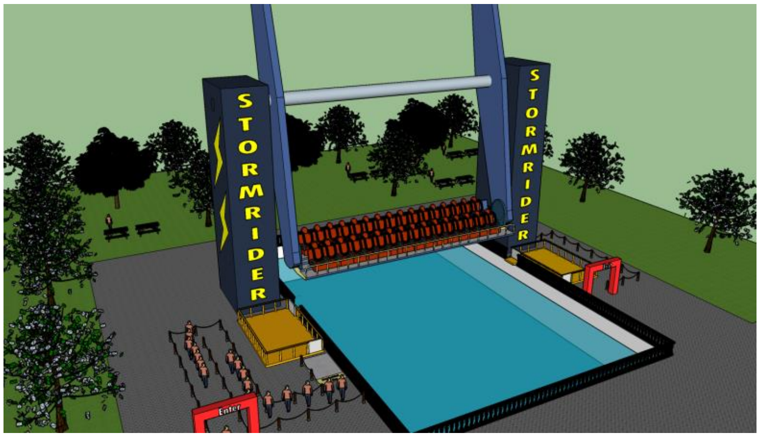
The gondola was unable to tilt because of the constraint put on it so one of the changes that would like to be added to the includes a motor on the side of the gondola. This motor would be able to turn the gondola independently while the ride itself is turning around the axle. This would raise the thrill level of the passengers.

Another future change includes more control over the water pumps. The motor shield only had space for 2 DC motors while in reality, there were 3 motors that needed to be coded. In the future, the circuit would be designed so all 3 motors could be coded and go off when the ride is above the water,

An aesthetic component that could be added to the model design includes RGB lights. These lights would be placed around the pool and would be coded to change colours in certain intervals. This way the water would seem like it has many different colours and makes the ride looks more attractive at night. Lights could also be added to the ride stands that were holding up the ride and the axle. Through this addition, the ride could be seen from far away and would be able to attract more attention to the ride.







Links Used For Research

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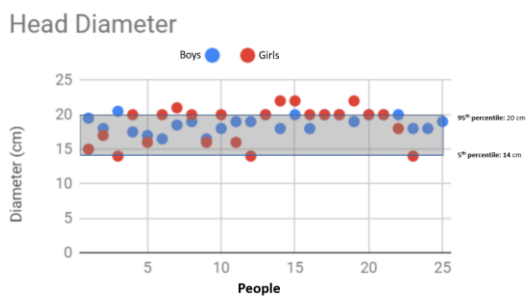
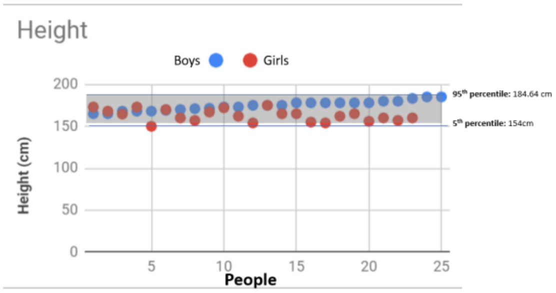
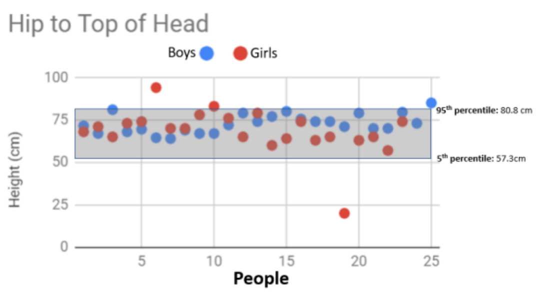
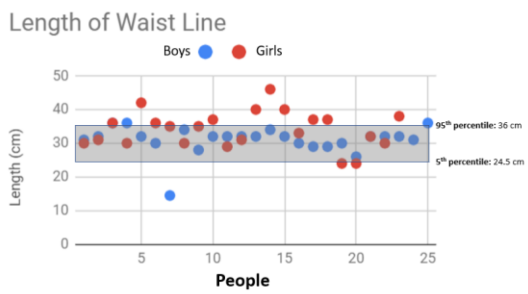
Appendices

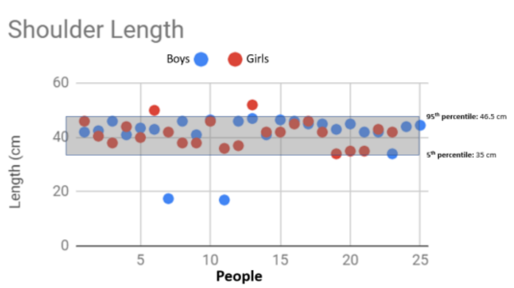
Anthropometric Data Conducted from Surveys

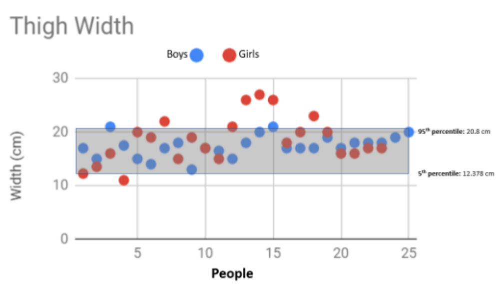


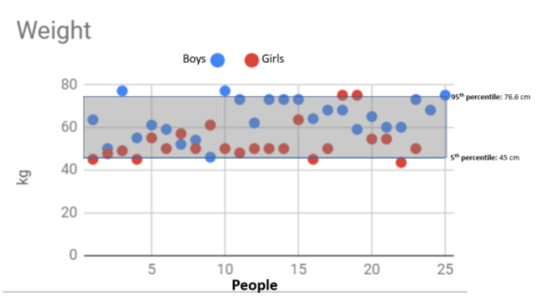












CALCULATIONS

Gear Train System

$$\text{Gear ratio} = \frac{\text{number of teeth on the driven gear}}{\text{number of teeth on the driver gear}} = \frac{18}{6} \text{ or } \frac{3}{1}$$

Gear ratio $= 3{:}1$

Three rotations of the stepper motor results in one rotation of the gear with the axle and the ride.

Rack and Pinion System

$$\text{velocity ratio} = \frac{\text{number of teeth on the pinion}}{\text{number of teeth on the rack/cm}} = \frac{20}{4}$$

$$= 5 \text{ cm}$$

1 rotation of the pinion makes the rack move 5 cm

We need it to move up by 2cm

8 teeth from the rack would result in 2 cm being moved up
(4 teeth per cm x 2 cm = 8 teeth)

$$\frac{8}{20} = \frac{?}{360} = 0.4$$

The gear would have to turn about 144 degrees to raise the platform to the level it has to be at.