Grades 6, 7, &8

STEM Club Amusement Park Challenge

Problem How can we create an amusement park with the best rides?

Lesson Summary *Club members will be presented with a series of challenges with increasingly larger demands and more intricate design properties. The final challenge will incorporate planning/budgeting, story-board schematics before building, construction, testing of design and animation program as well as cost analysis.*

Major Topic and SOL

Math SOL (2009)

6.7 (The student will solve single and multi-step practical problems involving addition, subtraction, multiplication and division of decimals.)

7.3 (The student will add, subtract, multiply and divide integers.)

8.1 (The student will simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers.)

Science SOL (2010)

6.2 The student will investigate and understand basic sources of energy, their origins, transformations, and uses.

LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
a) models and simulations are constructed and used to illustrate and explain phenomena;

PS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
a) models and simulations are constructed and used to illustrate and explain phenomena;

Language Arts SOL (2010)

6.1 The student will participate in and contribute to small-group activities.
a) Communicate as leader and contributor.
b) Evaluate own contributions to discussions.
c) Summarize and evaluate group activities.
d) Analyze the effectiveness of participant interactions.

6.2 The student will present, listen critically, and express opinions in oral presentations.
b) Compare and contrast viewpoints.
c) Present a convincing argument.

Length of Time: 1 hour per available week (approximately 25 weeks)

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Student Objectives

- The students will work in 5 cooperative teams of 5 or less
- The students will, using the particular challenge guidelines, design, build, animate using Hummingbird Robotics, and program using Visual Programmer, Scratch, or Arduino, the requested amusement park ride.
- The students will compare and evaluate the different groups' products using a rubric specific to the current challenge mathematically deciding which of the 5 entries will be used by the club in the final amusement park assembly. All non-winning entries will be unassembled so that the robotics and the materials can be reused.
- Students will use team journals to record their progress and ideas allowing them to communicate from one week to the next.
- Students will track supplies used and extrapolate a total expense for their team project which from the 3rd challenge on will be a Rubric Requirement.
- Students will utilize an excel spreadsheet to create a budget plan based on preliminary drawings. This spreadsheet will be used to analyze actual versus budget expenses which from the 4th challenge on will be a Rubric Requirement.

21st Century Skills

- Critical-Thinking and Problem Solving
- Communication
- Creativity and Innovation
- Collaboration
- Information and Media Literacy
- Contextual Learning

Assessment Evidence

- Observations of all soft skills
- Rubrics for each challenge.
- Team Journals
- Photo Journal

Supplies/Materials/Technology

- Sharps Sign-out Sheets
  (*please see attachment*)
- Hummingbird Robotics Kits (5)
- 8 laptops preloaded with the necessary software
- Assorted arts and crafts materials to include
  - Hot Glue guns and glue sticks
  - Craftsticks
  - Decorative materials such as googly eyes, buttons,

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- Duct Tape
- Construction Paper
- Cardboard, empty toilet paper/paper towel cardboard rolls
- Pipe cleaners
- Zip ties
- Exacto Knives and Cutting mats
- Safety gloves and eyewear
- Scissors
- Precision screwdriver sets
- Assorted rulers, protractors, and compasses.

Challenge 1: (5 – 1 hour periods)

- Students will be introduced to the Hummingbird Robotics kit and the Visual Programmer platform by which to program it.
- First challenge only requires basic conditions which does not include tracking of supplies.
- Please see Challenge 1 attachment for Pendulum Ride

Challenge 2: (7 – 1 hour periods)

- The Engineering demands have been increased as well as the expectations for aesthetics.
- This challenge also requires the tracking of supplies, to include waste, and the introduction and use of a Team Journal so that members can plan and communicate from one session to the next.
- Please see Challenge 2 attachment for Centripetal Ride

Challenge 3: (9 – 1 hour periods)

- This challenge will require the pairing of more than one motor and/or servo to create the ride. This challenge will require that the engineering be planned on story boards before the assembly can start. Along with this the members must again track supplies/waste and extend these totals based on provided material costs to derive a total cost of project.

Challenge 4: (6 – 1 hour periods)

- This challenge will require the pairing of more than one motor and/or servo to create the ride. This challenge will require that the engineering be planned on story boards before the assembly can start. Members will also be required to complete a preliminary budget based on their drawings. A formatted spreadsheet will provided that will assist with this process and allow for multiple concepts and anticipated costs to be compared. Members must again track supplies/waste and extend these totals based on provided material costs to derive a total cost of project which, based on a rubric guide, will be compared with their projected costs

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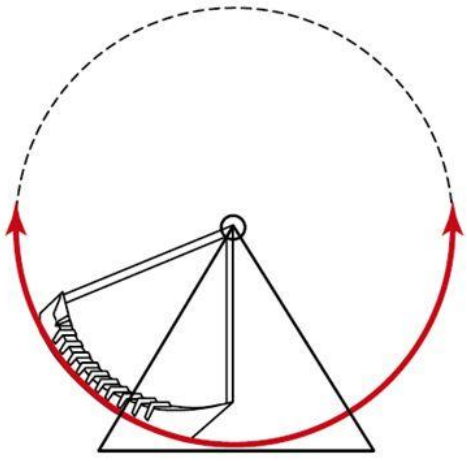
STEM Club Challenge 1

Design, build, and animate a Pendulum Ride similar to the "Battering Ram" at Busch Gardens Williamsburg.

Pendulum Rides

- Although most pendulum rides do not make a full circle, riders do experience circular motion.
- Swinging back and forth on this curved path allows you to feel the sensations of both high and low G's.



A drawing of a typical pendulum-type ride.

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Considerations:

Size of Model

In the dormant (ride not running) position, the ride model may not exceed a 12 inch by 12 inch footprint. There are no height restrictions.

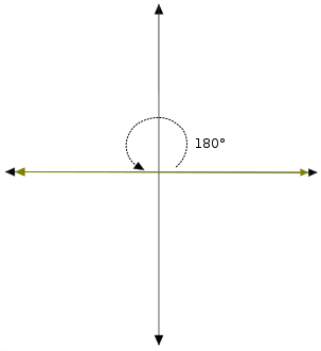
Animation:

The design must take into consideration how the ride motion will be achieved.

Our two mechanical options are:

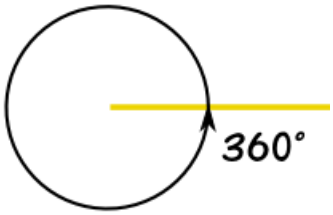
The Servo

which offers 180 degree movement,



The Motor

Which offers 360 degree



continuous movement.

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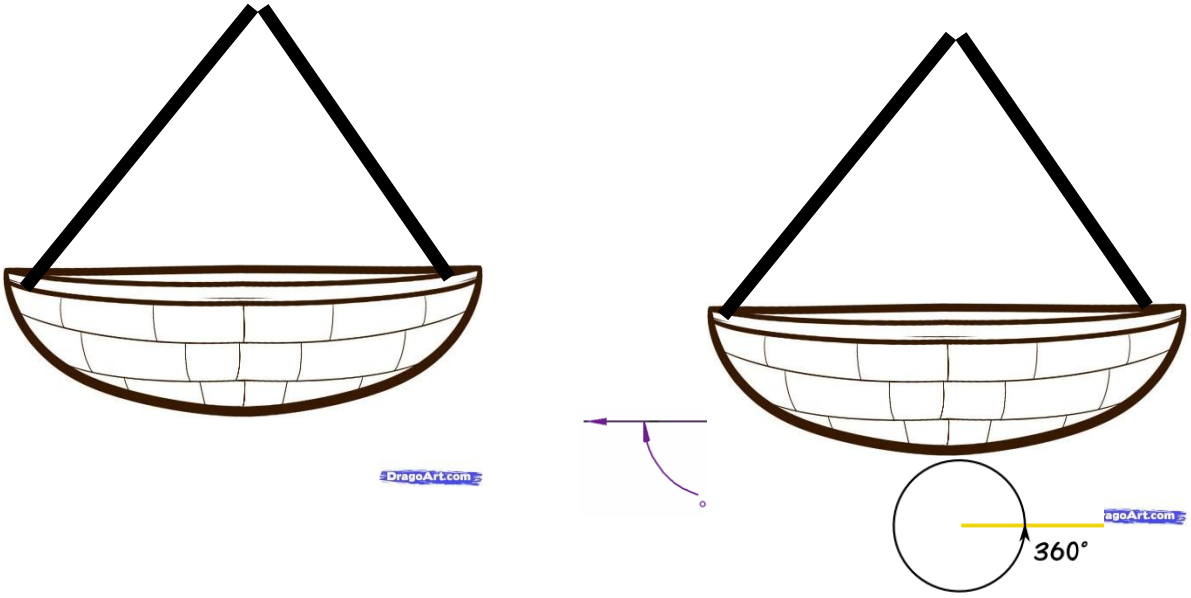
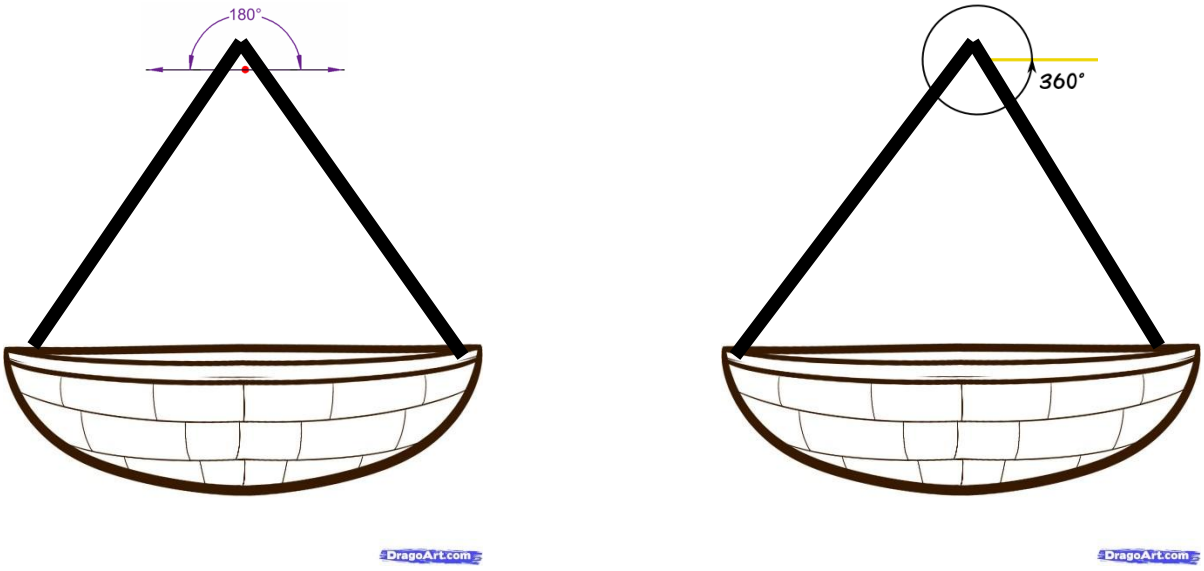
Should the motor or servo be under the boat?



Should the servo or motor be at the top of the pendulum?



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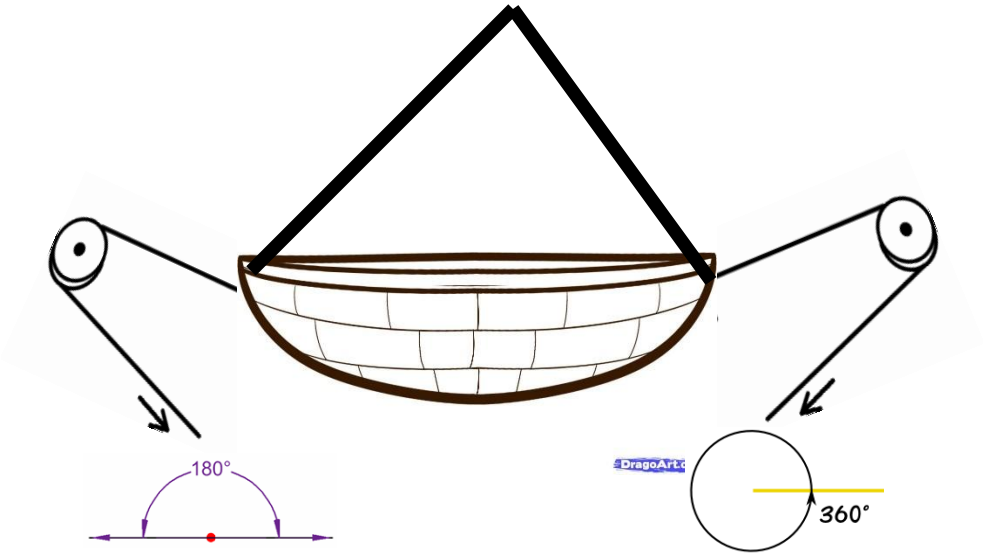
Could a rope and pulley system be used?



How will servos, motors, lights etc. be disguised so riders cannot see the wires?

Will the programming take into account the ride “start up”?

(Gradual increase in boat rotation at beginning and gradual decrease at end)

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Pendulum Ride Design

Group Number: _____

CATEGORY	4	3	2	1
Completion	The entire project is complete.	Most of the project is complete.	Half of the project is complete.	Less than half of the project is complete.
Measurements	In the dormant (ride not running) position, the ride model does not exceed the 12 inch by 12 inch footprint. (144 square inches)	In the dormant (ride not running) position, the ride mode slightly exceeds the 12 inch by 12 inch footprint. (144 square inches)	In the dormant (ride not running) position, the ride model exceeds a 15 inch by 15 inch footprint. (More than 225 square inches)	In the dormant (ride not running) position, the ride model exceeds an 18 inch by 18 inch footprint (More than 324 square inches)
Use of Hummingbird Robotics	Robotic accessories used in a proper fashion. More accessories were used than just a motor or a servo.	Robotic accessories used in a proper fashion. Accessories used were just a motor or a servo.	Robotic accessories used in a proper fashion. Programming was done but motors and servos not attached.	Did not have an opportunity to program the robotics.
Design	Ride is well organized and attractive to the eye. All wires, motors, servos, and circuit board are not visible.	Ride is organized and attractive to the eye. Most of the wires, motors, servos, and circuit board are not visible.	Ride is somewhat organized. Many of the wires, motors, servos, and circuit board used are visible.	Ride still in basic construction phase.

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STEM Club
Challenge 2

Design, build, and animate a Centripetal Ride similar to the Carousel at Busch Gardens Williamsburg.

- Centripetal means 'center-seeking' and is the force that is acting on the carousel. The platform upon which the horses and people are riding is the centripetal force that keeps them traveling in circular motion. As long as the ride is moving slowly enough, the centripetal force of the platform can keep everyone and everything on board. In theory, if the carousel starts moving really fast, centrifugal force* ('center-fearing') takes over and breaks the hold the platform (centripetal force) has on the riders and the riders will fly off. (Amusement Park Rides & Physics, 2015)

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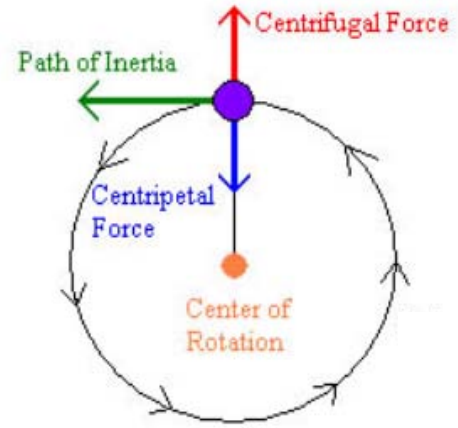

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Considerations:

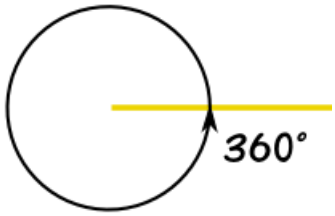
Size of Model

The ride model, without the que area (the area where riders line up and wait to get on the ride), must be at least 10 inches in diameter but may not exceed a 15 inch by 15 inch footprint.

There are no height restrictions.

Animation:

The motion of the centripetal ride will be accomplished using the Motor



Which offers 360 degree continuous movement.

A centrally located, vertically mounted motor will require the ride to be balanced and symmetrical.

Structure Requirements:

The outside structure of the ride, for safety considerations, must be stationary. The ride itself must revolve within this solid structure but must be completely visible from all views.

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Structure Considerations:

If additional functions such as lights, vibration, or sensors are used, you must consider that wires will twist if these functions are incorporated in the moving component of the ride. Consideration should be given to mounting these to the outside stationary structure.

Sound Requirements:

Ride must have a musical component to entice younger riders to ride.

Aesthetic Requirements:

All motors and wires, other than the main feed wires to the circuit board must be concealed.

In an effort to track the amount of supplies and robotic components we are using, (solely for the purpose of making sure we do not run out) please track all supplies used or wasted on the following tally sheet.

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Centripetal Ride Design

Group Number: _____

CATEGORY	4	3	2	1
Completion	The entire project is complete.	Most of the project is complete.	Half of the project is complete.	Less than half of the project is complete.
Measurements	In the dormant (ride not running) position, the ride model does not exceed the 15 inch by 15 inch footprint. (225 square inches)	In the dormant (ride not running) position, the ride mode slightly exceeds the 15 inch by 15 inch footprint. (225 square inches)	In the dormant (ride not running) position, the ride model exceeds an 18 inch by 18 inch footprint. (More than 324 square inches)	In the dormant (ride not running) position, the ride model exceeds an 19 inch by 19 inch footprint (More than 361 square inches)
Use of Hummingbird Robotics	Robotic accessories used in a proper fashion. More accessories were used than just a motor or a servo.	Robotic accessories used in a proper fashion. Accessories used were just a motor or a servo.	Robotic accessories used in a proper fashion. Programming was done but motors and servos not attached.	Did not have an opportunity to program the robotics.
Design	Ride is well organized and attractive to the eye. All wires, motors, servos, and circuit board are not visible.	Ride is organized and attractive to the eye. Most of the wires, motors, servos, and circuit board are not visible.	Ride is somewhat organized. Many of the wires, motors, servos, and circuit board used are visible.	Ride still in basic construction phase.
Planning Document	Every step was planned and document was completed.	Every step was planned, document was not completed	All steps were not planned and document was partially completed.	No planning was done and document was not utilized
Use of Music	Music starts when ride commences and ends appropriately. Appropriate type of music used.	Music starts when ride commences but does not end at the appropriate time.. Appropriate type of music used.	Music does not starts when ride commences and does not end at the appropriate time.. Appropriate type of music used.	No attempt to use music was made.
Supply Tracking	All materials including waste was tracked, tallied and totaled on tracking sheet.	Materials were tracked, tallied and totaled on tracking sheet but waste was not accounted for.	Not all materials were tracked, tallied and totaled on the tracking sheet.	Tracking sheet not utilized.

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Centripetal Ride Material List

ITEM	TALLY	TOTAL USED
Hot Glue Sticks		
Craft Sticks		
Construction Paper (full sheets used)		
Pipe Cleaners		
PomPoms (each)		
Googley Eyes (x2)		
Pencil		
String/wire (1 foot)		
Duct Tape (1 foot)		
Scotch Tape (1 foot)		
Zip Tie		
Styrofoam Ball		
Toilet Paper Roll		
Cardboard (by approx. square foot		
Servo		
Motor		
LED light		
TriColored LED light		
Vibration Motor		
Sensor		

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STEM Club Challenge 3

Design, build, animate, and derive a final cost of materials for a Rising, Tilting, Centrifugal Force Ride similar to “Der Wirbelwind” Swing Ride at Busch Gardens Williamsburg.

Centrifugal Force

When something is going straight, it always keeps going straight unless something else stops it or turns it. If it can't go straight, then it goes as straight as it can. So when you hit a tetherball, it tries to go straight away from you. But the rope pulls on it and keeps the tetherball from going straight. So the tetherball goes as straight as it can - around the pole in a circle. That's centrifugal force - the energy of something trying to go straight even though it can't.

The Earth is also affected by centrifugal force. It is moving, so it tries to keep moving in a straight line. But the gravity of theSun pulls the Earth toward it, just as the rope pulls the tetherball. Gravity can't pull the Earth into the Sun, because the Earth keeps trying to go straight. So the Earth takes a middle road, going in a circle around the Sun. *Exerpt taken from* *http://quatr.us/physics/machines/centrifugalforce.htm*

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Ride Animations:

"The Swashbuckler" Six Flags Magic Mountain

The ride in its dormant state must be low enough for the riders to easily enter and seat themselves. The ride must then lift the riders from the ground to prevent injury when the rotations start.

"The Texas SkyScreamer" at Six Flags Over Texas allows up to twenty-four riders to sit in open-air swings while spinning in a 124-foot circle at speeds up to 35mph, 400 feet above the ground.

Read more: http://www.dailymail.co.uk/news/article-2331066/Six-Flags-Over-Texas-Amusement-Park-Worlds-highest-swing-ride-opens-taking-thrill-seekers-400-FEET-air.html#ixzz3yZQDu12x
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Once the ride achieves its full height and commences its rotations, the rotating carriage must tilt to add extra excitement for the riders.

When the ride has finished, total duration between 2 minutes 30 seconds and 3 minutes, the ride must level, gradually stop rotating and lower to the ground to allow the riders to exit.

Considerations:

Support of the entire ride is critical which includes the motor/servo mounts. The ride must maintain a balanced appearance even though weight will shift when the rotating carriage is tilted. The center support is critical to the success of this ride.

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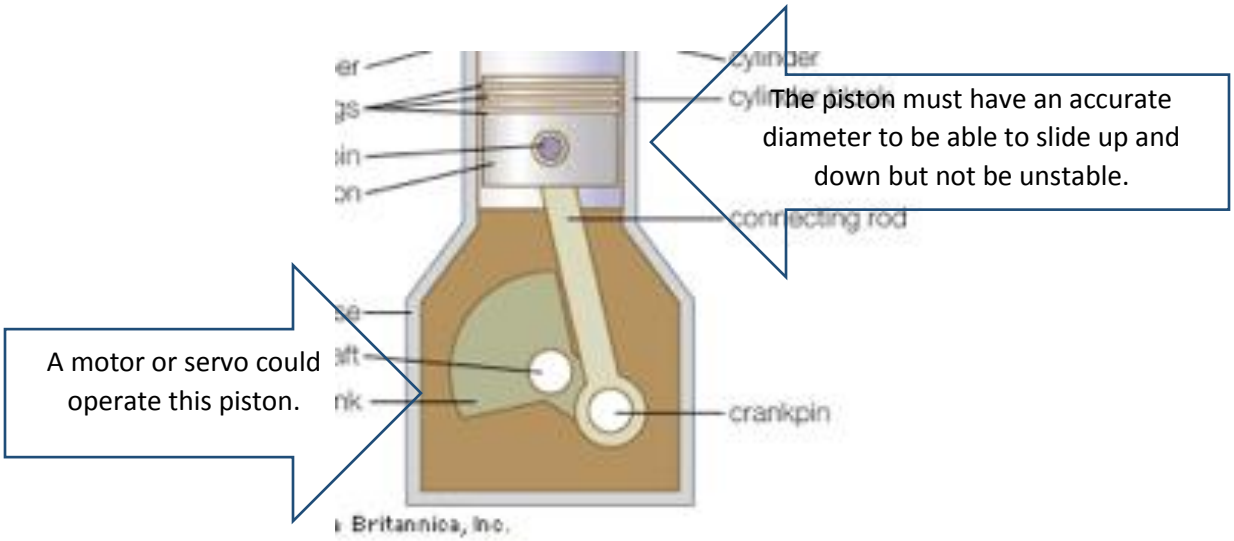
The lift process could be achieved using a piston approach like that of an automobile engine but, we are open to other approaches.



Capacity Requirements:

Ride must accommodate no less than 12 riders.

Light Requirements:

Due to the height of this ride when lifted, stationary blinking lights must be at the highest point due to air traffic concerns.

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Sound Requirements: Ride must have a musical component that will entice young adult riders with music programmed to correspond with the ride operation.

Size of Model:

The ride model, without the que area (the area where riders line up and wait to get on the ride), must not exceed a 20 inch by 20 inch footprint.

The center post must have a diameter that is 6 inches or less.

The height of the model has no restrictions but, when the ride commences, the riders must be lifted a minimum of 2 inches.

Planning:

Due to the complexity of this model, supplies for construction will not be provided until plans are prepared for the appearance, operation, and programming of this ride. Once basic plans are drawn, roles assigned (job foreman, construction specialists, programmer, and aesthetic designer), and plans are signed-off by Mrs. D, Mr. B, or Mr. W, you may start construction. To help with your planning we have

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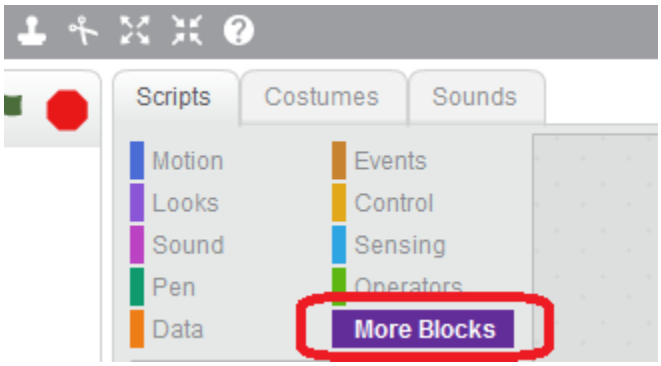
provided Design Planners for you draw on and a Role Roster to assign responsibilities with.

Programming:

Due to the complexity of this challenge and the need to have more than one function occurring at the same time it is recommended that you use the Scratch platform.

Launching Scratch with Hummingbird

1. Plug in a Hummingbird.
2. Start the BirdBrain Robot Server helper application.(This is located on your desktop.)
3. Start Scratch 2.0 by pressing the **Open Scratch** button on the BirdBrain Robot Server. In Windows/Mac, the Hummingbird Scratch blocks should be pre-loaded under the **More Blocks** category:



Hummingbird Block Descriptions

Motor Commands

- **HB servo:** Sets servos 1 through 4 to a value from 0 to 180 degrees.
- **HB motor:** Sets motor port 1 or 2 to a value from -100 to 100.
- **HB vibration.** Sets vibration motor 1 or 2 to an intensity value from 0 to 100.

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LED Commands

- **HB LED:** Sets the intensity of light on a single color LED on ports 1 through 4. Intensity ranges from 0 to 100.
- **HB triLED R G B:** Sets the full color LED at port 1 or 2. The R, G, and B arguments control the intensity of the red, green, and blue elements in the tri-color LED. Range is 0 to 100 for each color.

Sensors

All sensing commands allow the user to specify a number corresponding to the port the sensor is on. For example, a distance sensor on port three would be read by Hummingbird distance on port 3.

- **HB temperature:** Returns the value in Celcius of a temperature probe.
- **HB sound:** Returns the value of a sound sensor, range is 0 to ~100.
- **HB rotary:** Returns the value of the hummingbird's knob; range is 0 to 100.
- **HB light sensor:** Returns the value of a light sensor, range is 0 to 100.
- **HB distance sensor:** Returns the distance to an object from a distance sensor in centimeters. The range is 8 to 80 cm with the kit's range sensor (a value greater than 60 cm should be considered as not seeing an object).
- **HB voltage:** Returns the raw analog voltage reading at the sensor port, range is 0.00 to 5.00.

Speak Block

The "speak" block will cause the computer to say whatever text is placed in the box.

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Supply Tracking and Total Cost Calculations

ITEM	TALLY	TOTAL USED x	Real Cost per Item	Total Cost per Category
Hot Glue Sticks			$550.00	
Craft Sticks			$225.00	
Construction Paper (full sheets used)			$75.00	
Pipe Cleaners			$30.00	
PomPoms (each)			$65.00	
Googley Eyes (x2)			$82.00	
Pencil			$137.00	
Hemp String/wire (1 foot)			$43.50	
Plastic String (1 foot)			$38.00	
Duct Tape (1 foot)			$275.00	
Scotch Tape (1 foot)			$115.00	
Zip Tie			$143.25	
Styrofoam Ball			$87.30	
Toilet Paper Roll			$295.00	
Cardboard (by approx. square foot			$1,295.00	
Servo			$2,568.00	

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Swing Ride Design

Group Number: _____

Motor			$4,875.00	
LED light			$750.00	
TriColored LED light			$750.00	
Vibration Motor			$423.00	
Sensor (Due to the energy savings that sensors provide a credit shall be given for each sensor used.)			CREDIT $-5,000.00	
			Total for Ride	

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CATEGORY	4	3	2	1
Completion	The entire project is complete.	Most of the project is complete.	Half of the project is complete.	Less than half of the project is complete.
Measurements	In the dormant (ride not running) position, the ride model does not exceed the 20 inch by 20 inch footprint. (400 square inches)	In the dormant (ride not running) position, the ride mode slightly exceeds the 20nch by 20 inch footprint. (400 square inches)	In the dormant (ride not running) position, the ride model exceeds an 24 inch by 24 inch footprint. (More than 576 square inches)	In the dormant (ride not running) position, the ride model exceeds an 28 inch by 28 inch footprint (More than 784 square inches)
Lift Requirement	When ride operation commences the swings are lifted at least two inches above their starting position.	When ride operation commences the swings are lifted at least one inch above their starting position.	When ride operation commences the swings are lifted at least ½ inch above their starting position.	The ride is currently unable to lift.
Tilt Requirement	When ride is fully elevated, the ride carriage will tilt achieving at least a one inch difference between the high and low side.	When ride is fully elevated, the ride carriage will tilt achieving at least ¾ inch difference between the high and low side.	When ride is fully elevated, the ride carriage will tilt achieving at least a ½ inch difference between the high and low side.	The ride is currently unable to tilt when fully elevated.
Light Requirement	Blinking Light attached to highest point of ride. Operates even when ride is in dormant state.	Blinking Light attached to highest point of ride. Only operates when ride is in motion.	Light attached to highest point of ride. Light does not blink.	Lights were not utilized in this model.
Use of Hummingbird Robotics	Robotic accessories used in a proper fashion. More accessories were used than just a motor or a servo.	Robotic accessories used in a proper fashion. Accessories used were just a motor or a servo.	Robotic accessories used in a proper fashion. Programming was done but motors and servos not attached.	Did not have an opportunity to program the robotics.
Design	Ride is well organized and attractive to the eye. All wires, motors, servos, and circuit board are not visible.	Ride is organized and attractive to the eye. Most of the wires, motors, servos, and circuit board are not visible.	Ride is somewhat organized. Many of the wires, motors, servos, and circuit board used are visible.	Ride still in basic construction phase.
Planning Document	Every step was planned and document was completed.	Every step was planned, document was not completed	All steps were not planned and document was partially completed.	No planning was done and document was not utilized

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CATEGORY	4	3	2	1
Use of Music	Music starts when ride commences and ends appropriately. Appropriate type of music used.	Music starts when ride commences but does not end at the appropriate time.. Appropriate type of music used.	Music does not starts when ride commences and does not end at the appropriate time.. Appropriate type of music used.	No attempt to use music was made.
Supply Tracking	All materials including waste was tracked, tallied and totaled on tracking sheet.	Materials were tracked, tallied, and totaled on tracking sheet but waste was not accounted for.	Not all materials were tracked, tallied and totaled on the tracking sheet.	Tracking sheet not utilized.
Total Real-World Cost Calculations	Total real-world cost including waste has been calculated and totaled. Cost was lowest model.	Total real-world cost including waste has been calculated and totaled. Cost was neither the lowest nor highest model.	Total real-world cost including waste has been calculated and totaled. Cost was highest model.	Real-world cost not completely calculated. Information is incomplete.

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"**Swing Project" Team _____**

Phase: Circle one(Construction, Aesthetics, Mechanical, Programming)

Date: _____

Designer Responsible for this drawing/plan.

_____

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STEM Club Journal

Team _____

Members

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STEM Club Sharps Sign-Out

By signing this sheet you are stating that you understand and will comply with the following rules:

1. A protective glove will be worn on the hand which DOES NOT hold the exacto knife or scissors at all times.
2. Protective eye-wear is to be worn at all times when using the exacto knife or scissors.
3. At no time is anyone permitted to hold material and/or assist with cutting unless they are wearing protective gloves on both hands and protective eye-wear.
4. Cutting mats are to be used whenever exacto knives are used. You will be held responsible for any damage you cause, intentionally or accidentally to school property.

Failure to comply with any of the above rules will result in immediate and permanent expulsion from the STEM club

Printed Name	Signature	Time Out	Time In

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