Problem 1.5 Vehicle Restraint Design

Introduction

As you read in the story, Angelina was looking forward to riding the bumper cars at the amusement park. Suzi and Mylo were not sure if they wanted to join her on the ride. After the three friends watched the cars bump and crash into each other, they decided to give it a try.

Bumper cars are designed to collide with each other. As you learned in the last project, energy can be transferred during a collision as motion, heat, and sound.

Just like Angelina, Suzi, and Mylo, you will design and model a system to protect a passenger in a car during a collision. Additionally, you will evaluate test data from your prototype passenger protection system and present suggestions for improvement.

All work related to this design challenge should be recorded in your Launch Log.

Equipment

- VEX IQ® equipment
- Ramp
- Egg
- Launch Log
- Other materials as available such as rubber bands, cushion wrap, plastic wrap, pipe cleaners, tape, foil, and cotton balls (optional)

Procedure

1. As part of a team, you will design and evaluate a vehicle restraint system to keep a passenger safe during a collision. A raw egg will represent a passenger that will ride on the vehicle you assembled during Activity 1.3 Speed and Energy. The vehicle will roll down an inclined plane and collide with a solid object. Your egg must survive the collision without breaking or cracking in order for your vehicle to be considered successful.
2. You will use an engineering design process as you work to develop a solution to the vehicle restraint problem.
    - The **design process** is a step by step way to solve problems.
    - An **engineer** is a person who is trained to use technology, mathematics, and science to solve problems.

- Engineers use the design process to develop many possible solutions to a problem.

3. 

   a. The first step is **Ask**

   b. In this step you will:

      - Explain how the design problem addresses a need or want.
      - Describe the criteria that will lead to a successful outcome.
      - Explain how the constraints will impact the design.

   c. Review your responses in your Launch Log to the following:

      What is the need or want that we are trying to fulfill?

      What will make the design solution successful?

   d. Review the criteria and constraints for the design problem below and add this information to the Ask section of the Launch Log.

Criteria	Constraints
A raw egg will travel on a vehicle down an inclined plane and collide with a solid object. After the collision the egg should not be broken or cracked in any way.	None of the base parts of the car may be removed. Additional VEX IQ parts may be added. A list of additional materials will be provided.

   e. Follow your teacher's directions to complete the self-assessment at the end of the Ask section.

4. 

   a. The second step is **Explore**

   b. In this step you will:

      - Research how others have tried to solve this problem.
      - Brainstorm several ideas that may solve the problem.

   c. Write or sketch in the Explore section of your Launch Log how others have tried to solve the same problem.

   d. You may find more information by researching restraint systems using the Internet as directed by your teacher.

e. Brainstorm several ideas that may solve the problem and write or sketch them in the same section.

f. Talk to your team and share ideas. Add any additional ideas by writing or sketching in your Launch Log.

g. Follow your teacher's directions to complete the self-assessment at the end of the Explore section.

5. 

a. The third step is **Model**

b. In this step you will:

- Compare multiple solutions to see how well each one meets the criteria and constraints.
- Sketch, model, and write about the best solution.

c. In this step you will compare the solutions that your team has generated from the Explore step.

d. To compare multiple solutions and determine how well each one meets the criteria and constraints, you will use a decision matrix.

- A **decision matrix** is used to compare design solutions against one another, using specific criteria that are often based on project requirements.

e. Use a decision matrix to choose one design and sketch the final design in your Launch Log in the Model section. Label your sketch with materials and other details. An example decision matrix for this problem may be viewed in the dashboard for this module.

f. Follow your teacher's directions to build a prototype, or testable version, of your design.

g. Document your prototype by sketching the final design or taking photographs before you begin testing.

h. Follow your teacher's directions to complete the self-assessment at the end of the Model section.

6. 

a. The fourth step is **Evaluate**

b. In this step you will:

- Plan a controlled test.
- Conduct and document a controlled test.

- Use data to identify aspects of your design that can be improved.

c. Follow your teacher's directions to test your vehicle restraint system. Your vehicle will roll down an inclined plane and collide with a solid object at the bottom.

d. Record the results of your test in your Launch Log.

e. Follow your teacher's directions to complete the self-assessment at the end of the Evaluate section.

7. 

a. The last step is **Explain**

b. In this step you will:

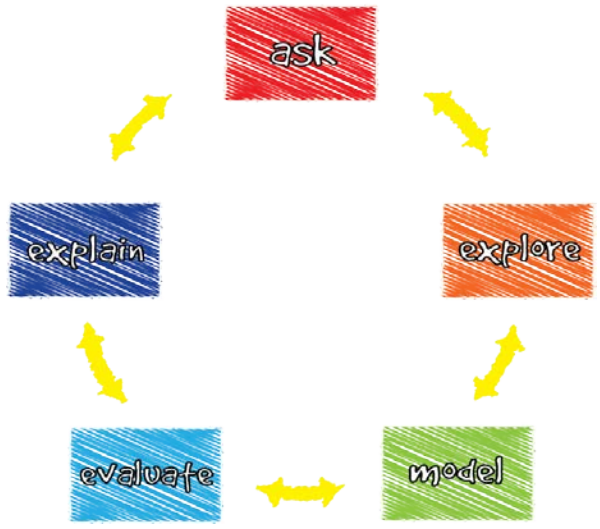
- Explain how the prototype solved (or did not solve) the problem.
- Suggest ways to improve your model.
- Predict how the improvements will make your model a better solution to the problem.
- Communicate your solution to others.

c. Complete the Explain section of your Launch Log.

d. Follow your teacher's directions to complete the self-assessment at the end of the Explain section.

8. Follow your teacher's directions to share your design with your classmates and others.

9. It is important to note that although the design process was presented in a specific order in this problem, you may find that you moved back and forth between different steps as you brainstormed new ideas and identified problems while building your vehicle restraint system.



Conclusion

1. Was the energy transferred to the egg or was it transferred somewhere else? How do you know?

2. What changes would you make to improve the design?

3. What is one way you could decrease the kinetic energy of the vehicle before it collides with the object at the end of the ramp?