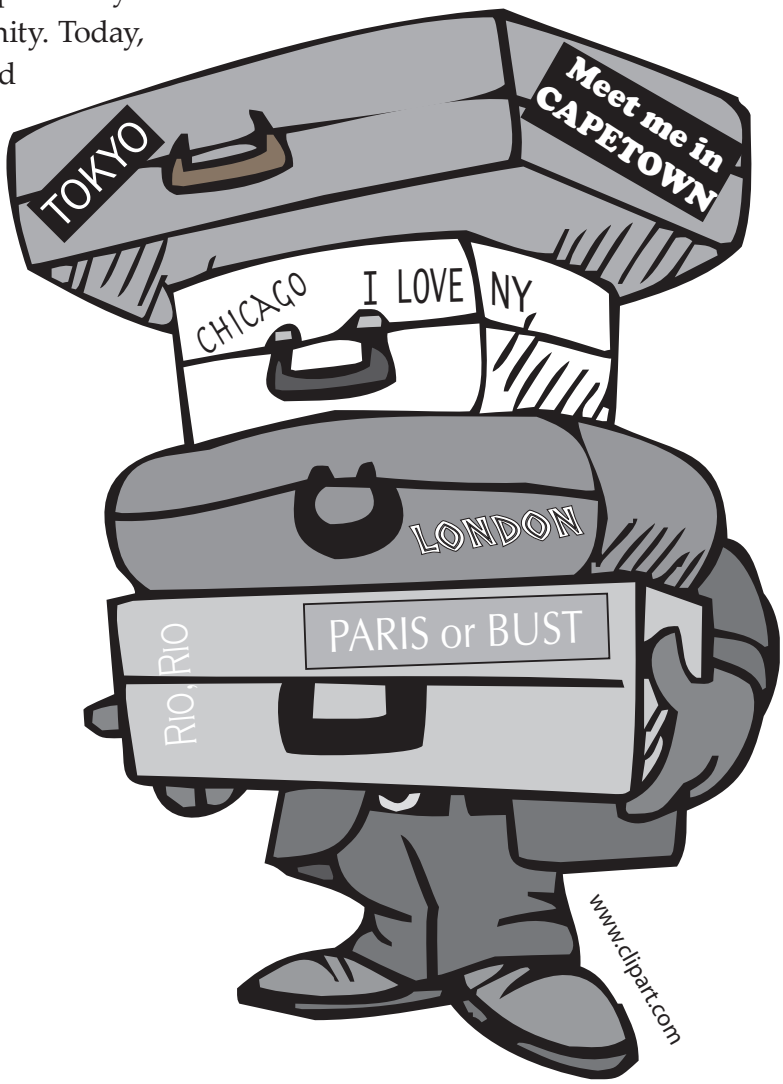
Learning Cycle Four

Out of Control!

4

Introduction

WITH THE TECHNOLOGICAL ADVANCEMENTS made to transportation devices and systems, our world seems to have become much smaller. Not so long ago, traveling great distances took a significant amount of time and energy. A child born just 200 years ago would spend his entire life in close proximity with his family and community. Today, with our advanced knowledge about propulsion and control systems, we have the ability to travel greater distances in less time.



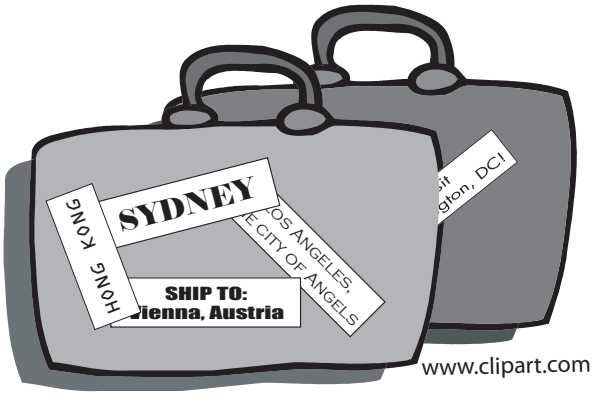
Most of us have experienced the discomfort of pedaling a bicycle up a hill or swerving around an object in the road. Have you ever considered the technology that allows us to accomplish these movements using less energy and with more control? How can we transfer energy in order to do work? How can we control and direct the output of that energy?

In this learning cycle, you will be exploring the technical concept of control. You will learn how various controls are applied to transportation systems to allow them to move from one place to another. After completing this learning cycle, you will be able to start identifying different methods of controlling the movement of your solution to the *Primary Challenge*.

Objectives

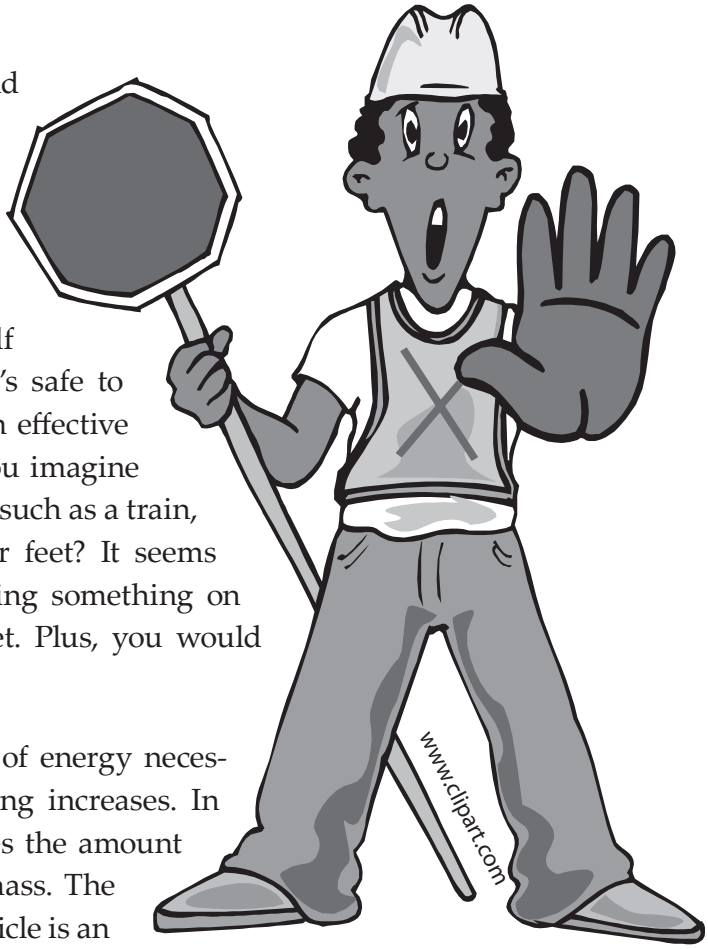
After completing this learning cycle, you will be able to:

1. Utilize a variety of systems for controlling distance and direction of a vehicle.
2. Analyze the relationship between force and distance using mechanical systems.
3. Select appropriate control systems for a given application.



What aspects of a vehicle can we control?

Exploration 1



Have you ever ridden a bicycle and stopped yourself with your feet? What happened as you began to slow down? You might have smelled some hot rubber as you gradually decreased speed. You also may have felt yourself losing control of your bicycle. It's safe to say that using your feet is not an effective method to stop a bicycle. Can you imagine stopping a faster-moving vehicle, such as a train, airplane, or car using only your feet? It seems unrealistic to think about stopping something on such a large scale with your feet. Plus, you would ruin a lot of shoes!

As speed increases, the amount of energy necessary for decelerating and stopping increases. In addition, a greater mass increases the amount of required energy to stop the mass. The ability to safely decelerate the vehicle is an important aspect of its control system.

Constraints/Requirements

Braking Systems
mechanical
hydraulic
pneumatic
electrical

Your instructor will assign you to a two-person team. Each team is responsible for conducting research to better understand how braking systems work.

Each team must also present their findings to the class in a three- to five-minute presentation.

The research and presentation should answer the following questions:

- How is friction produced in this braking system?
- On what transportation vehicles is this type of braking system common?
- Where might this braking system be used in the future?
- How can climatic factors such as ice, snow, or rain affect the control of a vehicle when this type of braking system is utilized?
- What are some of the safety trade-offs of using this type of braking system (e.g., health, cost, disposal)?

Reflection

Find the answers to the following questions and write them in the Inventor's Logbook spaces provided. Be prepared to discuss your answers with the class.

Inventor's Logbook

Logbook 4.1

1. What type of braking system would you use to quickly stop a car going over 200 miles per hour?

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_____

_____

2. What braking system would be the most unsafe for a car going over 200 miles per hour?

_____

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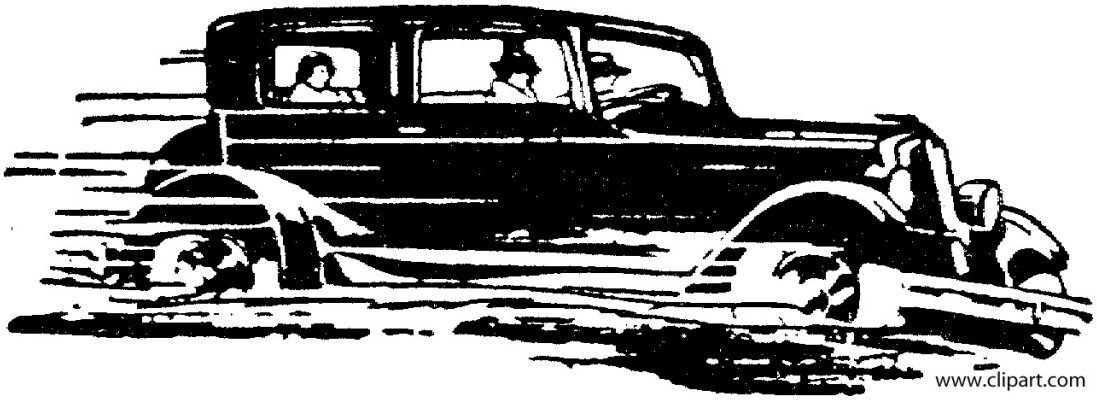


3. How has the need or desire for speed affected or changed the technologies used for braking systems?

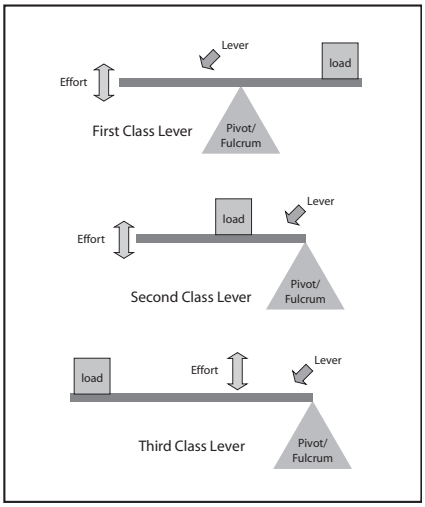
4. Beyond safety, how have braking systems improved transportation?

5. Explain how stopping a car is more than just stepping on the brake pedal. Diagram what happens when the brake pedal is depressed.

6. What causes a vehicle's brake pads to wear down?

Exploration II

The shortest distance between two points may be a straight line; however, it is rare that a transportation device can take a straight path. Inevitably, turns must be calculated and controlled. Trains use a system of rails to control direction. Transporting fluids requires the use of connected pipes to direct and control the flow. Airplanes use rudders, elevators, and ailerons to maintain a safe flight path. A garden tractor may use tie rods and linkages to control movement around trees and shrubs. Every transportation system needs some form of controlling mechanism to ensure that we reach a destination successfully.



Many transportation devices incorporate levers into their control mechanisms. A lever is used either to increase the force that is applied to one end, to make something move in a different direction, or to make something move a greater distance than otherwise imaginable. A wheelbarrow, for example, uses a lever system to lift and transport material that would otherwise be too heavy to carry. There are three common components of every lever. All levers work with *applied force*, which is used to move one side of the lever. The *load* is what is being moved or directed by the lever. The *fulcrum* is the point at which the lever rotates.

There are also different classes of levers. A lever is classified into one of three classes according to the placement of force, the fulcrum, and the load. *First-class levers* are those that have the fulcrum between where the force is applied and the load is placed. *Second-class levers* have the fulcrum at one end of the lever with the force being applied at the other end. The load is in between the fulcrum and the force. *Third-class levers* have the fulcrum at one end and the load at the other end. The force is applied in between.

For this *Exploration,* your instructor will assign you to a two-person team.

Study the linkage configurations found in Figure 1. Beside each linkage, write the predicted direction(s) for the various points in the system as you pull or push each linkage configuration at point A.

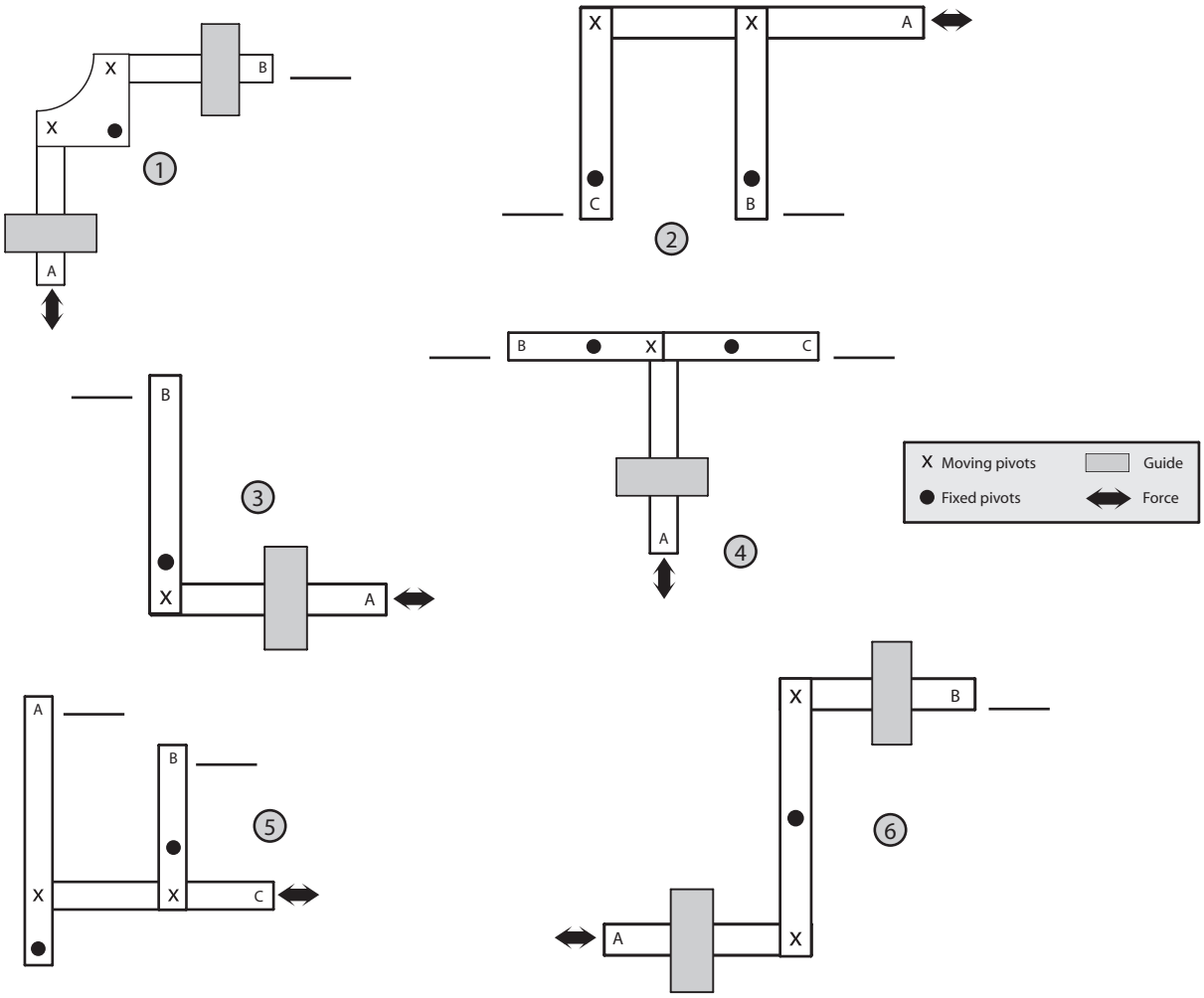
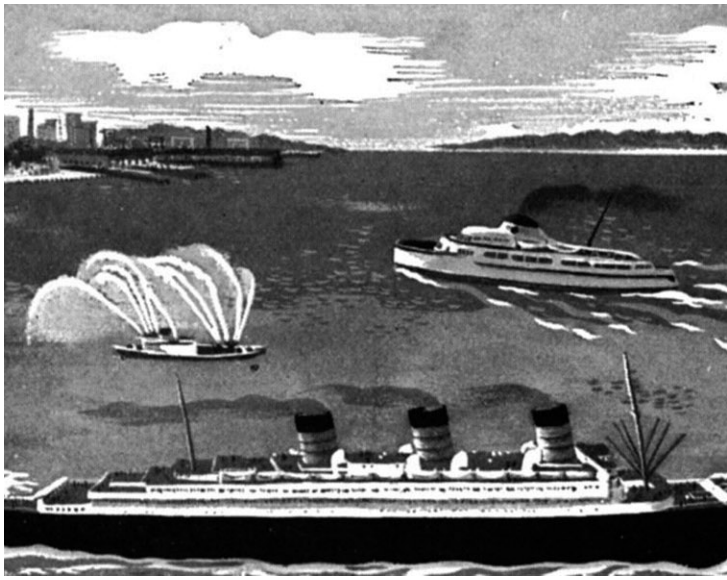


Figure 1. Linkage configurations and predicted movements

Each team should obtain the following materials to explore the various linkage configurations.

- Cardboard or paper
- Tongue depressors
- Paper hole punch
- Steering/Lever pegboard
- Brass fasteners



Use the materials provided to construct each linkage configuration one at a time. After constructing each linkage system, check your prediction for accuracy. Did the linkage system work the same way you predicted? Analyze any discrepancies that you or your partner found in the prediction.

After constructing each linkage configuration and analyzing how it might be used to guide a transportation device, it is time to test your understanding. Each team member should take a turn at designing a linkage configuration. As you design and construct your configuration, your partner should not be allowed to watch.

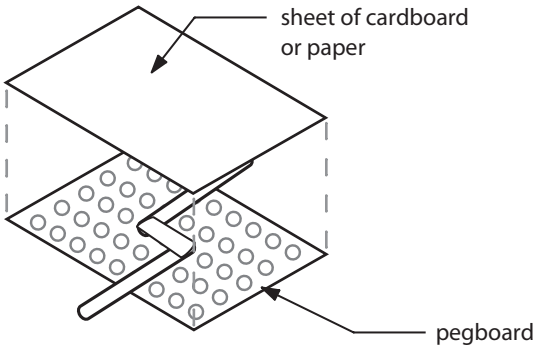
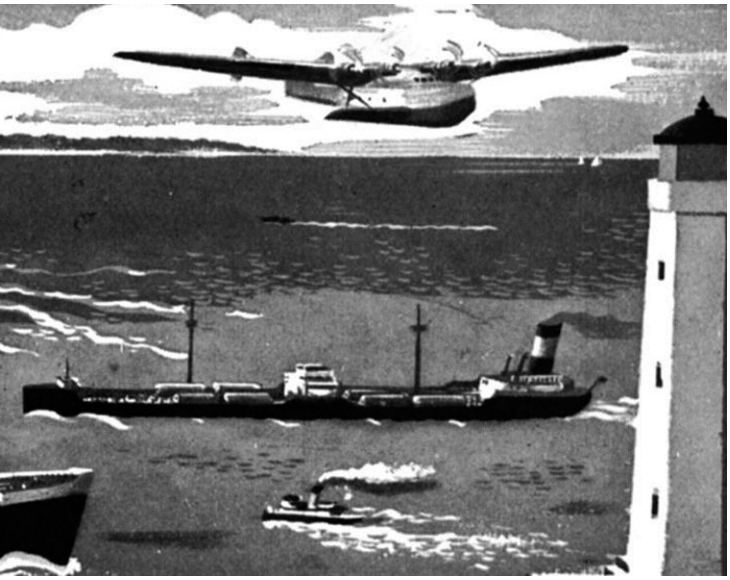


Figure 2. Detailed view of linkage system test



After constructing the linkage configuration, cover the board with paper, cardboard, or another opaque material so that your partner cannot see your configuration (as shown in Figure 2). The moving points should stick beyond the cover so that your partner can observe their movement.

Allow your partner to pull and/or push one of the points of your system and observe what happens to the other exposed point. After your partner observes your configuration, he or she should sketch a plausible linkage system that performs like yours.

After the sketch is completed, you should uncover your system and see how closely your partner's solution matches the configuration. If the solution is different, you should work together to construct the solution and observe how it works. You may find that there is more than one plausible solution to configuring the linkage system.

After one team member has completed this test, the other team member should take her or his turn. If time permits, this should be repeated using different configurations.

When both team members have tested their knowledge of linkage configurations, return all materials to your instructor and write the answers to the *Reflection* questions in the Inventor's Logbook spaces provided.

Reflection

Find the answers to the following questions and write them in the Inventor's Logbook space provided. Be prepared to discuss your answers with the class.

1. There are three classes of levers used in the linkage configurations in the *Exploration II* activity. Sketch each configuration and identify which class of lever is used in each configuration. This may take some additional research on your part.

Inventor's Logbook

Logbook 4.2

2. Look around your classroom. What examples can you find for each class of lever? Identify three examples of each.

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_____

3. What type of linkage system allows for the greatest amount of control with the least amount of effort? Why?

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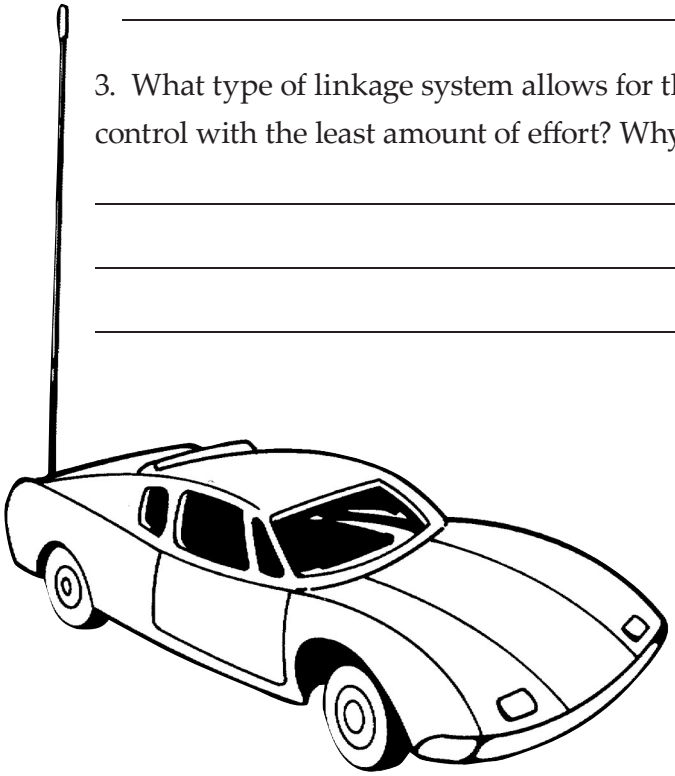
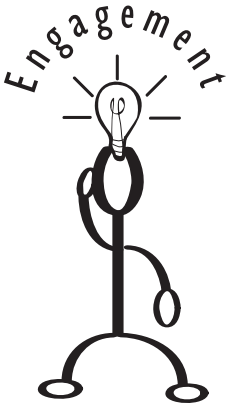
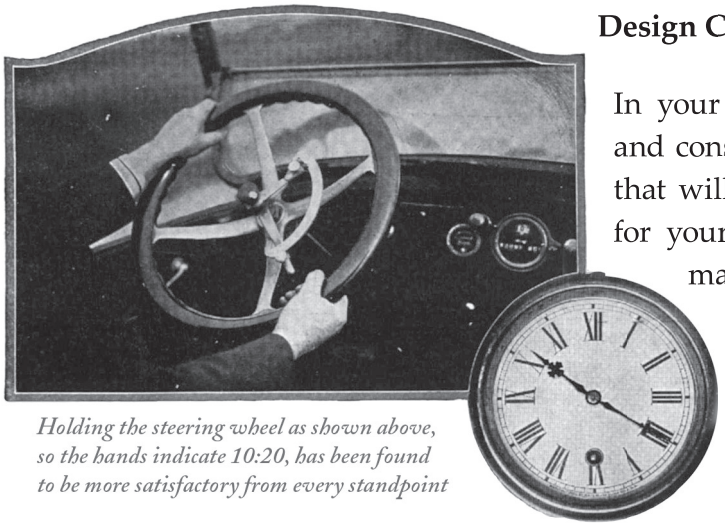




How do design engineers work together to solve complex problems?

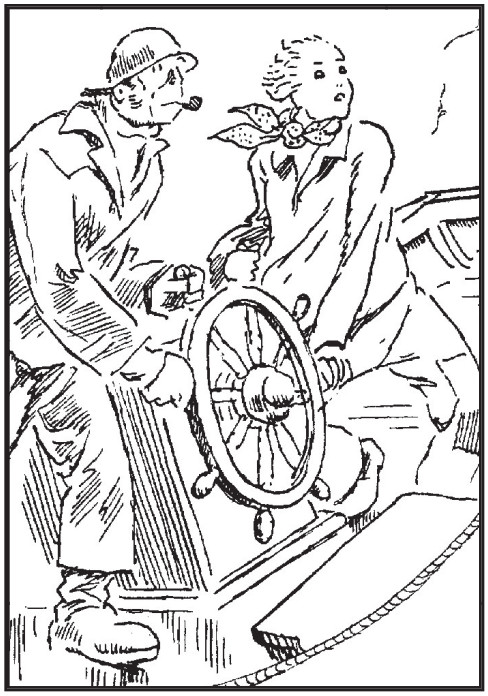
Control systems work closely together with other sub-systems to help the operator control the speed and direction as a vehicle travels. The safe transport of passengers and cargo are an essential goal of transportation technology. In this activity, you will work with your *Primary Challenge* team to create the carriage system to be incorporated into the *Primary Challenge* solution. The carriage system must provide safe transport of the designated cargo.



Holding the steering wheel as shown above, so the hands indicate 10:20, has been found to be more satisfactory from every standpoint

Design Challenge

In your *Primary Challenge* teams, design and construct a full-size carriage system that will be used to transport the cargo for your *Primary Challenge* solution. You may need to go back and read the constraints for the *Primary Challenge* before beginning your design work.



Criteria/Constraints

1. Your carriage system must be full size.
2. You must have a way to attach the carriage system to the final vehicle.
3. Your team will need to present your carriage system to the rest of the class and explain how it works.
4. To get started:
   a. Sketch two to three different designs on a separate sheet of paper.
   b. Select a design.
   c. Create a materials list and submit the list to your instructor.
   d. Begin construction.

Expansion

Select one of the following *Expansion* activities in which to engage and follow the directions.

1. High-speed rail systems, such as magnetically levitated trains (mag-lev), present a variety of challenges to the designer. Conduct research and prepare a paper or class presentation on the control systems used in a high-speed rail system.

2. Construct three different levers (one from each class) illustrating how to measure force.

3. Design and construct a Rube Goldberg contraption (i.e., a device that strings together a number of steps to do a simple task in the most complicated way possible) that incorporates at least two different classes of levers to control parts of the contraption.

Here are some careers related to this learning cycle. For more information, visit the United States Department of Labor's Occupational Outlook Handbook at: www.bls.gov/oco

Career Connections

Chauffeur
Pilot
Automotive Service Technician

Within your *Primary Challenge* teams, continue working on your carriage system. When your team has finished, determine how you will connect the system to the structure of your vehicle.

Inventor's Logbook

Logbook 4.3

Out of Control!

Name: Date:

Element	Criteria				Points
	4	3	2	1	
Research Research	Exceptional amount of research conducted about historical developments of brake system	Above average amount of research conducted about historical developments of brake system	Average amount of research conducted about historical developments of brake system	Limited research conducted on brake system	
Documentation	Exceptional documentation of research; more than 10 logbook entries/ sketches.	Above average documentation of research; 7-9 logbook entries/sketches.	Average documentation of research; 4-6 logbook entries/ sketches.	Below average documentation of research; 1-3 logbook entries/sketches.	
Presentation and Communication Preparation	Exceptional preparation of presentation with strong visual aids/appropriate technology.	Above average preparation of presentation with good visual aids/ appropriate technology.	Average preparation of presentation with basic visual aids/ appropriate technology.	Below average preparation of presentation.	
Effectiveness	Presentation was exceptionally effective, clear, and accurate.	Presentation was effective, clear, and accurate.	Presentation's effectiveness, clarity, and accuracy were average.	Presentation's effectiveness, clarity, and accuracy were below average.	
Informative and Interesting	Presentation was extremely informative and interesting.	Presentation was highly informative and interesting.	Presentation was informative and interesting.	Presentation was neither informative nor interesting.	
Design Carriage system	Exceptional creativity and innovation in design.	Above average creativity and innovation in design.	Average creativity and innovation in design.	Below average creativity and innovation in design.	
Inventor's Logbook Entries	Fully answered all entries and provided good examples.	Answered 80% of the entries and provided some examples.	Answered 70% of the entries and provided few examples.	Did not answer entries and did not provide examples.	
				Total Points	

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