PEEK 2003 Second Grade Curriculum

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Lesson 1:
Introduction to Legos and Engineering

Lesson 2:
Exploring Gear Trains

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Building a Sturdy Car

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Lesson 1: Introduction to Legos and Engineering

Lesson Objective: To engage students in a 45 min-1hr discussion about how to identify engineered things around us, and what important features each has to have.

Learning Objective: To learn the names and purposes of Lego building pieces.

The Challenge:

Materials:
- Lego Simple Machine kits or other Lego building pieces including beams, bricks, axles and wheels
- Large laminated picture of Lego beams & bricks

Vocabulary:
- brick
- beam
- gear
- axle
- wheel

Procedure: Before students arrive, prepare identical baggies of pieces for each student in the class. Depending on the amount of Legos you have available, use 3-4 different beam sizes (from the smallest to the largest), 2 or 3 brick sizes, some different axles to measure against the beams, and a wheel to identify. Secondly, think about items in the classroom that the students can recognize as "engineered." How are you going to get them to say "Design, Build, Test"?

Get the class together as a group and bring up the concept of Engineering. Ask if anyone know what it is. If not, explain to them that engineers make things that other people need. First the engineer thinks about what he wants/needs from a product (Design). Then, he makes the product (Build). Finally, he tries the product out to see if it works (Test). See if you can get the students to think about other objects in the classroom, and what qualities they needed to have to be built (i.e., height of tables, height of doorknob, etc.).

Next, start identifying Lego pieces. Compare and contrast beams and bricks. Count the studs on each piece. What are the differences between a 1x10 beam and a 2x4 brick? Identify all the pieces and then call out pieces for them to find ("Find me a 1x4 beam!").

After you've finishing discussing pieces, go through a following directions exercise. Have the students put the pieces together in a specific way as you dictate. Be exacting, but you don't have to build something clearly identifiable. Then have the kids name these creations!

Engineering Challenge: At the end of class, give the kids a few minutes of free time to build anything they want with the pieces they were given. Here, it would be good for them to have at least two wheels! After building, have the children present their creations. What did they design their structures to do? Did it work? Were they hard to build? How could the children change their creations to meet their needs better? (Hard questions, but you might get to them.)

Extensions:

Assessment:

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide

Lesson 2: Exploring Gear Trains

Lesson Objective: To familiarize students with how gears work.

Learning Objective: To learn about what gears are and to learn the rotation and speed rules.

The Challenge: To build different types of gears and observe how they turn.

Materials:
- •Lego Simple Machine kits or other Lego building pieces
- •Gear Worksheet

Vocabulary:
- driver
- follower
- speed
- rotation

Procedure: Have the children build a gear train with two gears. Turn the driver to the right. What direction does the follower turn? Next, have each child make a gear train with a little gear and a big gear. Which gear turns faster? Instruct them to draw pictures and show which gear is faster. Finally, have the students add a middle gear, resulting in a total of three gears. Does the direction of the last gear change? Instruct them to draw pictures.

Extensions: Let students add more gears. In which direction does each gear turn when you rotate the driver? Draw pictures of the gears, indicating the ways in which they turn.

Assessment:

Troubleshooting:

Resources:
- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide

Exploring Gear Trains

Two or more gears working together are called a **gear train**. The gear on the train to which the force is initially applied is called the **driver**. The final gear on the train is called the **follower**, or **driven gear**. Any gears between the driver and the driven gear are called **idlers**.

Build a simple gear train with two gears. Rotate the first gear (the driver). How does the other gear move? Compare its speed and direction of rotation with that of the first gear. Record your results, using the gear cut-outs provided or a system of your own devising.

Build and record other gear trains.

Can you detect patterns? Write down the rules you've discovered below.

ROTATION RULES:

SPEED RULES:

Gearing up and gearing down: **Gearing up** means that the follower in a particular gear train turns faster than the driver. **Gearing down** means the follower turns more slowly that the driver. Look back at your data. For each gear train you built, note whether it is gearing up or gearing down.

Lesson 3: Building A Sturdy Car

Lesson Objective: To build a sturdy car using Lego blocks, wheels, and axles.

Learning Objective: To learn the important elements of building a sturdy structure.

The Challenge: To build a car that can withstand being dropped from the teacher's knee.

Materials:
- Lego building piece
- Handout - Building Design Sheet: A Sturdy Car

Vocabulary:
- wheel
- sturdy
- bushing

Procedure: The lesson begins with a short discussion about what makes a Lego structure sturdy. Questions you might want to ask to guide the discussion include:
- What problems do you have if a structure is not sturdy?
- What did you do to make your structures strong?

After the discussion, introduce the engineering challenge.

Engineering Challenge: Explain to the children that they will be working with partners to build sturdy cars. They may test their cars as they build to see how sturdy they are. When completed, each car will be dropped from the teacher's knee and should not fall apart.

Extensions: Review the rules of making a sturdy car. Be sure to use the diagrams located at the end of this lesson as a guide. After discussing the rules, have the children make additions to their cars. What could make their cars stronger? What might be necessary to have on the cars? After building a sturdy car, how can you one include gears on the car?

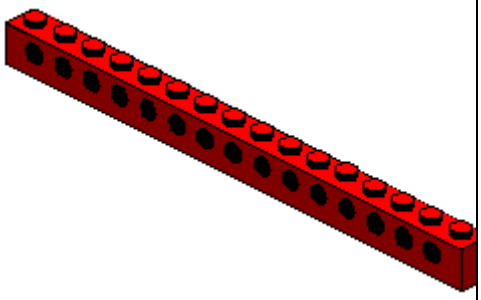
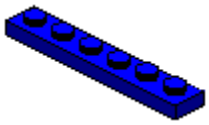
Assessment: Bring the class together to discuss their various designs and what they found worked well. What was the biggest problem they had as they were building? What did they try? Did it help?

Troubleshooting:

Resources:

Steps to build a sturdy car -

- Build a basic frame for the car
- The frame of a car is made from:

	Tire	Wheels are made from tires and axel hubs
	Hub	Hubs are the center part of tires
	Bushing	Bushings keep
	Axle	Wheels are attached (using the hubs) to the axle
	Beam	Beams form the structure of the car and can support the photo
	Plates	Plates form a base for the motor

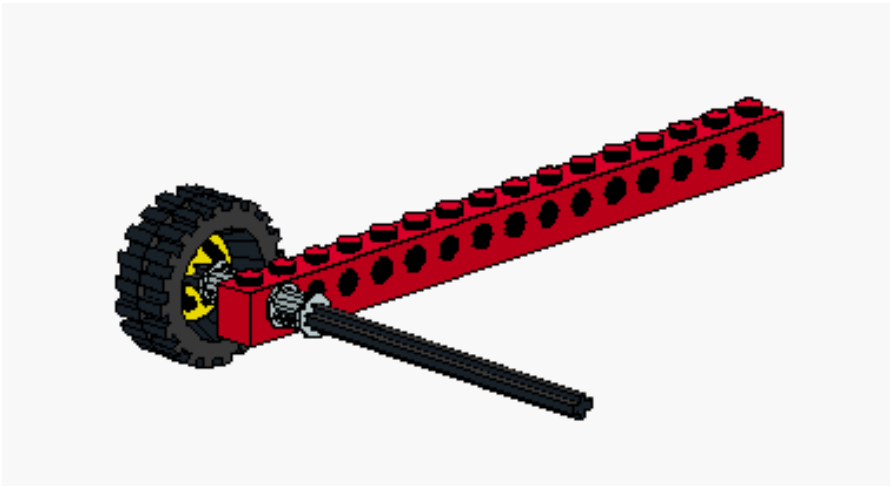


Figure 1: Partial Car Frame

Bushings are put on each side of the beam to keep the tires from sliding back and forth. They should be close to the beam but not TOO close. If they are too close the axle will not be able to turn (and hence the car will not be able to move).

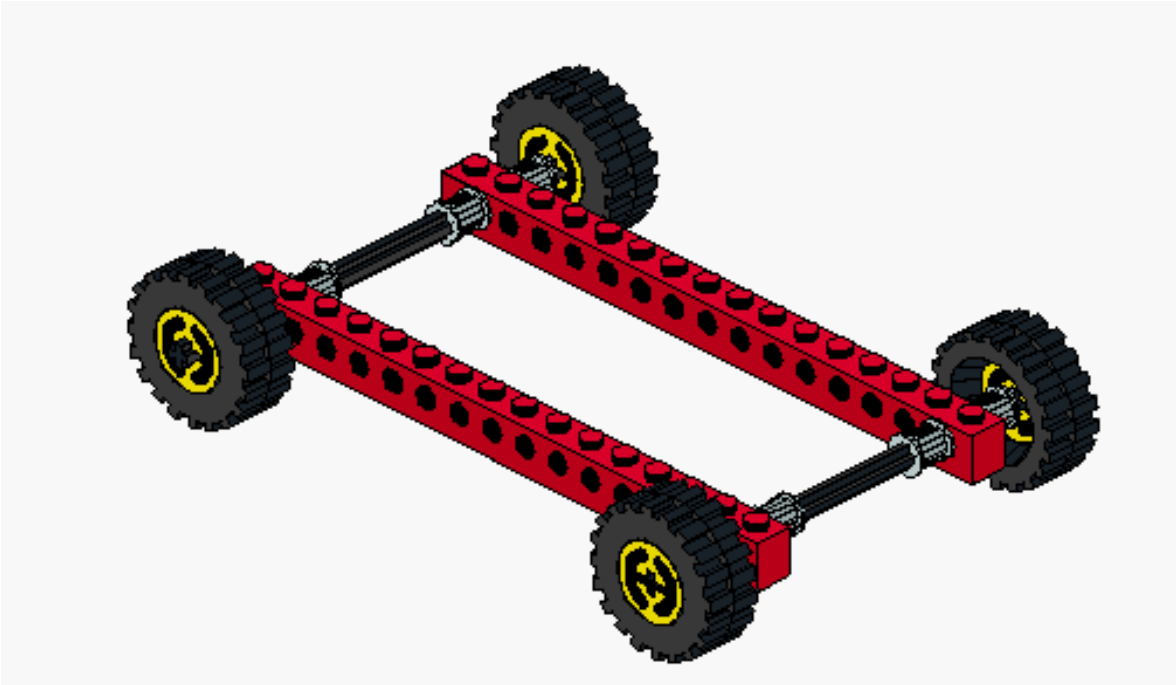


Figure 2: Sturdy Car Frame

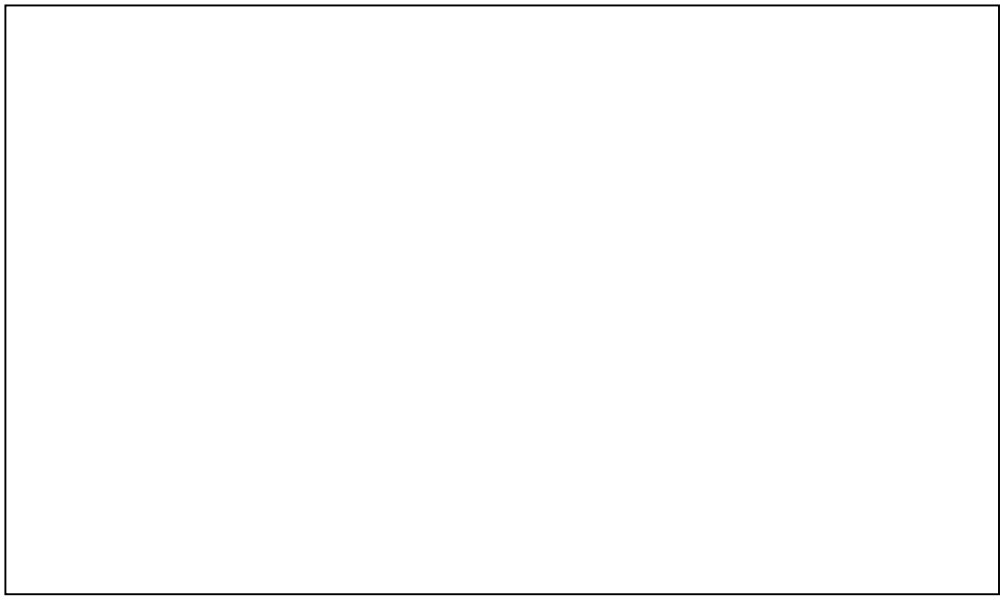
It is important that the frame be as rectangular and symmetric as possible. If there is more friction on one side the car will tend turn in that direction.

Engineer: _____ Date:_____
Partner: _____

Building Design Sheet: A Sturdy Car

Challenge: To build a car that can withstand being dropped from the teacher's knee.

1. Draw your idea:



2. Write about your idea:

_____

_____

_____

_____

_____

3. Share your plans with your partner.

Lesson 4: Introduction to the RCX

Lesson Objective: To familiarize students with the function and use of the RCX.

Learning Objective: To learn how to incorporate an RCX into the building of a sturdy structure.

The Challenge: To build a stable car that drives up a ramp.

Materials:
- Lego Pieces: RCX, connector pegs, and various Legos to build a car
- Robolab 1.0

Vocabulary:

Procedure: Split the students into groups and give each group an RCX. Have the students look at the RCX and discuss features that will help them build with it, such as bumps and holes for connector pegs. Have students play around with the RCX, bricks, beams, connector pegs, and other various pieces.

Discuss how the RCX can be incorporated into a design. Discuss things the students should be careful not to do (i.e. imbedding the RCX into a position on their structure such that they cannot touch the buttons or change the batteries).

Engineering Challenge/Programming: Have students build cars with the RCX as the central structural element and motors attached to the wheels so it can drive across the room (or a ramp).

Extensions:

Assessment: Get the students together as a group and discuss the following questions:
- Can you think of reasons why you wouldn't want to put the RCX in the middle of a structure?
- How many different ways did you attach pieces to the RCX?

Troubleshooting:

Resources:
- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta "Simple and Motorized Machines" Teacher Guide

Lesson 5: Snail Car

Lesson Objective: To familiarize students with the principles of gearing down.

Learning Objective: To learn different ways to slow a car down, including adjusting gears.

The Challenge: To build a snail car that is designed to move as slowly as possible.

Materials:

- RCX
- Lego pieces - Use any kit with gears of different sizes and materials to construct cars (beams, axles, wheels, motors).
- Minimum ROBOLAB: 1.0
- Paper, markers, pipe cleaners, and other materials for making cars snail-like (optional)

Vocabulary:

Procedure: Before students arrive, make a starting line on the floor with tape. Once the cars are built, you and the students can then determine an appropriate length for the race. (If the designs are successful, the racecourse may be only a few centimeters long.)

Hand out the rules for the race that are included in the Worksheet/Handout section. Students are to build snail cars that are designed to move as slowly as possible. Students may use gears, friction, or any other strategies they can think of in order to slow their cars. You may want to demonstrate the use of the 'worm gear' - using gearing down to make the wheels of the car move much more slowly than the motor. If students use multiple gears on the same axle, they should be able to produce cars that move too slowly to detect the motion with the naked eye.

After the students are finished building, race the cars. If the cars are very slow, the issue may be to determine whether the cars are actually moving - some cars may go too slowly for the movement to be readily discernible.

Programming: The programs will be fairly simple. They will include the green light, red light, and motor icons. Cars will be programmed to go forward indefinitely.

Extensions: You may wish to add an additional constraint to the activity - that the snail cars look as snail-like as possible. You can allow students to use paper, pipe cleaners, and other materials to decorate their snails.

Assessment:

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide