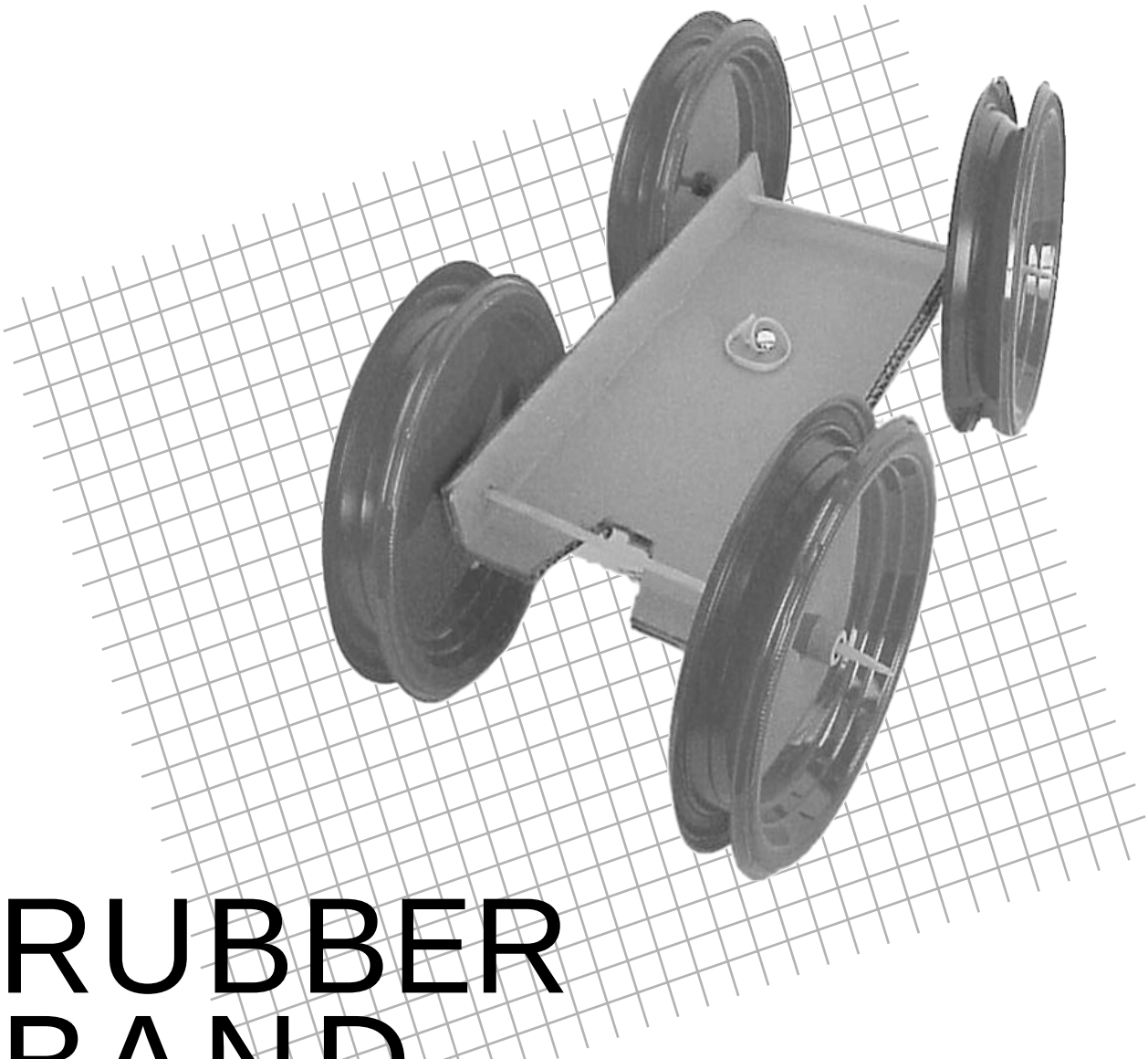

RUBBER BAND POWERED CARS

KELVIN® Stock #651663

DESIGN IT! ENGINEERING IN AFTER SCHOOL PROGRAMS

Education Development Center, Inc.

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Activity 1: Assembling a Car

Here is your chance to build a toy car.

What Materials Do I Have?

- cardboard (16 inches x 8 inches)
- 2 dowels (3/16-inch diameter, 12 inches long)
- 8 plastic plates (5 or 7 inches in diameter)
- 1 brass fastener
- 8 beveled plastic washers
- 8 pieces of plastic tubing (3/16-inch inner diameter, 1/2 inch long)

Alternative:

- 8 rubber bumpers *or*
- 8 rubber stoppers

- masking tape
- scissors
- *Data Sheet—Activity 1*

The Challenge

Make a car out of the available materials.

How far will your car travel when placed on a ramp?

What Do I Do?

1. Talk with the members of your team about how you will assemble a car with the materials provided.
2. Decide which materials would be best to use to hold the wheels on the axle, and attach them.
3. Decide how you will attach some of the materials to the cardboard so the wheels spin freely.
4. When you think your car is ready, test it by rolling it down the ramp.
5. How far did it go? Write down the results on *Data Sheet—Activity 1*.
6. Make changes to the car or wheels that might make it run more smoothly. Test it and record the results.

Data Sheet—Activity 1

Team Members: _____

_____

_____

When you think you have a good working design for a car, make a drawing of it here.

Top View

Side View

How far did your car travel? Write the distance (in feet and inches) in the chart below during each test.

Test #	1	2	3	4	5	6	7
Distance							

Activity 1: Assembling a Car

Preparing Ahead

The pieces of cardboard should be cut and scored (so that the edges can easily be folded) before the first session.

1. From large pieces of cardboard, cut rectangles 16 inches x 8 inches. This should be done so that the longer side is cutting across the cardboard's corrugation (Figure 1.1).
2. To score the cardboard, measure off a line as shown in Figure 1.2.

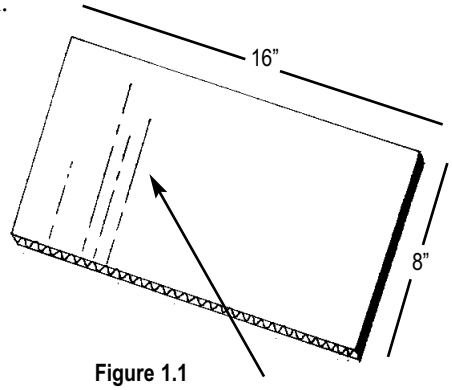


Figure 1.1
Note how the ridges are parallel to the shorter side.

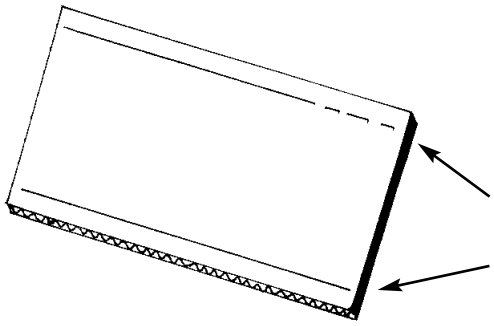


Figure 1.2
Measure approximately 1 inch from the edge.

3. Carefully cut into the cardboard along these lines (Figure 1.3, a) just deep enough so that only one side of the cardboard has been cut (b). Make SURE not to cut through both sides (c). The aim of this operation is to be able to fold the cardboard easily along the cut lines (d).

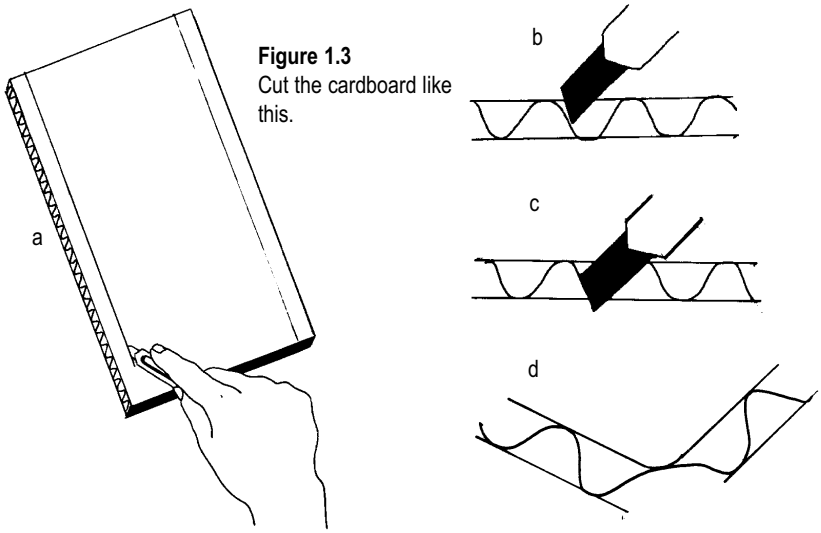


Figure 1.3
Cut the cardboard like this.

Materials

FOR EACH TEAM

- cardboard (16 inches x 8 inches)
- 2 dowels (3/16-inch diameter, 12 inches long)
- 1 brass fastener
- 8 plastic plates (5 or 7 inches in diameter)
- 8 plastic washers and
  8 pieces of plastic tubing (3/16-inch i.d., 1/2 inch long)
  alternative: 8 rubber bumpers or 8 rubber stoppers
- *Data Sheet—Activity 1*

FOR THE WHOLE GROUP

- masking tape (3/4-inch wide)
- pencil compass
- paper punch
- plate template, having a hole in the center
- scissors
- pieces of cardboard or wood (at least 24 inches x 36 inches)
- yardstick

FOR THE PROGRAM LEADER

- 1 retractable blade knife or craft knife
- nail or push pin (optional)

Creating plate templates

One important detail the children may not notice at first is that the wheels work much better if the axle (dowel) passes *exactly* through the center of each plate.

Three methods for finding the center of the plates that you might use yourself or show to the children are given on page 51. When you have found the center of one plate quite accurately with any of these methods, you can use the master plate (template) to find the center of other plates. If you are making the holes, you may find it easiest to heat the tip of a nail and melt a hole in the center of the plate. Children should not use this method.

Building a ramp

Once you have completed the templates, find a place in your center where the assembled cars can be tested. Although the cars in Activity 1 will likely not travel far, you should find a space for your ramp with a "runway" of at least 25 feet to accommodate the testing in the rest of the activities. Also, prepare a piece of cardboard 3 feet long and 2 feet wide, which will be used as a ramp (see Figure 1.4). Find some books, blocks of wood, or other objects to prop up one end of the ramp.

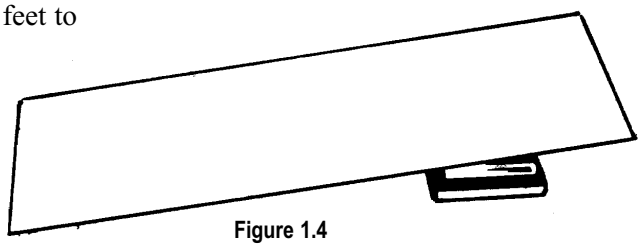


Figure 1.4
The ramp looks like this.

For ease in measuring the distance traveled, you can place pieces of tape on the floor marking every foot. If the children are testing their cars on a floor with tiles, children can count the number of tiles their cars traveled.

Make enough copies of the Challenge Sheet, including *Data Sheet—Activity 1*, for each team.

Introducing the Activity

Tell the children that they will be working on an extended project where they will be challenged to build a model car to be powered by a rubber band. They will not be doing this all at once, but will work toward this goal one step at a time.

The goal of the first activity is to construct a car and see how far it can travel when allowed to roll down a ramp. Before showing them the materials, ask them what they know about toy cars.

?
- How are toy cars constructed?
- How are the wheels placed on the car?

Show them the materials and explain that, working in teams, they will use only these materials to make model cars in this first activity. Also, show them the plate templates and how they can be used to make holes in the center of the plates they will be given. Make it clear that these templates are for everyone to use.

Form teams and have them first discuss among themselves how they will use the materials. After each team has come up with a way of assembling a car, hand out the materials.

THE CHALLENGE

Make a car out of the available materials.

How far will your cars travel when placed on a ramp?

LEADING THE ACTIVITY

Assembling the car

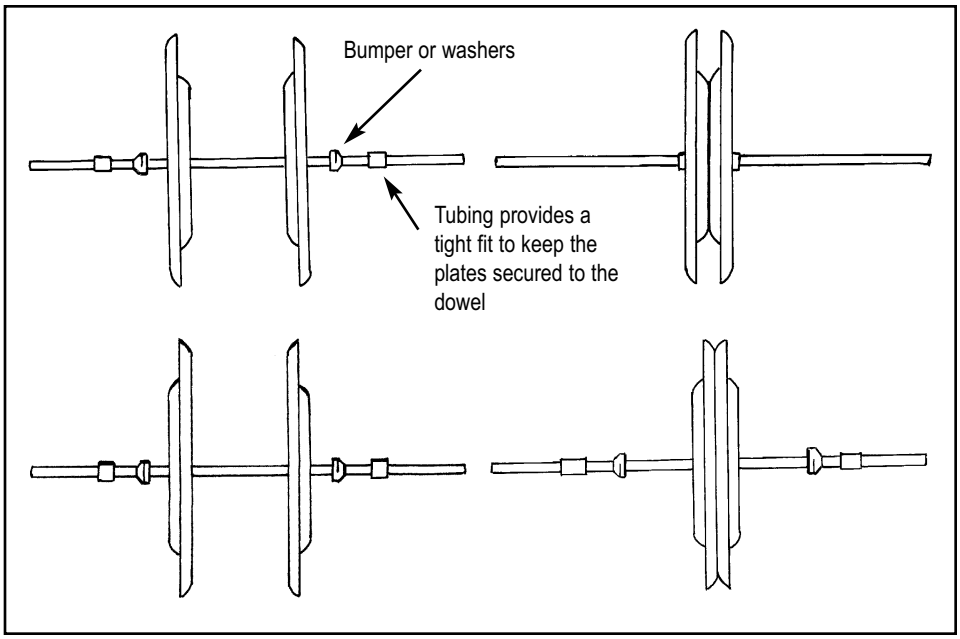


Figure 1.5
Different configurations of wheels. Notice how the plates in the top row are facing outward whereas the plates in the bottom row are facing inward.

The children will readily adapt the plates to make wheels and slide them onto the dowels (see Figure 1.5). There will probably be differences among the teams as to where and how they attach the dowels to the cardboard. The axles may be mounted on the base of the cardboard so that they are fixed or move freely. If they are fixed, the wheels must be able to move freely for the car to travel. If the axles move freely, the wheels must be fixed to the axles for the car to travel effectively. Either arrangement can work in the first

activity. At this point, the main goal is to construct a functioning car—one that rolls easily and in a relatively straight line. Let them place the dowels and wheels whatever way they think will work. When they test the cars, they will quickly discover some of the problems of their arrangements.

Children may be unsure about how they are going to mount the dowels so that they are attached to the cardboard but still move freely. You will have to discuss this with some teams to help them think about the best way to accomplish this.

SAFETY

Make sure the children are using the compass or scissors in a safe way.

Once each team has their car assembled, they can immediately test it on the table or floor. Tell them to push it gently to see how it rolls. There are three considerations they should address. If they have any of the following problems, they need to figure out how to correct them.

- Does the car roll straight or does it curve to one side as it moves?
- Do the wheels move with a minimum of friction and not rub against the side of the cardboard?
- Does the car stop quickly after it has been pushed?

Testing the car with a ramp

Set up the ramp where the cars can roll on a flat surface for a long distance. If a team feels confident with the design of their car, have them place it at the top of the ramp, release it, and see how far it travels. Have them use the yardstick to measure the distance, and then record their results on *Data Sheet—Activity 1.* They can use "feet" as the unit of measurement.

After each trial, encourage the teams to make adjustments to their cars with the goal of having them travel farther on the next trial.

Troubleshooting

The cars for some teams may not travel very far.

1. **The dowels are taped to the cardboard.** The plates must rotate freely on the axles if the car is going to move.
2. **The axles are pushed through holes they punched in the cardboard.** Have them check to see how freely the axles rotate in these holes. The holes in the cardboard may be too small, causing the axles to experience a lot of friction. These teams will have to take the axles off of the cardboard and use a pencil or the points of a pair of scissors to enlarge the holes. Caution them to not make the holes too big because the axles will start to wobble.
3. **The holes were made poorly, leaving pieces of cardboard rubbing against the dowels.** These teams will have to make new holes. The paper punch creates a clean hole, but it will have to be enlarged slightly to let the dowels rotate freely.

4. **The cars do not move in a straight line.** Have teams check the alignment of their axles. Both axles need to be parallel to each other and to the front and back edges of the cardboard (see Figure 1.6). Point out to the children that the corrugation of the cardboard can be used to line up the axles so that they are parallel to each other.

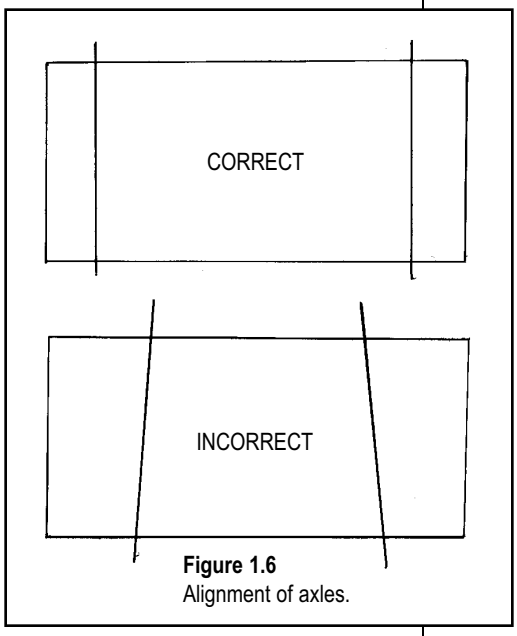


Figure 1.6
Alignment of axles.

Just before the children launch their cars, they need to push the tubing and washers tightly together so that the wheels don't slip or wobble.

Make sure each team records the distance their cars traveled. Tell them this will help them determine whether changes they make on their cars result in a better performance.

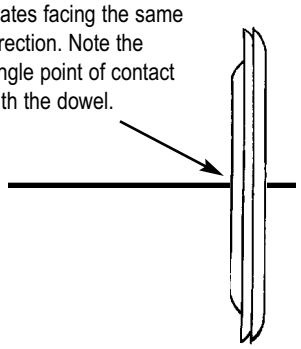
Leading the Discussion

Have the children gather in a Discussion Circle when they've finished the ramp tests to talk about their results and about how their designs could be improved. It is best if the children do not have direct access to their cars and materials during this discussion so that they can give full attention to what is being said. Have them gather at the front of the room in their teams. First, have each team report the longest distance their car traveled. Teams will tend to want to be "better" than other teams, but explain to them that this is also a time where they can combine their experiences and help each other improve the performance of their cars.

Have the more successful teams show how they constructed their cars. What allowed their cars to travel well? You can also have the less successful teams show their cars to the other children. Ask the whole group to make suggestions on how these cars might be improved so that they will move better. There are at least three design issues that should be discussed.

1. **Friction of the axle.** The paper punch creates a hole in the cardboard that is just big enough to allow a dowel to slide through. This results in a lot of rubbing or friction between the dowel and the cardboard. Ask the children what they could do to the hole to reduce this rubbing or friction. One possibility is to use the dowel, itself, to push slightly against the sides of the hole so as to enlarge it.

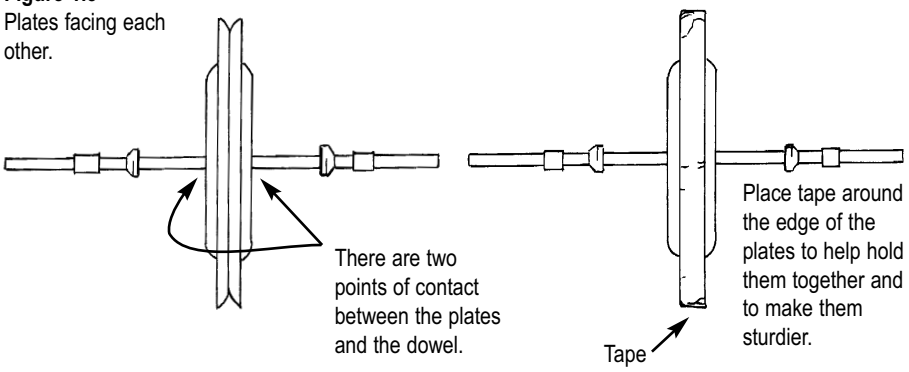
Figure 1.7
Plates facing the same direction. Note the single point of contact with the dowel.



2. **Wobble.** Depending on how the plates were placed on the dowels (for instance, if both plates on a wheel are facing in the same direction), the wheels may wobble as the car moves forward (see Figure 1.7).

   The wobble may also cause the car to travel off to one side. Ask the children how they might lessen the wobble. Here is one possibility: Line up two plates so that the edges of the plates face each other (see Figure 1.8). In this manner, there are two surfaces instead of one for the dowel to support. However, the edges of the plates have to be lined up carefully or there still may be some wobble.

Figure 1.8
Plates facing each other.



3. **Car does not travel straight.** Ask those teams whose cars do not travel in a straight line to show them to the whole group. Have them discuss what might be changed to correct this problem. One problem, as discussed above, is that the car is wobbling, causing it to roll to the side. Other possibilities include that the axles are not lined up parallel to each other (as they are in Figure 1.9) or that the plates on one or both axles are not centered properly and the wheels are rotating in an uneven manner.

   Those unsuccessful teams should also show how they constructed their cars. Ask everyone if they can make suggestions that will help these teams.

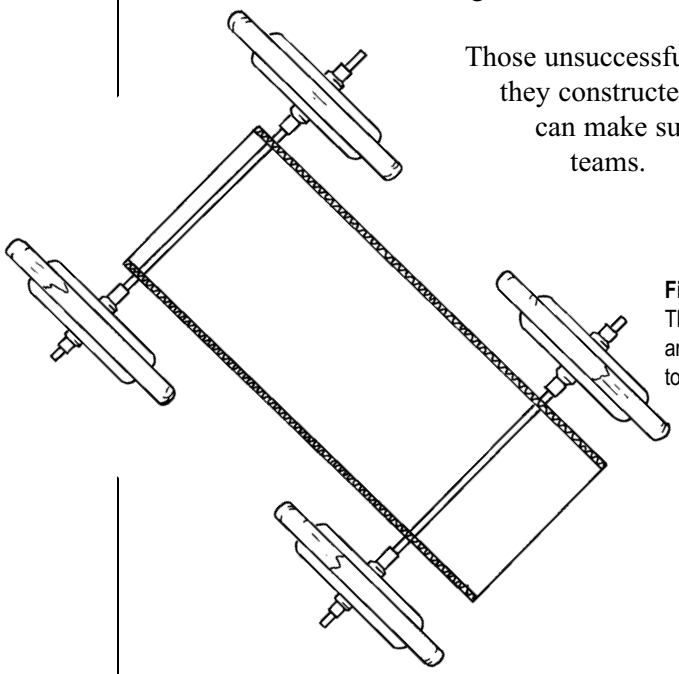


Figure 1.9
This is the best arrangement to get the car to travel straight.

Activity 1: Assembling a Car

Rationale

The overall challenge in this project is to build and test a rubber band powered car. Younger children will need to be taken through a series of steps to arrive at this goal. Some children have problems simply assembling a car, particularly when trying to figure out ways to attach the rubber bands to the cars' axles.

This first activity is solely for children to construct their cars and to make them move well, go straight, and travel easily. They need to be able to give their full attention to these tasks before moving on. Once they feel comfortable with how their cars are constructed, they will be challenged to add a rubber band propulsion system.

Introducing the Activity

In their first attempts to construct a car, some teams might attach their axles to the cardboard in ways that will not be useful later on. Also, the way the plates function as wheels may not work when the rubber bands are used to power the car. This may not be apparent to the children even during the testing in this activity. Use the results from the testing with the ramp to get them to pay special attention to these two design features. When a car doesn't travel very far, try to have the children examine their cars and isolate what they think can be improved. The two most important concerns is to get the cars traveling as straight as possible, and to have the wheels and axles moving with little friction.

When introducing this activity, you may also want to have the children think ahead about how the axles should be lined up on the cardboard. Will all of the different arrangements of axles suggested by the children allow the cars to travel straight (see Figure 1.10)?

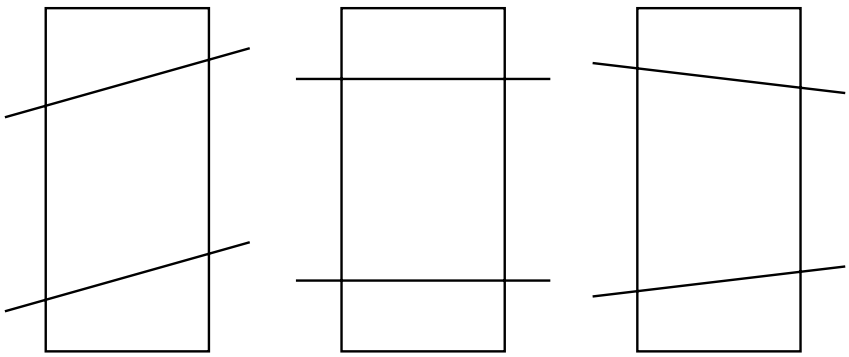


Figure 1.10
Arrangements of axles.

Leading the Activity

Urge the members of each team to talk to each other about what they are about to do with the piece of cardboard. Rather than randomly putting materials together, they should try to think ahead to the results they want to achieve. For instance, what might happen if they attach the axles so they are not parallel, or if the wheels don't move freely on the axles? Sometimes children will have a problem finding the words to describe their thoughts. Encourage them to demonstrate with their hands or with their cars what they think will happen.

Troubleshooting

Given the type of materials being used, it is likely that the cars will not work well during the very first tests. Sometimes they will blame the poor performance on the materials. Try to get the children in the habit of making changes to their cars. Encourage them to watch closely how the car moves and try to isolate what may be causing the problems. Some of these problems may not be obvious to them, so you may need to give a little guidance. Rather than telling them what may be wrong, ask questions about the different parts of the car to draw the children's attention to these problems.

Leading the Discussion

It is important that time be taken after each activity for children to discuss what they have been doing. They probably expect to have immediate success. Tell them that for most projects, engineers have to make adjustments after first assembling something. Given their limited experience, the children can expect that their first efforts may not work well. Part of the design process is to try to figure out why something doesn't work well and to find ways to improve its performance. Isolating the different problems at this point is important. It will help the children make a car that will be ready for the next step: attaching a rubber band to make it move.

Assessment

During the first activity, you should observe each team closely with respect to three behaviors and watch how these behaviors change over the course of the project:

- How do they talk and plan their design? Do they immediately start working with the materials without discussing with each other how they will proceed?
- How do they carry out the construction? Do they discuss with each other where to place holes in the cardboard for the dowels or does one child just start making holes without thinking where may be the best place for the axles? Are they careful in finding the center of the plates? Do they make the right size holes in the plates?
- How well are they working as a team? Does each child stay in his or her role? Do they argue over who does the construction?