

Activity 4

Puppet Power

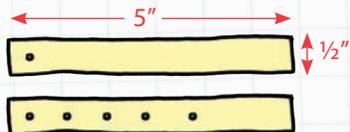
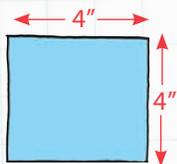
DESIGN A SHADOW PUPPET WITH MOVING PARTS AND USE IT TO TELL A STORY.

The tradition of using shadow puppets to tell stories dates back thousands of years, making it one of the oldest forms of motion-picture storytelling. Shadow puppet theater originated in India and China, where the tradition lives on today. Shadow puppets are often used to convey culturally important stories, such as myths, legends, folklore, and religious stories.

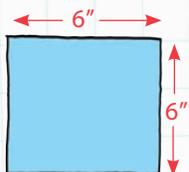


SMART START: Before doing this activity with your girls, build your own shadow puppets. This practice will help you guide your girls. For younger girls, you may want to do Parts 1 and 2 only.

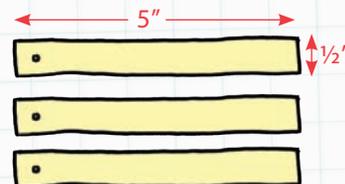
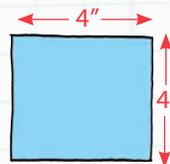
Prepare materials ahead of time. For Part 1, each **small group** will need a 4-in. square of cardboard and two cardboard strips, ½ in. x 5 in. Punch one hole in one strip and five holes in the other.



For Parts 2 and 4, **each girl** will need a cardboard square that is at least 6 in. x 6 in., but cut extras!



For Part 3, each **small group** will need another 4-in. square of cardboard and three more ½ in. x 5 in. cardboard strips with a hole punched in each strip. Groups will also need a cardboard disc with a 2-3 in. diameter and three holes punched in it.



You'll Need:

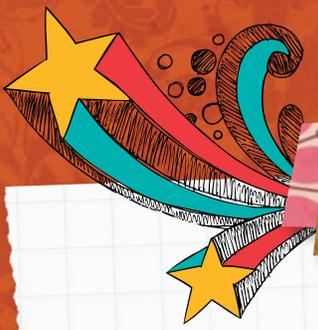
per girl

- ◆ 2-3 pieces of paperboard (e.g., cereal box, shoe box, tissue box)
- ◆ 20 brass fasteners (½ in. or ¾ in.) (office supply stores)
- ◆ 1 paint stirrer, ruler, or tongue depressor
- ◆ paper and pencil

per small group

- ◆ 1 paper punch
- ◆ 1 ruler
- ◆ scissors
- ◆ 1 roll of tape (masking or clear)
- ◆ light source (overhead projector, gooseneck lamp, clamp-on shop light with a 75- or 100-watt bulb) or a natural light source
- ◆ optional: decorative elements (e.g., feathers, cloth, lace, straw, doilies, colored cellophane, report covers)





Puppet Power continued

Part 1 Prototype a Simple Linkage

Here's how:

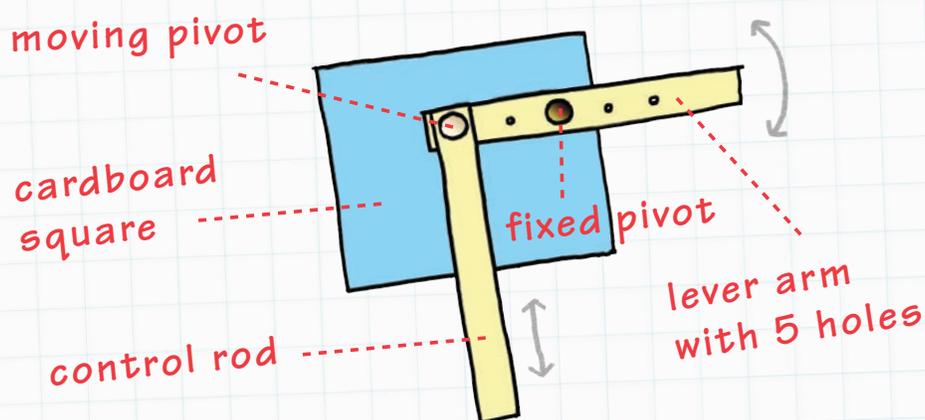
- 1. Introduce shadows.** Using your hands, make a shadow figure on a wall, floor, or table. (For example, make a rabbit head by forming a fist and extending two fingers. You can find other ideas by searching "Hand Shadows" on the Internet.) Point out how the outside edges determine a shadow's shape. Can you think of any street signs that feature silhouetted figures? ("Children Playing," "Deer Crossing," or "Crosswalk.") Point out that only the outline matters, rather than a puppet's surface details.
- 2. Introduce shadow puppets.** Ask if anyone has ever seen a shadow puppet show. Ask the girls how telling a story using puppets might be different from doing a play (puppets can do things people can't, like fly). How can working with shadows enhance a story? (You can make a

puppet look sharp or blurry or change its size by moving it closer or farther away from the light source.)

- 3. Make a prototype.** Ask your girls to break into pairs or small groups and give each group a cardboard square, two brass fasteners, and two lever arms to connect. (See below.)

Have your girls:

- ★ Explore how one pivot moves while the other is fixed in place.
- ★ Try placing the fixed pivot at different points along the lever to see how it changes how much the end moves.
- ★ Brainstorm actions a puppet could do based on a lever's up-down motion. (nod its head, wag a tail, chop wood, kick a leg, flap wings, open and close its jaw, etc.)³



Puppet Power continued



4. Plan each piece. To help girls see that a puppet's body and moving parts are separate, work through a prototype together. (Or, to save time, you can have an example ready.)



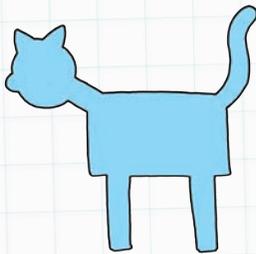
POINTER: Tell girls that this combination of levers and fixed and moving pivots is called a linkage. Linkages change the direction, motion, and/or force of the input force (i.e., the force on the control rod).

- ★ Sketch the puppet's outline on a half piece of paper. (See Step 1 below.)
- ★ Tell girls they want the neck and head to move. This part is, in fact, a long lever. The neck and head stick out while the control end remains hidden behind the main body. To show what the entire thing actually looks like, extend the lines of the neck back into the body. (See Step 2 below.)
- ★ Now, figure out what the body and moving part each look like as separate pieces. (See Step 3 below.)
- ★ Use a hole punch and brass fastener to put it all together. (See Step 4 below.)

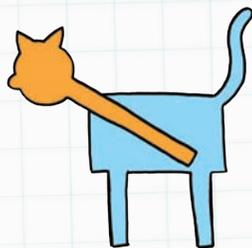
Linkages Are Everywhere!

Mechanical engineers use linkages in all sorts of machines, appliances, and gadgets (e.g., locking pliers, bike brakes, bolt cutters, folding baby carriages, folding drying racks, tire jacks). Bring in some examples to show your girls or have them think of examples from their own lives. ²

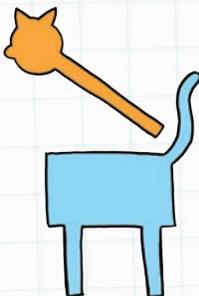
Step 1



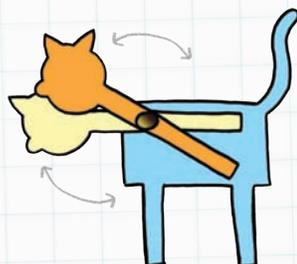
Step 2



Step 3



Step 4





Puppet Power continued



Part 2 Build Puppets with Simple Linkages

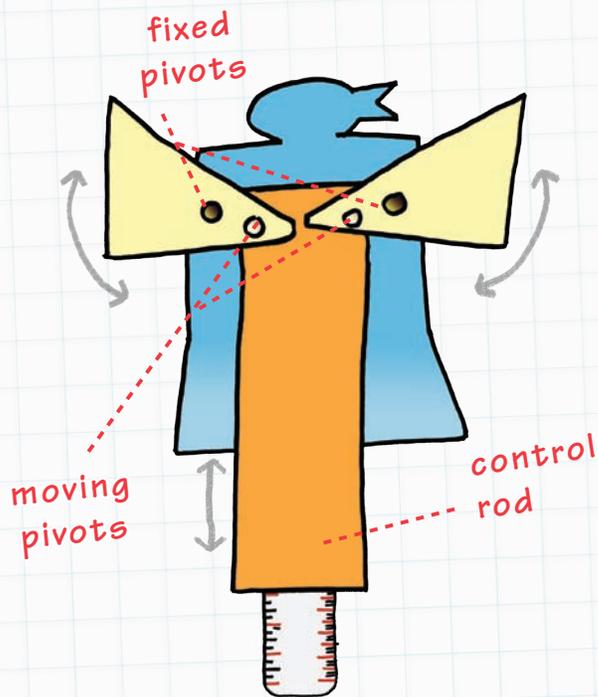
5. Sketch and make puppets. Give the **SciGirls**

Challenge: Design a shadow puppet with one or more moving parts. Each girl chooses a character for her puppet, such as a horse, dancer, or soccer player. Then girls sketch the main body and the moving part on a piece of paper. Referring to the sketch, the girls copy the body onto a piece of cardboard and cut it out. They repeat this process for the moving part.

6. Assemble the shadow puppets. By setting the moving part in place on the body and rocking it back and forth, girls can figure out where the fixed pivot(s) need to go to produce the motion they want. Have them mark the spot(s), punch hole(s), and then use brass fastener(s) to connect the body, moving part, and control rod. Have girls mount the puppet on a handle by taping it to a ruler, tongue depressor, or paint stirrer. (See right.)

POINTER: To add special effects, girls can cut or punch out details, such as eyes, a mouth, and hair, or they can attach decorative elements. Remember, only the silhouette matters with shadow puppets. ⁴

7. Test the puppets. If there's sufficient light, girls can cast shadows on the tables, walls, or floor. Otherwise, place lamps around the room and project them at blank spots on the walls. The girls can experiment with how to make the puppets come alive: move them so they walk, run, gesture, etc. Hold them near and far from the wall to change their size and definition. ³



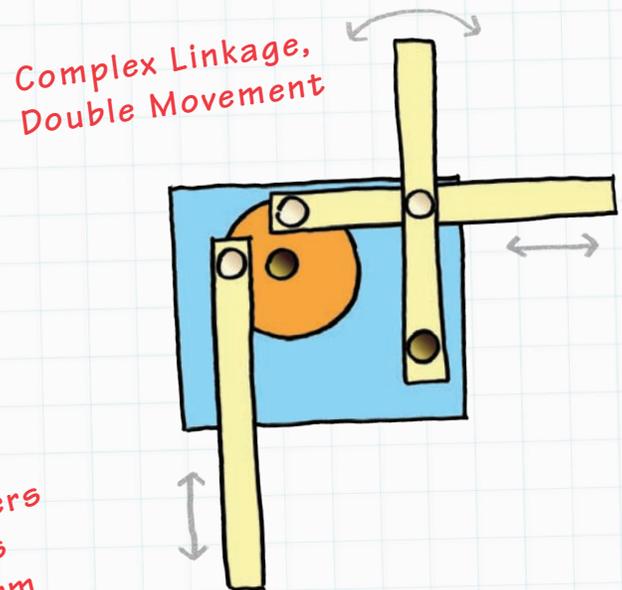
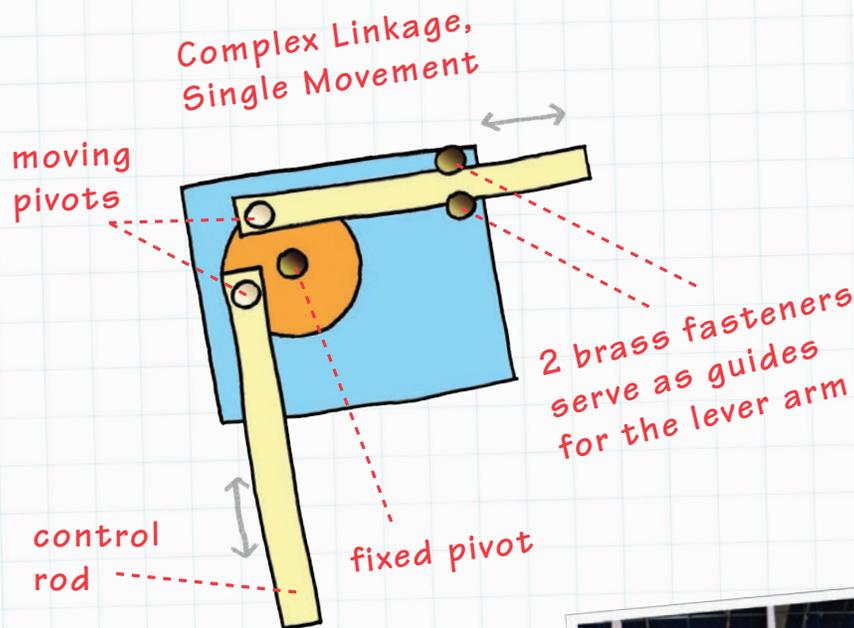
Puppet Power continued



Part 3 Prototype a Complex Linkage

8. Add a disk. Ask your girls to break into small groups again. Give each group a cardboard square, two lever arms, a disc, and five brass fasteners. Have girls connect them to create a linkage. (See below, left.) Ask the girls to compare this linkage to the one they made in Part 1. How does this linkage change the speed, force, or direction of the control rod's input force?

9. Be creative. The fun really starts when girls combine several elements. Take one of the samples made in Step 8 and connect a lever partway along one of the linkage arms. (See below, right.) What kinds of actions could this be used for? (ears wagging while sticking out a tongue) ⁶



Watch AnnMarie help SciGirls prototype on the *SciGirls Engineer It* DVD. (Select Puppet Power: Mentor Moment.) ⁷



University of St. Thomas, Mike Ekern

Mentor Moment

AnnMarie Thomas is a mechanical engineer who shares her love of the design process as a professor at the University of St. Thomas in Minnesota. When she's not helping kids look at the playful side of engineering (squishy circuits, anyone?), AnnMarie spends time exploring the circus arts with her two children.



Puppet Power continued

Part 4 Build Puppets with Complex Linkages

10. Sketch and make puppets. Challenge girls to make a puppet with one or more parts moved by linkages. (See below.) They can decide on a character first and then design the puppet, or they can create a linkage system and then develop a puppet around its movements. ^{3 4}

11. Discuss your results. What movements could your second puppet do that your first couldn't? Why do you think engineers use linkages? (to change the speed, direction or force of an input force, or to use a single input force to drive multiple outputs)



Watch the *SciGirls Engineer It* DVD. (Select Puppet Power: Share.) Do the SciGirls use linkages in their pig puppet? How? ⁶

12. Put on a play. Form groups that create and rehearse a brief skit or story that involves the characters. ⁴ Then, perform!



Share photos of your favorite shadow puppets on our website, at pbskidsgo.org/scigirls.

