Activity 4:

Levers at Play

Overview

Participants consider how a simple machine, a lever, turns a small push or pull (a small force) into a larger — or stronger — push or pull (a larger force) — and apply the concept to designing a model seesaw. In small groups, they explore a variety of materials in an open-ended process of building, testing, and revising. The challenge is set in an age-appropriate context of addressing one or more real-world challenges, such as designing a seesaw on which two people of different weights (e.g., a child and parent) or a person using a wheelchair can ride.

Activity Time:

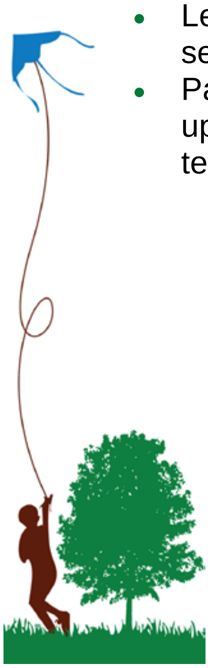
20 to 30 minutes

Intended Audience:

Families or other mixed-age groups, including children ages 5–7 *with assistance from an older child, teen, or adult*
School-aged children ages 8–9
Tweens up to about age 11

What's the Point?

- Levers are a type of simple machine that can be used to lift heavy loads — a seesaw is one fun example that is found at a park!
- Participating children, tweens, and adults, like engineers, can create and improve upon a model seesaw through the creative process of thinking, building, testing . . . and doing it again!



Materials

For the Facilitator

- ☐ *Implementation Guide* (available at www.starnetlibraries.org), which includes:
    - ☐ *Playful Building's* key features
    - ☐ Annotated facilitation outline
    - ☐ Facilitator background information
    - ☐ Shopping list
    - ☐ Extended supporting media suggestions
    - ☐ Correlations to National Science Education Standards
    - ☐ Contact information
    - ☐ STAR_Net project overview
    - ☐ Credits and acknowledgments
- ☐ *Brief Facilitation Outline* page
- ☐ *Playful Building* PowerPoint presentation (or the instruction slides printed for the groups to use) (available at www.starnetlibraries.org)

Facility Needs

- ☐ 3 or more tables
- ☐ Optional: 15–20 chairs arranged at the table(s) for groups or families to sit together while they create their boats
- ☐ Optional: a writing surface where the groups may sketch and write, such as:
    - ☐ 1 white board

      OR

    - ☐ 2–4 (~36" × 48") pieces of butcher paper, posted on the wall or used to cover the tables

      OR

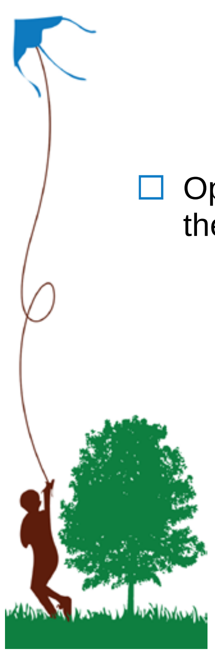
    - ☐ 5 or more sheets of poster paper

  AND

    - ☐ 4–8 dry-erase or other appropriate low- or no-odor markers

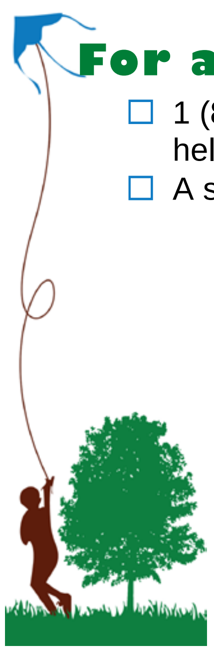
      OR

    - ☐ 4–8 crayons
- ☐ Optional: computer, speakers, projector, projection screen, and access to the Internet



For Each Family/Small Group of 3–4 Participants

- ☐ 10 small, relatively heavy objects, such as:
  - ☐ Weights
  - ☐ Pennies
  - ☐ Metal washers
  - ☐ Small rocks
  - ☐ Dried beans
- ☐ Optional: 2–3 LEGO® people
- ☐ A selection of long, thin, flat boards, such as:
  - ☐ Rulers
  - ☐ Paint stirrers
  - ☐ Popsicle sticks
  - ☐ Large craft sticks
  - ☐ Yardsticks
- ☐ A selection of cylinders, such as:
  - ☐ Soup cans (tape the edges on clean, repurposed cans)
  - ☐ Paper-towel tubes
  - ☐ Dowels
  - ☐ Ribbon and thread spools
  - ☐ Markers
  - ☐ Pencils
  - ☐ Triangular blocks
- ☐ 2 small paper cups (such as 3-oz. Dixie® bath cups)
- ☐ Optional: 3 adhesive labels (pre-printed with the terms “load,” “fulcrum,” and “effort”) AND ☐ Bean-bag chair or other fairly heavy object
- ☐ Optional: broom or long, flat board



For an Audience of 15-20 to Share

- ☐ 1 (8½" × 11") *Be Creative…Be an Engineer!* poster (for tweens, teens, and adult helpers)
- ☐ A selection of adhesives:
  - ☐ 3 or more rolls of masking tape
  - ☐ 3 packages of putty adhesive, such as Sticky Tack
  - ☐ 1 (½" size, 200-ct.) roll of Glue Dots®

Supporting Media

Consider setting up a digital media player (such as a computer), speakers, and access to the Internet to display videos, images, podcasts, or websites before, during, or after the activity. Offer one or more books about levers, as well as seesaws and other playground equipment.

A more extensive list is included in the *Implementation Guide*.

Online Resources

Sway Fun Accessible Glider
www.youtube.com/watch?v=u-S3p4h1poo
The PlayBooster® Sway Fun® Glider is a real-world example of a wheelchair-accessible seesaw.

Grand Challenges for Engineering
www.nae.edu/Activities/Projects/grand-challenges-project/Videos_grandchallenges.aspx
"Build your Dream"

Books

Hop! Plop!
Corey Rosen Schwartz and Tali Klein, Walker Childrens, 2006, ISBN: 9780802780560
Friends Elephant and Mouse visit a playground and struggle to use the playground equipment. For example, Mouse is sent flying when Elephant sits opposite him on the seesaw. Appropriate for ages 3 and up.

On the Seesaw Bridge
Yuichi Kimura, Vertical, Vertical, 2011, ISBN: 9781935654186
A fox and his potential prey, a hare, are trapped on a seesaw bridge. They use the bridge's movement to launch themselves to safety. Appropriate for ages 4 and up.

How Do You Lift a Lion?
Robert E. Wells, Albert Whitman & Company, 1999, ISBN-13 9780780779228
Children ages 4–8 can imagine how levers, wheels, and pulleys could be used to move heavy animals in this playful exploration of simple machines.

Preparation

Before the day of the activity

- ☐ Use the *Implementation Guide* to determine the setup of your engineering program(s), organize and prepare your presentation, and help you collect the materials.
- ☐ Prepare publicity materials for these or any other future engineering and technology events.
- ☐ Optional: Incorporate the *Playful Building* PowerPoint presentation into your facilitation plan. Modify the presentation to suit your needs.
- ☐ Collect and prepare materials.
    - ☐ Construct one or more example levers, and adjust where the platform rests on the fulcrum in order to lift the heavier load.

Facilitator's Note: Here are a few examples of how levers can be constructed from the materials listed here:

- Place a broomstick or long, flat board on a soup can; balance a bean-bag chair on one end.
- Place a paint stirrer on a paper towel tube that has been taped to a table; stack three pennies on one end and six on the other.
- Place a ruler on a pencil that has been taped to a table; begin with the ruler resting on the pencil at about the 2-inch (5-cm) mark. Using glue dots, attach a "load" cup to one side of the ruler, and an "effort" cup on the other. Put a rock in the "load" cup and add pennies to the "effort" cup until the load lifts off the table enough to tip back and forth on the fulcrum.

The day of the activity

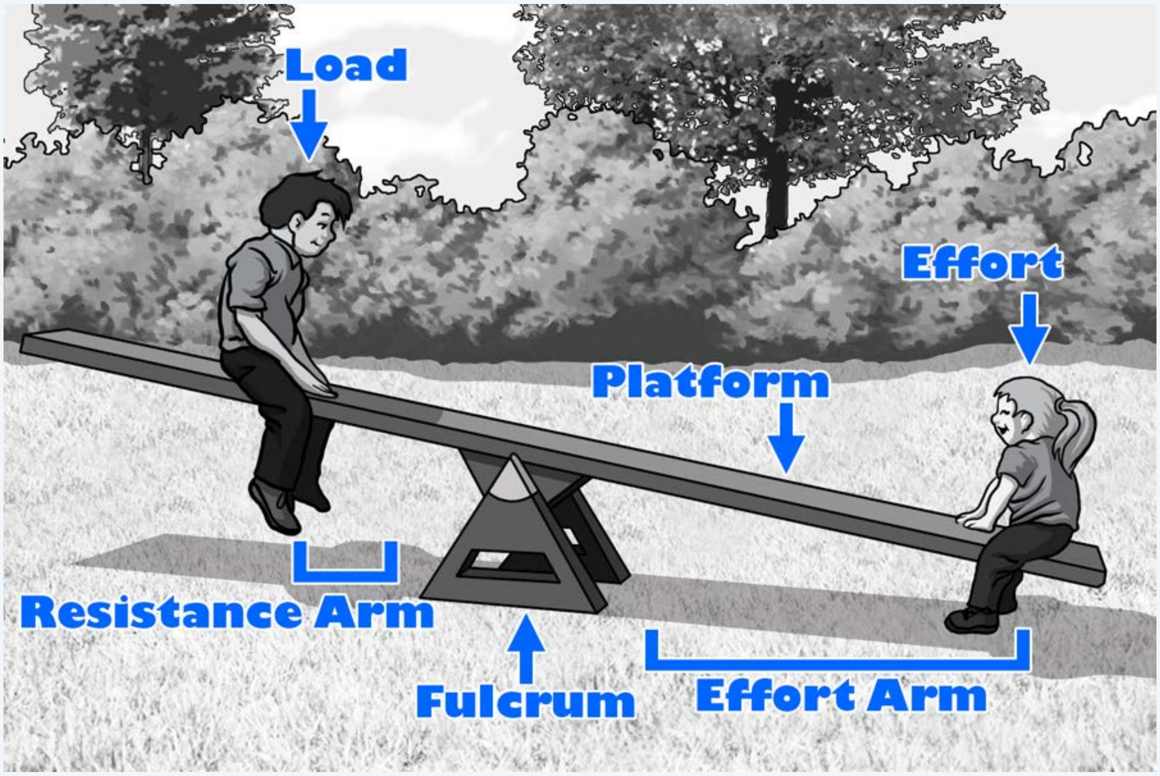
- ☐ Set up the facility.
- ☐ Set out the materials.
- ☐ Print the *Brief Facilitation Outline* page, which integrates the steps of the activity with the annotated facilitation outline presented in the *Implementation Guide*, to use as presentation notes.
- ☐ Provide access to any supporting media and the *Playful Building* PowerPoint presentation (or printed copies of the instructions slides for this activity).
- ☐ Set out the *Be Creative* poster (or hang it on a nearby wall).

Activity

1. Provide the example lever and encourage the participants to compare lifting an object directly with using a lever as you begin a conversation. For example, invite participants to lift a bean bag with one foot — first, *without* a lever. Then, try again using a lever.

2. Ask questions about what the participants know about levers and the ways they are used to facilitate a conversation about the following points:
   - A lever is a simple machine that turns a small push or pull (a small force) into a larger (or stronger) push or pull (a larger force).
   - A lever is made up of a platform, which is turned around a support (i.e., a fulcrum) — or other pivot point.
   - As the example lever illustrates, an object resting on the platform is easier to lift.
   - Both weight and distance are important in designing a lever. A single weight can lift a fairly heavy object or several weights — as long as the heaver object is far from the fulcrum.

Facilitator's Note: For example, the adult in this illustration sits far from the fulcrum. The child's smaller weight is transformed, via this simple machine, into a force that lifts the heavier adult.



- Levers help us:
  - Eat (scissors open packages, bottle openers open drinks, fishing poles catch fish)
  - Build our homes and other buildings — and maintain them (wheelbarrows lift dirt and bricks, the "claw end" of a hammer removes nails, the arms of mechanical cranes move heavy items)
  - Have fun!

3. Optional: Use the supporting media to explore applications for levers.

4. Challenge the participants, working in groups, to create a model of a seesaw that they would like to include in the park of their dreams! Provide suitable context for this challenge based on the materials you will be providing and the ages of your target audience. Allow time for questions.

Facilitator's Note: This activity is intentionally open-ended to encourage creativity. However, providing context is important for attracting the interest of girls and other underrepresented groups in science, technology, engineering, and mathematics (*Halpern et al.,* 2007).

Ages 3 to 6

- Create a seesaw on which two people of different weights — a child and parent, for example — can ride.
- Read **Hop! Plop!** and then balance a light object ("mouse") and heavy object ("elephant") on opposite sides of a lever by adjusting the position of the fulcrum.
- Read **On the Seesaw Bridge** and then — with the adult supervision and location necessary for launching (soft) projectiles — practice launching a lighter, soft object ("hare") using a heavier one ("fox").

Ages 7 and up

- Incorporate engineering and physics terms into the activity:
  - Have each group label one cup "Load" and use it to hold the weights that they'd like to lift.
  - Have them label another cup "Effort" and add weights to it to lift the load.
  - Refer to the cylinder or triangular-shaped block on which the platform rests as the fulcrum: The load rests on the "resistance arm." The opposite side of the fulcrum, where they apply "effort" to lift the load, is the "effort arm."
- Take on the real-world challenge of creating a model seesaw designed to accommodate persons in wheelchairs, allowing for both the size and additional weight of the wheelchair.
- Create model seesaw designs that can accommodate an entire group at once, which may involve multiple platforms attached at different angles and balanced on a single fulcrum.

References
Encouraging Girls in Math and Science: IES Practice Guide
ies.ed.gov/ncee/wwc/pdf/practice_guides/20072003.pdf
Diane F. Halpern et al, U.S. Department of Education, 2007

5. Break into groups (with three to four people each) and begin. Encourage each family to work together as a group — parents too!

6. Guide the children through the engineering design process as they work. Encourage groups to methodically improve one aspect of their levers at a time. Suggest:
   - Adding weights to one side of the lever (on the “effort arm”),
   - Moving the platform so that one side is closer to the fulcrum than the other, or
   - Using a different material to construct the lever.

Facilitator’s Note: As time allows, emphasize this stage of the engineering design process as much as possible. Adjusting and retesting their ideas is the best way to experience the ongoing work of an engineer! They will be rewarded by seeing improvement.

Reassure the participants that there isn’t a “right” answer that they must arrive at on the first try. Furthermore, failure is an essential part of figuring out what works and what doesn’t. It is OK to fail — and try again . . . and again . . . and again!

7. Optional: Have each group present their final model to the entire audience.

Extensions

Allow additional time, per the instructions provided on these external websites, if incorporating these activities.

Build a *Real* Playground, Community Garden, or Entire Park

The *Lever* activity introduces some basic experience relating to a simple machine, and a natural outgrowth could be to build and install playground equipment at an existing park. Consider taking the *Playful Building* module to the next level: Encourage teens and adults to build a seesaw, drawing on ideas represented by the model seesaws in this activity.

Additional Activity

Rocket Science: 50 Flying, Floating, Flipping, Spinning Gadgets Kids Create Themselves
Jim Wiese, John Wiley & Sons, Inc., 1995, ISBN: 9780471113577
Included in this book are step-by-step instructions for using levers to make a "balancer" — where two forks are balanced on a matchstick. Appropriate for ages 9–12.

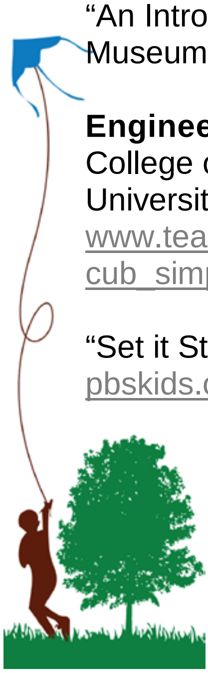
References

This activity was inspired by the following educational materials:

"An Introduction to Simple Machines," **Pre/Post Activities**, Copyright ©2008 Children's Museum of Houston.

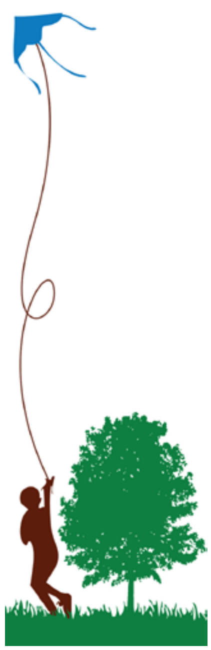
Engineering: Simple Machines, Integrated Teaching and Learning Program, College of Engineering, University of Colorado at Boulder, ©2005 Regents of the University of Colorado, www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_simple/cub_simple_lesson01.xml.

"Set it Straight," **FETCH!**, ©2010 WGBH Educational Foundation. PBS, pbskids.org/fetch/games/activities/pdf/FETCH_SetItStraight.pdf.



"Build a Lever," **Online Science Activities***,* Museum of Science and Industry, Chicago, www.msichicago.org/online-science/activities/activity-detail/activities/simple-machines-build-a-lever/browseactivities/0/

"Lesson 6: Levers," **Simple Machines: Force and Motion**, Chicago Children's Museum, http://www.chicagochildrensmuseum.org/SimpleMachines_Curriculum.pdf.



Brief Facilitation Outline

Introduction

- Introduce yourself and the library.
- Frame the activity with the main message: Engineers work to solve the basic challenges of life — including having fun!
- Conversation:
    - Ask open-ended questions about things we need for *enjoyment* in life.
    - Discuss examples of how engineers use (simple) technologies to improve lives, e.g., simple machines like inclined planes, screws, and levers are used for play.

Activity

- Example lever: Compare lifting an object — first, *without* a lever, then again using a lever.
- Conversation: Ask questions about levers — what they are, how they make it easier to lift things, and some real-life examples.
- Use supporting media to explore applications for levers (optional).
- Challenge (in groups of 3–4; parents too!): reate a model of a seesaw that is designed to serve a particular purpose (based on the materials you will be providing and the ages of your target audience).
- Encourage persistence: Successful engineering involves a process of thinking, building, testing . . . and doing it again!
- Emphasize the engineering design process; encourage groups to methodically improve one aspect of their boats at a time. Suggest:
    - Adding weights to one side of the lever (on the “effort arm”),
    - Moving the platform so that one side is closer to the fulcrum than the other, or
    - Using a different material to construct the lever.
- Present the final seesaw designs (optional).

Conclusion

- Summarize the groups’ explorations of how engineers solve life’s challenges.
- Congratulate the groups on their accomplishments.
- Advertise any future engineering and technology events.

Activity Materials to Print

Be Creative…Be an Engineer!

Think, build, test, do it again: That's the process engineers use when they tackle a problem. Engineers don't have official rules telling them to follow this set of steps. But, over time they've learned that they get the best results this way:

They think and brainstorm about a problem and factors they have to consider to solve it. They come up with an idea and build a prototype. They test the prototype. And, then they repeat the process to improve their results.

Engineers often move back and forth within the loop, repeating two steps over and over again before moving forward. It's a key to engineering success.