Engineering Challenge

Teacher Guide

Bio means life. *Mimicry* means to imitate. **Biomimicry** is the practice of imitating life to solve problems. Have students model the work of real engineers by designing nature-inspired solutions to problems. The challenge involves making observations of a plant or animal, describing its most unique or interesting structures and functions, identifying a human problem that mimicking the plant or animal could solve, and designing and advertising an invention using biomimicry.

An article about the way owl wings inspired a design for quieter airplanes can be found at this link: https://techxplore.com/news/2017-08-owl-wings-bio-inspired-ideas-quieter.html

STEP 1: STUDY OWLS

Using the "Explore More for Kids" page in the back of the book and other resources, have students identify some unique or interesting structures the owl has that helps it function or survive in its environment. For example: their head can turn 270 degrees, their eyes are huge and they can see in the dark, their strong talons an carry heavy prey, ears on the side of their head give them excellent hearing, special feathers on their wings help them fly silently. Have a discussion with the class about the structures and their corresponding functions. (You may want to have younger students draw the structures and tell you about their functions, while older students may record them on a chart.)

STEP 2: IDENTIFY A PROBLEM

Ask students to think about their plant or animal and its unique structures and functions. How are they different from human structures? What human problems might an owl help solve? How?

STEP 3: BRAINSTORM AND DESIGN

Invite students to brainstorm an owl-inspired invention. Ask them what they could invent that would mimic, or imitate an owl in order to solve a problem. They might consider tools, toys, clothing, robots, or other technologies designed to mimic an owl. Next, have students sketch their inventions. Encourage them to label the structures on their invention that helps it solve a problem or meet a need.

STEP 4: BUILD A MODEL

Explain that engineers build models to test and share their inventions. Provide a variety of craft supplies for students to use to make a model of their invention. Have them experiment with the materials and choose the best ones for building their model.

STEP 5: SHARE THE SOLUTION

When they are finished building, have students create an advertisement to "pitch" their invention. They can give it a catchy name and use advertising features to appeal to consumers. In their pitch, students should be able to describe how their invention solves a problem and why people should use it. Have students share their models and advertisements. Discuss the design features of each invention and ask: *What problem does it solve? Why should people use it? How is it an example of biomimicry?*

Center:

Owl Pellets

Multiple Intelligence:
Naturalist

Objective:

Examine owl pellets for evidence of rodent, vole, shrew, or bird bones.
Classify and identify bones.
Optional: Reconstruct a rodent skeleton

Benchmarks:

Knows that objects can be classified by their physical properties. (Science 10, Level I)

Knows that living things can be sorted into groups in many ways using various properties to decide which things belong to which group; features used for grouping depend on the purpose of the grouping. (Science 4, Level II)

Knows that all animals depend on plants; some animals eat plants for food while others eat animals that eat the plants. (Science 8, Level II)

Knows that all species ultimately depend on one another; interactions between two types of organisms include producer/consumer, predator/prey, parasite/host, and relationships that can be mutually beneficial or competitive. (Science 7, Level III)

Effectively uses mental processes that are based on identifying similarities and differences (compares, contrasts, classifies). (Life Skills: Thinking and Reasoning 3, Levels I, II, and III)

Skill for Living:

Concentration — being able to focus attention.

Materials:

Owl Pellets (See description in *Center Directions*.) — one per student or student group
Toothpicks — one per student
Paper plates — two per student
Owl Pellets — Bone Identification Chart (Copy Master page 13) — one per student
Optional: magnifying glasses for students to share
Optional: spray bottle of water—for teacher to use to spray pellets to make them easier to break apart.

Teacher Preparation:

Order owl pellets. They are available from Pellets, Inc., Kim and Bret Gaussoin, PO Box 5484 Bellingham, WA 98227, Phone: 360-733-3012 OR (fax) 360-738-3402, http://www.pelletsinc.com.
Allow one week for delivery.
Make copies of *Owl Pellets — Bone Identification Chart.*
Copy and laminate *Center Directions*.

Reflection Questions:

1. What kinds of bones did you find in the pellet?
2. Were the bones difficult to identify and classify?
3. What techniques and strategies did you develop as you took apart the pellet and classified bones? What will you do the same or differently when you work with the pellets next time?
4. What information did the pellets give you about the owl's diet? Is the owl an herbivore or a carnivore? A predator or prey?

Note: Students have a lot of fun with this activity and can get very excited as they find the bones. I suggest that you do this activity first with the whole class, and then set up the materials at a center for students to explore again during center time.

Center Directions:

Owl Pellets

At this center you will:

Take apart owl pellets to discover information about the owl's diet.
Identify and classify the bones you find.

Materials you should find at this center:

Owl Pellets — one per student or student group
Toothpicks — one per student
Paper plates — two per student
Copy of *Owl Pellets —Bone Identification Chart* — one per student

What you need to bring to this center:

Paper and pencil
Concentration — being able to focus attention.

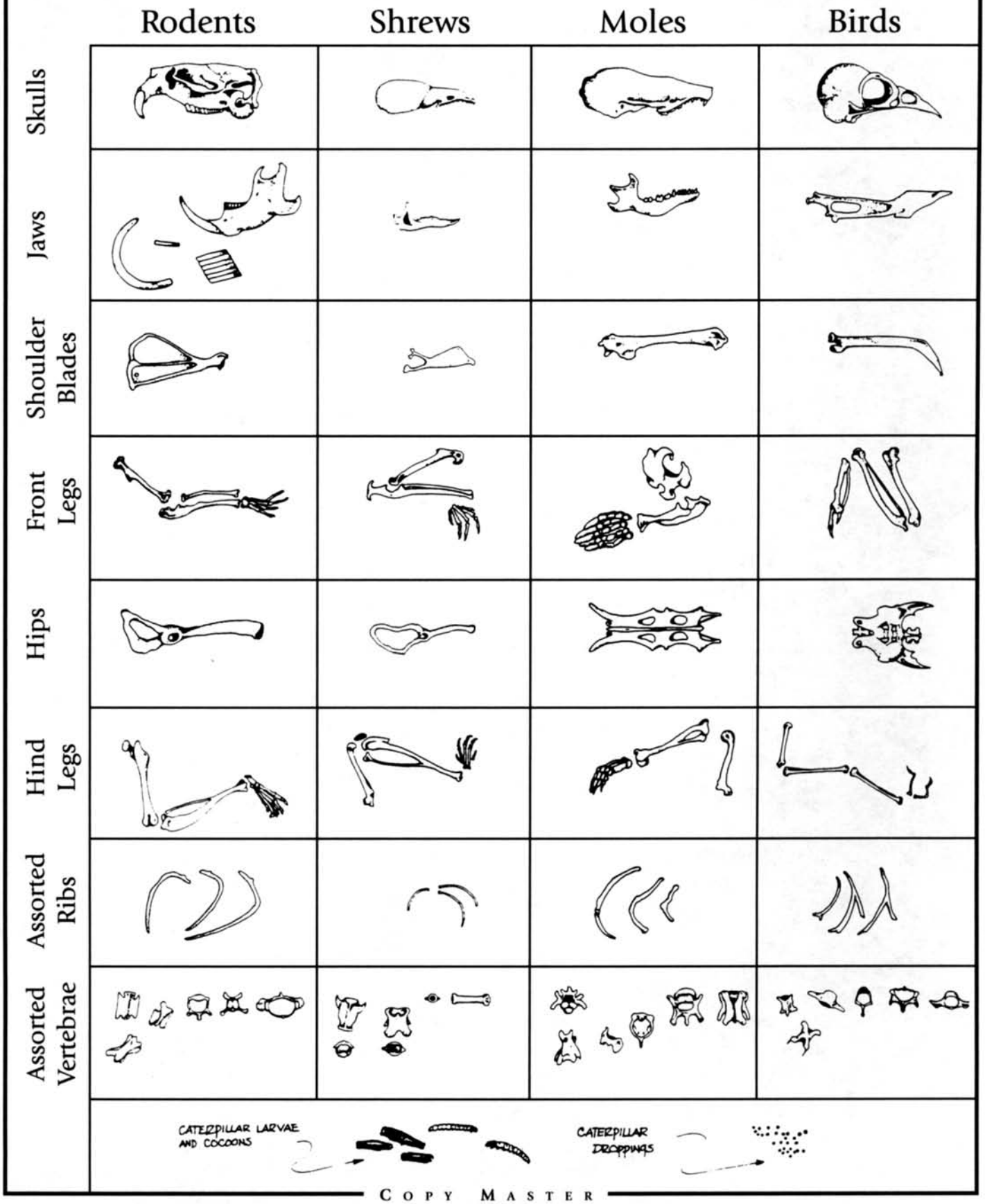
Student Directions:

1. Owl pellets are the compact undigested parts (bones and fur) from an owl's diet. Several hours after a meal, an owl will spit out a pellet. Put the owl pellet on one of your paper plates.
2. Using the toothpick, gently begin pulling it apart. As you separate the pellet you will find tiny bones mixed in with the fur. Wetting the pellet with water can sometimes help to loosen the fur.
3. Put the bones on the other paper plate. Use the *Bone Identification Chart* to identify the bones you find. Sort them by putting them in different parts of the paper plate. For example, the skulls go in one area, the leg bones in another, the ribs in another. You may have one area on your plate for unidentified bones.
4. Once you have sorted all of the bones in your pellet, count how many of each type you found and write the information on your paper. You may use this information at a later time.
5. Keep the bones in a place designated by your teacher. Throw away the toothpicks, paper plates, and fur. **Wash your hands.**

Extension Activities:

Put together a complete skeleton of a rodent.
Graph the amounts of each kind of bone that the class found.

Bone Identification Chart



COPY MASTER

Name:_____

Biomimicry Design Challenge

Student Sheet

Bio means life; mimicry means to imitate. So **biomimicry** is the practice of imitating life to solve problems. For this STEM challenge, you will design a nature-inspired solution to a problem.

STEP 1: OBSERVATION

Read the information about Great Horned Owls on the Explore More for Kids page. Look at the illustration. What unique or interesting structures does an owl have that help it function or survive in its environment?

Structure (Part)	Function (Purpose)

STEP 2: IDENTIFY A PROBLEM

An engineer wanted to find a way to make airplanes quieter. He knew that owls fly silently because of the way their wings are structured. He's using what he's learned about owl wings to create an ultra-quiet plane. What other human problem might an owl help solve? How?

_____

_____

_____

STEP 3: BRAINSTORM AND DESIGN

What could you invent that would imitate a part of an owl in order to solve the problem? Think about a tool, toy, article of clothing, robot, or other technology that could be designed to mimic an owl. Sketch your invention below.

Name:_____

STEP 4: BUILD A MODEL

Experiment with simple materials you could use to build a model of your invention, then build it! List the materials you used below:

_____

_____

_____

STEP 5: SHARE YOUR SOLUTION

Make an advertisement to "pitch" your invention. Give it a catchy name. (The engineer called an owl's silent wings its "hush kit.")

Describe how your invention solves a problem and why people should use it. Tell how the invention is an example of biomimicry.

Name:_____

Engineering Challenge

Student Sheet

Got a problem? Nature has a solution! Invent something that solves a problem using an owl as your inspiration. Draw it in the space below.

Name of Invention: _____

What problem does your invention solve?

_____

What part of the owl inspired your invention?

_____

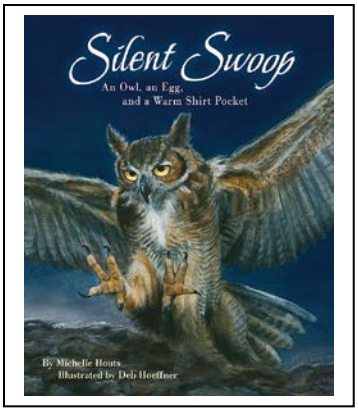
This activity is based on the book ***Silent Swoop: An Owl, an Egg, and a Warm Shirt Pocket***
by Michelle Houts

Fantastic Feathers for Flying

Introduction

Birds are the only animals that have feathers! In this hands-on activity, young children explore three ways that feathers help a bird to fly. (preK-2)

Materials



- The book *Silent Swoop*
- Feathers (purchased from a craft store)
- Scissors
- Piece of paper
- Tape
- Hand lens or magnifying glass
- Structure of a feather handout, below

Procedure

Important note: It is against a federal law to collect or possess bird feathers from most wild birds in the United States. Although feathers from domestic birds and game birds, such as chickens and ducks, are OK to possess, we suggest buying feathers from a craft supply store.

1. Read aloud the book *Silent Swoop: An Owl, an Egg, and a Warm Shirt Pocket.* Explain that in order for a bid to fly, its wings needed to be light, strong, and able to provide a broad surface to push against the air.
2. Tell children that they will explore these qualities in a feather. Give each child a feather, scissors, piece of paper, tape, and hand lens or magnifying glass.
3. **A feather is light.** Have children hold their feather in the palm of their hand. Ask: *Does it feel heavy or light?* Using scissors, have them cut through the central shaft of the feather, which is called the rachis. Ask: *What do you see?* (The thickest part of the feather is a thin tube, filled with air.)
4. **A feather is strong.** Demonstrate a feather's strength by using a sheet of paper. Have children hold the edge of a piece of paper and move the paper up and down. Ask: *What happens to the flat piece of paper?* The paper bends very easily. Then have them roll the paper into a tube and tape it so it doesn't unroll. Now have students hold the tube by one end and move it up and down. Ask: *Does the tube bend?* (The paper tube is much more resistant to bending than the flat sheet of paper and can support quite a bit more weight. A feather's hollow shaft keeps the feather light and also makes it strong.)
5. **A feather is able to push against the air**. In order to push a lot of air, feathers must form a solid wing. The part of the feather that forms this surface is called the vane. have children look closely at their feather to notice that the vane is made up of many long,

hair-like structures called barbs. For the feather to do its job, these barbs must stick together to form a continuous surface.

6. Have students hold their feather and separate the barbs by running their hand down the feather. Point out that now their feather would let the air flow through. Ask: *What would happen to a bird with many feathers in this condition?* (It would have difficulty flying.)
7. Explain that the feather is easily fixed. Have them use their fingers to smooth the barbs back into place so that they stick together and form the continuous surface that the bird needs. Using a hand lens or magnifying glass, look closely at the barbs. Each barb has many tiny hooks, called barbules. These hooks interlock with the barbules from the next barb, acting very much in the same way that Velcro does. This makes the feather easily repairable. Ask: *How does a bird keep the barbs of a feather in place?* (A bird pulls a feather through its beak to stick the barbs back together. This is called preening. Because healthy feathers are important for flight, a bird is careful to spend time preening every day.)

Extension: Feathers do much more than just help the bird fly. They trap air against the bird's skin, forming a layer of insulation. This keeps the bird warm in winter. Feathers also overlap to form a smooth, streamlined covering to help the bird's body slip easily through the air. They also give the bird its color, and male birds often use bright plumage to attract females. For more fun feather facts read the book *Feathers: Not Just for Flying* by Melissa Stewart.

Resources: Thanks to the Growing Science blog for these hands-on suggestions. Visit them at http://blog.growingwithscience.com/2014/03/feathers-not-just-for-flying-2/.
And for more information about feathers, go to the Cornell Lab of Ornithology at https://academy.allaboutbirds.org/features/all-about-feathers/#how-feathers-are-built.php.

Standards Alignment

Next Generation Science Standards (K-2)

Next Generation Science Standards (DCI: K-2)

Disciplinary Core Ideas
LS1.A-- Structure and Function

Science and Engineering Practices
Make observations to construct an evidence-based account for the natural phenomena.

Crosscutting Concepts
Structure and Function

This activity is based on the book ***Silent Swoop: An Owl, an Egg, and a Warm Shirt Pocket***
by Michelle Houts