Arts & Engineering Activity Packet
Grades 3 to 5

- Homemade Wigglebot
- Let’s Make an Elastic Puppet
- Music to Our Ears
- Shoo, Bird, Shoo

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Homemade Wigglebot

Create a simple robot that can draw its own designs.

**Instructions**

Students hook up a simple DC motor to a battery in order to make a simple, fun robot that wiggles around on a piece of paper and makes its own abstract art.

Instruct students to make their wigglebots like this:

1. Tape the markers inside the cup so that the tips of the markers protrude from the cup; these are the legs. It is important the tips are beyond the edge of the cup.

2. To attach the battery holder to the DC motor, wrap the wire from the battery holder around the leads on the motor.

3. Tape the battery holder (with the DC motor attached) to the top of the disposable cup, slightly off center. This might be easier if you make the tape narrower by cutting it lengthwise.

**Materials**

- Disposable cup
- Electrical tape
- 3 markers
- 2 AAA battery holder
- 2 AAA batteries
- 1.5V–3V DC motor
- Clothespin
- Popsicle stick
- Paper
- Scissors

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INSTRUCTIONS (CONTINUED):

4. Tape the motor onto the cup next to the battery holder.

5. Place the batteries into the holder to test the motor and the wigglebot’s balance. There should not be too much wiggling at this point. Just make sure there is some vibration but the cup can balance. Adjust placement if needed.

6. While the motor is still on, attach the clothespin to the top of the motor to make sure it does not cause the cup to fall.

7. Turn the motor off and remove the clothespin. The goal is for the cup to wiggle as much as possible without parts falling off. To do this:
   - Tape a popsicle stick to the clothespin.
   - Cut a long, narrow piece of electric tape. Fold the end over the top of the motor. Then, wrap the remainder around the motor so that the sticky side is facing out.
   - Attach the clothespin and popsicle stick to the tape-wrapped motor. The sticky part of the tape will adhere to the inside of the clothespin and hold it in place.

8. Make a face on the wigglebot.

9. Take the caps off the markers, plug the batteries in, and let the wigglebot go on a piece of paper. It will wiggle and spin, making its own art!

MATERIALS (CONTINUED):

- Permanent marker to draw face with
- Googly eyes and pipe cleaners for arms (optional)
- Glue (or hot glue gun; only needed if you use Googly eyes)
Engineering & Science Connections

All robots—no matter how complex—require a power source and one or more motors. Engineers need to understand the basic principles of these before they can build more complicated robots.

Other robots include drones, manufacturing robots and self-driving cars. There are more than a million robots in use today in industry alone.

With “artificial intelligence” development, robots are expected to become more and more commonplace. Engineers at the Massachusetts Institute of Technology (MIT), in fact, are trying to build a robot that can respond to emotional cues.

Engineers make motors for all kinds of machines, from toys to washing machines to cars. Robots are very important for space exploration. Two exploratory rovers, Spirit and Opportunity, are currently on Mars. They were designed to gather geological data and take pictures that are then transmitted to scientists on Earth. Both were built to last only for 90 days. Spirit lasted for 6 years, and Opportunity is still sending information back to Earth after 11 years.

Guiding Questions

What would happen if the legs weren’t all the same length? What if they were even longer?

What would happen if the wigglebot had more than 3 legs?

What could you do to make the wigglebot wiggle even more?

What if the motor were attached in a different spot? What if the motor and the battery pack were centered on top of the cup?
Let’s Make an Elastic Puppet

Construct a puppet out of fishing line and straws and test its elasticity.

Instructions

Students design a puppet out of fishing line and straws and experiment with its elastic properties.

1. Tell the students what they are about to do. Show them the example puppet, if you’ve made one.

2. Distribute materials.

3. The first step is to make notches in the 2 narrow straws, keeping the following in mind (show students the notches on the example puppet if available):
   - Where you cut the notches dictates how the straw moves. To make “arms” bend in one direction, make notches along the same side of the straw.
   - To make arms bend in different directions, alternate the notches on either side of the straw.
   - If joints don’t bend easily, students can cut a slightly deeper notch, but not so deep that the straw can’t go back to its normal shape when it is let go.

Materials

PER CLASS:
- Example puppet (optional)

PER STUDENT:
- 2 narrow straws
- 1 wider straw
- Scissors
- Transparent tape
- Fishing line
- Decorating materials, such as pipe cleaners, drawing supplies, paper, yarn

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4 Cut a fishing line 3 times as long as the straw. Thread it through one of the narrow, notched straws.

5 When the line pokes through the end of the straw, bend it over the tip and tape it. Leave the other end loose.

6 Cut another piece of fishing line and thread it through the second narrow straw.

7 Pull the loose lines and watch the straws bend.

8 Pull the loose lines of both narrow straws through the wider straw.

9 Wedge both narrow straws into the wider straw, enough so that they are secure but not so tightly that the fishing line pieces hanging down can’t slide easily without catching or rubbing.

10 Tape the hanging down fishing line together and make a little tape tab to tug. Pull the tab and watch the arms or legs of your puppet move.

11 Decorate your puppet with a head, body, eyes, and anything else you can think of!
**Elasticity** is the property of a substance that enables it to recover its original shape and size after it has been stretched, squeezed, or bent. All substances are elastic to some degree, but some much more than others.

By understanding the laws of elasticity, engineers know how a material will respond to certain forces during use. Seismic engineers are now designing elastic bridge connectors that will stretch during an earthquake but then spring back to their original shape.

In this activity, if the puppet loses its elasticity it will not function. Similarly, if a structure such as a building or plane engine part loses elasticity it can lead to a failure, causing damage or loss of human lives. That’s why engineers need to carefully test new designs.

Robert Hooke, an English physicist, first explored the theory of elasticity in 1660. He’s the namesake for Hooke’s Law, which states that the extension of a spring or an elastic object is proportional to the stress placed on it. Every spring or elastic object obeys this law, but each object is different in its level of resistance to stretching. Trampolines, retractable pens, rubber bands, and automobile shocks are examples of Hooke’s Law at work.

**Guiding Questions**

How does making more notches affect the ability of the straw to go back to its original shape?

When you have the fishing line threaded through the narrow straws and pull to make the straws bend, what kind of puppet are you inspired to create?

How could you make a dragon or a sea serpent instead of a person puppet?

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Music to Our Ears

Design a musical instrument and see if you can create it out of household materials.

**Instructions**

1. Solicit student suggestions to make a list of musical instruments. If kids don’t think of them, add kazoos, drums, rattles, tambourines.

2. Explain that students will choose a kind of musical instrument that they want to make. They will draw a design for it and then build it out of the materials displayed.

3. Give students time to explore the materials that they can use and tell them to think of something they want to make. Talk about sounds they could try for—beeps, squeaks, pings, rattles, thuds, whistles.

4. As they draw their plans, instruct students to: name their invention, describe the sounds they want it to make, the materials they’ll need, and what it will look like.

5. Tell kids to follow their plans to invent their instruments.

6. Have everybody take turns demonstrating their instruments and explaining how their inventions did, or did not, come out as planned.

**Materials**

**PER STUDENT:**
- Pencil
- Paper

**PER CLASS:**
- Masking tape
- Staplers
- Music making supplies—plastic and paper cups, paper plates, beans, beads, jingle bells, paper towel rolls, pipe cleaners, straws, waxed paper, combs, rubber bands, balloons, craft sticks, plastic containers, aluminum foil, small boxes, other found objects
Engineering & Science Connections

Acoustics is the scientific study of sound. Engineers use acoustics to figure out how to build better instruments, by improving the quality of the sound that comes from the vibrations of strings (as with a guitar or piano), wind chambers (as with a flute or saxophone), or skins (as with drums). Engineers test instrument designs using recording equipment in special rooms where sound doesn’t reflect; every surface is covered in sound absorbing foam.

Historically, musical instruments were used to create sounds to inform people. In Africa, people have used drum telegraphy for centuries to communicate with each other from miles away. In the US, the bugle was used in war to signal the attack or retreat.

To solve problems and make inventions, engineers use an approach called the engineering design process. In this activity, the students invented an instrument. After testing their initial design, they may have revised and retested it to better serve its intended purpose. That is what engineers do too.

Guiding Questions

Why do inventors make plans?

If your instrument isn’t turning out as planned, how will you revise your design or change your goal?

What did you learn about the process of invention from making your instrument?
Shoo Bird, Shoo!

Design and build a mobile that warns birds away from a window or a building.

Instructions

Engineers design ways to protect buildings from all kinds of things: bad weather, earthquakes, and even birds. Birds can cause problems for buildings and the people coming and going from them. Birds like to roost where their droppings make a mess; they make nests in unsafe spots, where vents may open or shut on them. Worst of all, they fly straight into windows because they can’t see them.

DEFINE THE PROBLEM

1. Ask students to think about why birds are not welcome or safe around most buildings. Make a list of their ideas.

2. Explain that birds will stay away from objects that catch the light and that flutter or move in the breeze. A bird deterrent or bird preventer is something that makes a bird not want to do something—like roost right over the doorway of a building or fly into a window. Today students will design a bird deterrent in the form of a mobile.

3. Give students the specs:
   i. The mobile must have parts that sway, spin, or flutter so that birds notice the movement.
   ii. The mobile must include parts that catch sunlight and sparkle.
   iii. The mobile must move in light breezes, but not get tangled in heavy winds.
   iv. The mobile must be attractive to people because it will be placed where they can see it.

Materials

PER TEAM:
- Pencil
- Pencils and paper for drawing designs
- Scissors
- Hole punchers
- String, yarn, ribbon
- Foil pie tins and scraps of aluminum foil
- Plastic beads
- Old CDs and DVDs
- Wire shirt hangers
- Paper clips, binder rings, paper fasteners
- Stick-on rhinestones and jewels
- Single-use plastic items that can be cut up
- Optional: glue gun (with adult supervision)

TESTING MATERIALS:
- Fan with low and high settings
- Area where mobiles can be hung up for testing
4 Decide whether each student will make their own mobile or collaborate. In either case, divide the class into teams of 2–4 students so they can go through the planning process together. Show students the materials they can use.

5 Instruct teams to experiment with the materials and sketch their design ideas.

BUILD AND TEST

6 Tell students to build their mobiles. Assure them that after their first designs have been tested, they can change and improve their mobiles.

7 To test the designs, hang up all of the mobiles where students can see them but where they won’t interfere with each other if they blow in a breeze. Turn on a fan from across the room so that all of the mobiles get a gentle breeze. Have students note which designs flutter the most. Then bring the fan a few feet in front of each mobile to give it a strong wind, and have students note which designs get tangled. Also, have students note which designs reflect light well.

EVALUATE AND REDESIGN

8 As students think about how to improve their designs, encourage them to consider how using strings of different lengths might help keep the mobiles from tangling. Ask them to consider how adding a little weight to one or more elements would affect the mobile’s balance.

9 Have students test their mobile outside on a building and, as practical, observe long enough to check whether birds have a reaction to it.

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Glass windows are not only invisible to birds—they can look like inviting places to fly because they reflect the sky or trees that look nice to land in. If birds can see through the window, the space on the other side often looks safe to fly toward. Birds sometimes see their own reflections in windows, and then they try to attack the other bird they see. They don't realize it's a reflection of themselves, as they are protecting their territory or their nests from invaders.

Birds' eyes are different from the eyes of humans. Their eyesight is a lot better than ours because their eyes have three times more sensory cells than human eyes. If eagles could read, they'd be able to read a newspaper that was a whole football field away! Birds also look at things differently because they rely on their necks to direct their heads rather than muscles to make eye movements. On the other hand, each bird eye can be looking at different things at the same time. Humans can only focus on one thing at a time.

Engineers collaborate with building designers and bird experts to construct buildings that keep birds safe by preventing them from flying into windows. They have developed ways of using shaded and/or frosted glass to make windows visible to birds but still let plenty of light in. Engineers have also created windows with patterns that birds can see but humans can't because birds can see types of light (the ultraviolet spectrum) that are invisible to us. They have other methods for deterring birds too, such as screens, netting, overhangs, and shutters.