EDUCATORS SUMMIT

GROWING FUTURES TOGETHER

STEM ACTIVITY GUIDE

BURNS McDONNELL

BLIND BUILD | DUPLICATE A LAYOUT

Use effective communication skills to redesign a master layout and experience the collaborative approaches used by project managers, engineers and other STEM professionals to complete projects every day.

To succeed in this challenge, each member must focus on his or her specific responsibility and use effective and positive communications. Successful teams will come closest to having an exact copy of the master layout when the game ends.

MATERIALS

- Two sets of matching blocks (e.g., Lego, Mega Bloks)
- Two screens or partitions
- Two tables or floor spaces far enough apart to avoid overhearing conversations between the two spaces

METHOD

1. Place each set of blocks in separate spaces. Place a screen or partition at the end of each space so the set of blocks can't be seen by the project manager traveling between the two tables.
2. Divide students into groups of four and assign each student a different role. Seat the client at one table and the engineer at another table. The project manager will make trips between the two tables. The quality reviewer will observe all three.

   CLIENT: Uses one set of matching blocks to build a model object. The client is the only person who can see the object. They must give clear instructions to the project manager so the engineer can build an exact replica of the object.

   PROJECT MANAGER: Listens to the client's instructions for how to build the model object and then communicates those instructions to the engineer, without looking at the model object or the reconstruction. The project manager may ask as many questions of the client and answer as many questions from the engineer as time allows, moving back and forth between the client and engineer tables without looking at the model object, reconstruction or building materials.

   ENGINEER: Listens to the project manager's instructions to reconstruct the object. The engineer may ask as many questions of the project manager as time allows.

QUALITY REVIEWER: Observes the exercise and makes notes about each participant's communication strengths and areas for improvement.

3. Set a time limit for the exercise. A minimum of 10 minutes is suggested.
4. When time expires, compare the model object and the reconstruction to see how closely they match. The quality reviewer should report his or her observations of the exercise.

LEARN MORE

Can students improve the outcome of matching the reconstruction to the model by repeating the exercise in the same roles? In different roles?

What technical skills did you use in this activity? What "soft skills" (e.g., communication, teamwork, problem solving, conflict resolution, leadership) did you use in this activity? Which skills were most important?

What would make this activity easier? Imagine if the project manager could see the model and take notes or the engineer could reference sketches of the model.

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SAY HELLO TO STATIC ELECTRICITY

Learn how electrons attract protons to get objects moving.

Rubbing a balloon on your hair, a towel, a T-shirt or carpet transfers electrons from that surface to the balloon and creates a buildup of static charge. The electrons (negative charge) on the balloon attract the protons (positive charge) of the metal soda can, causing the can to roll toward the balloon.

MATERIALS

- Empty soda can
- Inflated balloon
- Your hair, towel, T-shirt or carpet

METHOD

1. Put the soda can on its side on a flat, smooth surface and hold with a finger until it stays still.
2. Rub balloon back and forth on hair, towel, T-shirt or carpet really fast.
3. Hold balloon an inch in front of the can and watch the can start rolling. Move balloon to the other side of the can and watch it roll in the other direction.
4. Document how fast and far the can rolls.

LEARN MORE

Race other students to see who can best control the static electricity.

What other materials are influenced by a static charge on a balloon? Hint: hold charged balloon near your hair, a trickling faucet or a wall.

You may have noticed your clothes stick together in the dryer and make sparks when you pull them apart. How do dryer sheets reduce static electricity?

What careers rely on an understanding of electricity? (e.g., electronics designers, electrical engineers, electricians, transmission line crew members)

NOTES

DESIGN AN INCREDIBLE EDIBLE LANDFILL

Experience and understand how high-tech landfills are designed.

Modern landfills have several layers that separate waste from the surrounding environment (water, soil and air) to reduce contamination. This activity uses kid-friendly foods to demonstrate each layer's purpose and encourages students to think about where their trash ends up.

MATERIALS

- Pre-made pie crust in a tin
- Graham crackers
- Licorice
- Fruit roll-ups
- Vanilla and chocolate pudding cups
- M&Ms
- Oreos

METHOD

1. Use the pre-made crust in pie pan to represent compacted clay soil. Clay soils provide landfills with a watertight base to prevent leachate (contaminated liquid) from polluting groundwater or soil.
2. Line the crust with fruit roll-ups to represent a high-density plastic used to line the bottom of a landfill. The plastic liner is impermeable and resistant to the harmful compounds found in the leachate.
3. Add licorice to represent leaching tubes, which collect leachate that has percolated through the trash and channels it to a treatment center.
4. Cover the licorice with graham cracker crumbs to simulate sand or gravel used to drain leachate by gravity to the pipe collection system.
5. Mix vanilla pudding and M&Ms (or use your imagination) to create a mixture that simulates the trash that gets dumped in the landfill.
6. Crush Oreos to represent topsoil. Alternate the trash and topsoil in thin layers. Trash arrives daily at landfills and is compacted to decrease the volume. At the end of each day, a layer of topsoil covers the trash to reduce odor and deter scavengers (e.g., rodents, birds).
7. Add a layer of chocolate pudding to represent the landfill cap. When the landfill reaches its permitted height, a layer of compacted clay and a drainage layer (combination of geomembrane and gravel or sand) are placed on top of the landfill to drain precipitation but prevent it from entering the landfill.
8. Sprinkle crushed Oreos on top of the edible landfill to represent protective cover soil. As the landfill is completed, the cover soil protects the landfill cap, and native grasses are planted to prevent erosion.
9. Eat your creation!

LEARN MORE

Where is your local landfill? How much trash can be stored and when will the landfill be complete?

How can you reduce the amount of trash that ends up in a landfill?

Think about what you toss in the trash. Why is it important for environmental engineers to separate trash from the environment in a landfill?

NOTES

FLY HIGH WITH CATAPULTS

Send your objects soaring while learning the laws of physics.

A projectile is propelled with an initial velocity, and then gravity acts on the projectile to bring it back down to earth (e.g., tossing a baseball, rocket launch). By applying a force (press or stomp) to a catapult lever arm, students can launch a projectile into the air at varying velocities and observe how gravity acts on the projectile to create a parabolic trajectory.

MATERIALS

- Several wooden boards in varying lengths (suggest 1x4 or 2x4 boards cut 3 to 4 feet long)
- Wooden blocks (suggest 4x4 boards cut 4 inches long or multiple 1x4 or 2x4 boards screwed together to form cubic shape)
- Assorted projectiles: marshmallows, bean bags, plush toys, plastic containers

METHOD

1. Assemble several catapults by screwing a length of board (lever arm) to a wooden block (fulcrum). Vary the location of the fulcrum between the end of the board length and the middle of the board length.
2. Place catapults on ground and assign students to each catapult.
3. Place projectile on one end of each board.
4. Use hands and or feet to press down on the opposite end of each board.
5. Determine how fast and how far the projectiles fly depending on the force applied (how hard the student presses or stamps down on the board).
6. After students have had time to test their catapults, rotate students to another catapult to see how changes to the lever arm and fulcrum affect the projectile’s trajectory.

LEARN MORE

How does this activity demonstrate Newton’s First Law of Motion?

How does the mass of each projectile affect its trajectory?

Does the fulcrum placement affect the trajectory for an object of the same mass?

What launch angle makes the same projectile travel the farthest or the highest?

How does varying the force applied to one end of the lever arm affect the projectile's trajectory?

What careers rely on an understanding of Newton's First Law of Motion? (e.g., roller coaster designer, rocket engineer, baseball pitcher or soccer forward)

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STRETCH YOUR SKILLS TO BUILD A ROBOTIC ARM

Learn the mechanical similarities between robotic and human arms.

Robotic and human arms are similar. Both use flexible parts (string or muscle) to move rigid parts (cardboard or bone). The string's or muscle's pull is directed by a guide (straw or tendons), and the guide's position affects the arm's efficiency. Finally, the brass fasteners mirror our joints. This activity challenges students to re-create their arms using everyday materials.

MATERIALS

- One large strip of corrugated cardboard (about 2 x 8 inches) with a hole punched in one corner
- One small strip of corrugated cardboard (about 1 x 4 inches) with a hole punched in one corner
- One medium (1-inch) brass fastener
- One straw, cut into 1-inch sections
- Smooth string or fishing line (about 3 feet)
- Two large paper clips
- One 3-ounce cup
- Tape (any kind)

METHOD

1. Set out materials and challenge students to think about how their arm works. Have students brainstorm and design a mechanical arm that mimics their own using the materials provided. A more detailed procedure is outlined below.

    a. Connect the large cardboard strip (upper arm) to the smaller strip (lower arm) using a brass fastener (elbow joint) through the corner holes.

    b. Tape straw guides (tendons) to the cardboard strips to create a path for the string to follow.

    c. Insert string (muscle fibers) through the straw guides. Tape one end of the string to the smaller cardboard strip (lower arm). The free end of the string is used to control the arm. Adjust the brass fasteners so the arm moves freely when the string is pulled.

2. Use the robotic arm to play "kick the cup," a game where students keep their robotic arms flat on the table and quickly pull the string to activate the lower arm and "kick" the cup. This will help make sure the sections pivot properly and demonstrate how to use the string and guides to move the lower arm.
3. Next, challenge students to add a hook to their robotic arms to pick up an object.
4. Unbend paper clips to form hooks and poke them into one of the robotic arm's corrugation tubes.
5. Attach a second paper clip hook to a cup and use the robotic arms to hook this "target" cup.

LEARN MORE

What other devices could you attach at the end of your robotic arm to help you move objects?

How can robotics designers and mechanical engineers help people accomplish everyday tasks?

Your arm also has a joint at the wrist. Can you modify your robotic arm to have another section (upper arm, lower arm and hand)?

Can you modify your robotic arm to contract and extend?

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GET A TASTE OF MOTHER EARTH

Learn the science of elements, metals and magnetism.

What could your breakfast cereal have in common with the Earth's crust? It has similar materials, including iron, which is found in lots of places, such as rocks, metals and even your bloodstream.

MATERIALS

- Breakfast cereal that contains iron, such as fortified cornflakes (Check the label to see how much iron each serving contains. The more the better.)
- Blender
- Magnet (as strong as possible)
- White piece of paper
- Resealable plastic bags
- Water

METHOD

1. Fill blender with iron-fortified dry cereal. Add water and blend to create a cereal slurry (semi-liquid mixture).
2. Carefully pour the slurry into the resealable plastic bag.
3. Seal the bag and gently swirl the slurry while holding a strong magnet in contact with the outside of the plastic bag.
4. Stop swirling and slowly guide the magnet up the wall of the bag and look for iron filings following the magnet. The iron has been physically separated from the initial cereal flakes.
5. Release the magnet and observe the collected iron.

LEARN MORE

Place a cornflake on the table. Can you move the cornflake with a magnet? Now place a cornflake floating in a small cup of water. Can the magnet move the cornflake now?

In this activity, iron was physically separated from the cereal. What are other ways to separate materials in a mixture?

What processes does a chemical engineer use to separate materials in a mixture?

Repeat the activity with different types of cereals. Are you able to extract the most iron from the cereal with the highest iron content? (hint: check nutrition facts)

Why do humans need iron in their diet?

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OIL SPILL CLEANUP

Learn the science behind an oil spill cleanup.

This hands-on experiment teaches students the issues surrounding environmental cleanup from the perspective of an environmental engineer and an oil company owner responsible for the cleanup. They must be familiar with different methods of cleanup and then effectively communicate these strategies with the community, the cleanup crew and the company/person behind the spill.

MATERIALS

- One aluminum pie pan or baking tin
- Bird feathers
- One plastic spoon for skimming oil from the pie pan
- Oil-absorbing cloth pads for absorbing oil (obtained by cutting big sheet into squares or using cotton balls/squares)
- One small squeeze bottle of Dawn (or any "grease-fighting") dishwashing detergent labeled "dispersant"
- Pitcher of water
- Plastic squeeze bottle (about 100 mL) containing dark vegetable oil (can be died with food coloring)

METHOD

1. Brainstorm different methods for cleaning up an oil spill and discuss how effective and expensive those suggestions could be.
2. Discuss chosen methods to include skimming, because oil floats; absorbing it onto pads that specifically absorb oil, and adding a dispersant to break up the oil "slick" on the surface into little droplets.
3. Place the pan on a table and add water until it is about half full.
4. Place a small amount (about one tablespoon) of oil (some type of dark vegetable oil or vegetable oil with food coloring added) into the pan.
5. Place a feather in the oily water. After 30 seconds or so, remove the feather to observe the effect of the oil. What impact can students conclude that oil has on birds and other wildlife?
6. Use the skimmer (spoon) to try to remove the oil, noting approximately what percentage of what they removed was oil versus water.
7. Next, use the absorbent cloth to absorb the oil, observing how well the cloth removed the oil from the water.

8. Lastly, have students place one or two drops of "dispersant" into the pie pan and stir it around with the spoon. Students will notice that the oil appears to break up into small droplets. Is this an effective means for cleanup?
9. The water, vegetable oil and dispersant from the pan can be safely washed down the drain; place pans in garbage bags.

LEARN MORE

Which oil spill cleanup method was most effective? Which methods are used most frequently by environmental engineers responding to real-life oil spills?

Research more materials to respond to an oil spill. Are they more or less effective than the methods in the activity?

What kind of tools are being used by engineers and other companies to assist in oil spill cleanups around the country?

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