

Day 5

Paper Bots

Overview:

Paper bots are battery powered paper constructions that dance, wiggle and vibrate across a surface using a small pager motor and a coin cell battery. The paper bots activity builds on the understanding of circuits, applying it in a new way. Paper bots are constructed largely of scrap paper and masking tape to encourage iteration and design, as well as providing an accessible entry to a complex concept.

We use simple everyday materials to create the bots which provides a level of comfortability and confidence when building their bots. These simple materials are also meant to provide a platform for iteration; they are easy to manipulate and modify to create different patterns of movement. Each adjustment will affect the balance of the object, so the learner will easily be able to observe and document changes in movement and stability in order to explore the process of trial and error with a manageable risk factor.

Materials

- Paper of different weights, sizes and types.
 - Construction paper
 - Cardboard
 - Chipboard/cereal box
 - Cardstock
 - Copy paper
 - Origami paper
- Masking tape
- Coin cell (CR2032) batteries
- Vibrating motors
- Markers
- Scotch tape
- Scissors
- Sticky backed googly eyes
- Folding instructions for different shapes
- Paper geometric shape templates (included in kit)
- Origami book (included in kit)

Optional Materials

- Hole punchers
- Craft scissors

Introduction/Discussion

When introducing the activity, emphasize iteration and trial and error as part of the experimentation process.

Start the conversation by reviewing the previous circuitry work that the learners have done in the program. *What did we do last time we met? What materials did we use? Did you enjoy the activity? Why or why not?* If one of the participants is new to the group or was absent, use this conversation to help fill them in on what the group has been doing. Have the returning kids explain the experience from the previous session.

Today we'll be creating more circuits, but we will use different materials. Instead of using an LED and thread or copper tape, we'll be using tiny motors and wires to create our circuits.

Helpful Hint: It may be helpful to use a larger DC hobby motor and an AA battery. How would you make a circuit? Pass it around and let them try. How is this different from the circuits we made previously? You can also discuss polarity. Demonstrate how the polarity affects the larger DC motor by adding a cardboard wheel with an arrow drawn on it to the motor shaft. The motor moves in different directions depending on how it is connected.

Does anyone have a cell phone? What happens when it is silenced and someone calls or texts you? What is happening? What makes it vibrate? Connect a coin cell battery to the pager motor and let the motor bounce on a hard surface like a desk or the floor. What do you notice about the motor? Does it move? Why? Can we transfer that movement to another object? How would we do that?

Present learners with a sample paper bot. *What is this? What is it made of? Turn it on. What is it doing? How? Why? Could we change how it moves?*

We suggest sharing a very simple paper bot in this demonstration allowing for the focus to be on the movement instead of the design.

Start Making

1. Explore Motor Movements: Attach the motor to the battery using your fingers or a piece of masking tape and observe what happens. Let students play with the motor and the movements.

Observe what happens and be mindful of the discussions that take place during this step.

2. Paper Bot Prototype: Use one sheet of paper and make a shape or object to attach to your motor. Have learners experiment and test the motor with a few different materials before they decide which materials they want to work with.
3. Design and Build: Decide on a few different materials you would like to make your bot with. Fold, crumple and create any shape you like with the materials you have chosen. Try attaching the motor to different areas of the bot.
Encourage them to move the motor around to different spots on their creation. What happens?
4. Iterate: Once the bots are moving, encourage learners to experiment with different materials of different size and weight. Notice how those differences affect the movement of their creation. Emphasize the importance of iteration. The idea is to experiment with different materials and constructions rather than to create a single “perfect” project. They can use the same motor with different creations for quick experiments.
5. Create four different bots using different materials. Video or photograph each bot, play music, and post to social media (use #tinkerpaperbots).
6. Additional Challenge: Try to combine multiple bots together into a megabot! Video or photograph your results.

Extension

If students finish all of their bots or need more complexity, encourage them to apply what they learned about circuits in earlier activities to this one. *How might you create a switch for your bot? Can you use copper tape, conductive thread to make your creation more complex?*

Facilitator Notes

Paper bots are all about iteration. Here are some prompts you can use to help them articulate their process and lead to further iteration.

- “What are you working on?”
- “How did you do that?”
- “How might you do that differently?”
- “What do you think would happen if you moved the motor or battery?”
- “What will you try next?” or “Do you think you can change anything to make it do something else?”

For learners that are creatively challenged and are not sure what to do, we have included some design challenge resources to inspire projects.

Design Challenges

- Try different bot types:
 - origami bot
 - geometric bot
 - crumple bot
 - organic shape bot
 - architecture bot
 - animal bot
 - vehicle bot
 - food bot
- Add two motors to a single bot.
- Have two motors moving in opposite directions on a single bot.
- Combine all four bots into a mega bot.

Material Tips

Tearing Tape: Most people have used masking tape and we often see people cut strips with scissors. It is easier and less time consuming to tear the masking tape.

Demonstrate how easily masking tape can be torn or removed from paper and cardboard. This will help with iterating on their project designs.

Documentation

Encourage students to take photos or videos of their projects. If they post to social media, have them use #tinkerpaperbots so all of our media will be collected in one place!

Journal Prompts

- Write a story about your bot(s). Give it a name, describe its origin, where it lives, and how it came to be. Create a character for it and draw a picture.
- Describe your creative process for each of your bots. What similarities do they share? How are they different?
- Describe or draw how your bots move. What do you think makes them different?

Facilitator Debrief Prompts

- What conversations about iteration and changes did you hear?
- Were there any similarities in designs or solutions between learners? How did these similarities lead to iteration?
- Did any of the learners have a hard time generating ideas? What kinds of facilitation support did you provide? What would be helpful in building the creative process?
- Did you notice any knowledge or ideas that carried over from sewn circuits or paper circuits? How was it applied?
- Have you noticed any changes in the ways learners manage disappointment or problem solving? What do you think contributed to this?