Go GREEN with Creative Circuits

Activity Guide

STAR net
Science-Technology Activities & Resources For Libraries

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Go GREEN with Creative Circuits

Activity Time

This activity is flexible and open-ended; it can be done in 1 hour but children can take up to 2 hours, if desired.

Intended Audience

Families or other mixed-age groups, including children as young as 5 years old *with assistance from an older child, teen, or adult*
School-aged children ages 7 and up
Tweens

Type of Program

- ☑ Facilitated hands-on experience
- ☐ Station, presented in combination with related activities
- ☑ Passive program (if instructions are provided)
- ☐ Demonstration by facilitator

Overview

Participants explore Green energy through this engineering design challenge to create structures for a model neighborhood using conductive and insulating dough, LEDs, and hand-crank generators.

Key Concepts

- **Simple circuits made of conductive and insulating dough, LEDs, and a hand-crank generator have many of the same components as the infrastructure that allows us to have lights in our homes and neighborhoods.**
- **Engineers are working to capture clean energy from motions in nature – like the ocean tides and wind – and converting it to electricity to power our homes, schools, and businesses.**
- **Children, like engineers, can improve their designs through the creative process of thinking, building, testing . . . and doing it again!**

Materials

For a group of 20 children and their caregivers:

- ☐ 6 (or more) hand crank generators, such as the American Educational 7-1853 DC Crank Generator or Genecon Hand Crank Generator
- ☐ 36 (3 oz.) containers of conductive dough, such as Play-Doh or Squishy Circuits Store, LLC conductive dough
- ☐ 1 (1 lb.) package of insulating dough, such as modeling clay (select neutral colors to avoid stains on clothes and skin) or Squishy Circuits Store, LLC insulating dough
- ☐ 60 (3 mm and/or 5 mm) LEDs
- ☐ 10 copies of Tips for Creative Circuits (below)
- ☐ 10 copies of Engineering Design Process, preferably printed in color, double-sided, and laminated (below)

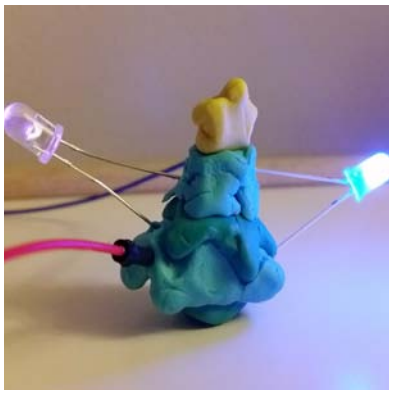
For the facilitators:

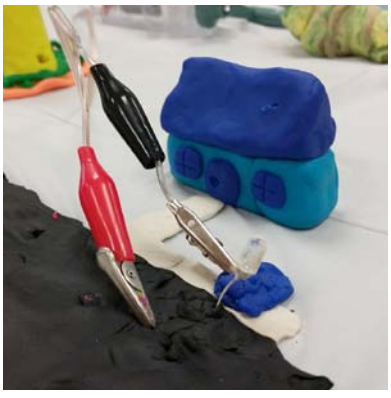
- ☐ 10 (5 oz.) containers of black conductive dough, such as Play-Doh
- ☐ 6 (or more) disposable table cloths
- ☐ Optional: 2 Squishy Circuits Store LLC battery packs and 8 AA batteries (preferably rechargeable)
- ☐ 1 Multimeter
- ☐ Facilitator background information:
  - ☐ Squishy Circuits Store, LLC *Quick Start Guide*
  - ☐ Click2Science "What Do You Know About Circuits?" (www.click2sciencepd.org/learning-modules/what-do-you-know-about-circuits)
  - ☐ Brief Facilitation Outline (below)

Technology:

- ☐ Optional: Snap Circuits Green

Many commercial educational products are available that demonstrate how clean energy from the Sun, ocean tides, wind, and other natural sources can be converted into electricity for our homes and cars. Consider providing one or more sets for participants to use before, during, or after the program





Preparation

- Arrange for three or more teens and/or adults to help facilitate this activity.

> Reach out to professional engineers and technicians, makers, or engineering students in your community to help facilitate this activity. Find partnership opportunities listed at www.starnetlibraries.org/stem-in-libraries/collaboration/partnership-opportunities/.

- Well in advance of the program, facilitators should follow the Squishy Circuits *Quick Start Guide* to create their own circuits with the conductive and insulating dough, LEDs, and battery packs. Then, experiment with powering the circuits with hand-crank generators instead of battery packs.
- Review tips for using conductive and insulating dough to create simple circuits with the following background information:
  - 2 brief Click2Science videos demonstrating learning conversations: "What Do You Know About Circuits?" (www.click2sciencepd.org/learning-modules/what-do-you-know-about-circuits)
  - Brief Facilitation Outline (below)
  - *Tips for Creative Circuits* (below)
- Line the activity tables with disposable table cloths.
- Set up three "streets" around which the participants can build a model community.
  - Roll black conductive dough into a rectangle to create each "street."
  - Connect a hand crank generator to a demonstration "street" by pressing the black lead into the dough.
- Create an example structure using conductive and insulating dough and an LED, then connect it to the "street" and test it with one or more hand crank generators. Adjust your design and the setup, as needed, to light your circuit.
- Optional: Set up an example circuit using the Snap Circuits Green or other commercial educational product(s) and included instruction guide.

Activity

1. Opening Discussion: Share ideas and knowledge.

- Introduce yourself. Help the participants learn each other's names (if they don't already know each other).
- Frame the activity with the main message: Simple circuits made of conductive and insulating dough, LEDs, and a hand-crank generator have many of the same components as the infrastructure that allows us to have lights in our homes and neighborhoods.
- Explain that the group will create a model neighborhood by adding their buildings to the three "streets." Each person or small group of people will create a house, library, school, store, or other structure and share the hand crank generators to light LEDs on their structures.
- Demonstrate how the example structure lights up when the hand crank is turned.
- Set the stage for the activity by exploring video clips and online animations that show how motions from wind, waves – or hands winding a crank – can be used to generate electricity.

Activity (continued)

2. Emphasize the following safe practices.

- Connect metal to dough, NOT metal to metal.
  - Keep the wires/terminals of battery packs (or other sources of electricity) from touching each other.
  - Do not connect LEDs directly to battery packs.
- Turn the hand crank generator with a smooth and steady motion to keep the gears from breaking.

3. Design Challenge.

Invite the participants to design, build, and iteratively test a model of a neighborhood using conductive and insulating dough, LEDs, and hand-crank generators. Provide each participant with a handful (~5 oz.) of conductive dough in any color(s), about 1 tablespoon of insulating dough, and two LEDs.

- First, have the participants work in small groups with the materials to light one LED. Form two pieces of conductive dough and put one leg of the LED into each piece. Share hand crank generators to test out these simple circuits.

Ideally, participants will discover for themselves how to construct a simple circuit. Be a "guide on the side," rather than a "sage on the stage" by prompting learners to work directly with the materials and talk about the process of assembling their circuits. View the two brief Click2Science videos, "What Do You Know About Circuits?, that demonstrate these types of learning conversations: www.click2sciencepd.org/learning-modules/what-do-you-know-about-circuits.

If learners are not able to get their LED to light, ask them to try one of the following strategies:
- Connect the LED in the opposite direction. LEDs have one "leg" that is slightly longer than the other. This longer leg must be connected to the dough with the red wire from the power source.
- Keep pieces of conductive dough from touching each other. If the electricity can bypass the LED – because electricity can more easily flow through the conductive dough – it will not light. If the two pieces of conductive dough touch, they "short circuit." Ask participants to separate the pieces or add insulating dough between the conductive dough to keep them from accidentally touching.
- Check the connections on the hand crank generator to make sure nothing is loose.
- Try turning the crank in the opposite direction.
- Use the battery packs and multimeter, if needed, to further troubleshoot the circuits.

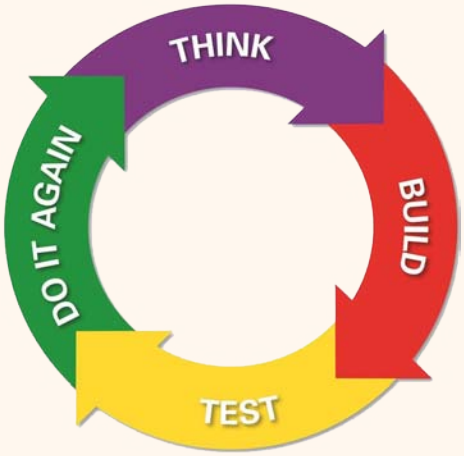
- Next, invite the participants to work alone or (preferably) with others to modify their simple circuits into the shape of a house or other structure.
- Add the structures to the "streets" to test them with the hand-crank generators.

Activity (continued)

Connect two hand crank generators to each "street" by pressing the black wires into the dough. The "streets" are made from conductive dough.

Make small adjustments to the structures, as needed, to connect it with the conductive dough and make a complete circuit.

- Invite participants to iteratively change one aspect of their structures at a time to make improvements or try new ideas



Guide the participants through the engineering design process as they work. Adjusting and retesting their ideas is the best way to experience the ongoing work of an engineer! As time allows, emphasize this stage of the engineering design process as much as possible. 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!

4. Conclude.

Optional: Have each participant describe their contribution to the model community. Celebrate the participants' efforts and persistence in working with the materials to iterate on their designs.

Next Generation of Science Standards

Assessment Standard

Engineering Design

Students who demonstrate understanding can:

- K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

ETS1.B: Developing Possible Solutions

- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.

Science and Engineering Practices

Asking Questions and Defining Problems

- Define a simple problem that can be solved through the development of a new or improved object or tool.
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Developing and Using Models

- Develop a simple model based on evidence to represent a proposed object or tool.

Crosscutting Concepts

Energy and matter: Flows, cycles, and conservation

References

This activity builds on ideas and materials from the Squishy Circuits Store, LLC, including the *Quick Start Guide*, *NGSS Curricula and Educator's Guide*, and *Creative Commons artwork*.

NGSS Lead States (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

Click2Science "What Do You Know About Circuits?" (www.click2sciencepd.org/learning-modules/what-do-you-know-about-circuits)

Brief Facilitation Outline

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2. Emphasize the following safe practices.

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  - Do not connect LEDs directly to battery packs.
- Turn the hand crank generator with a smooth and steady motion to keep the gears from breaking.

3. Design Challenge.

Invite the participants to design, build, and iteratively test a model of a neighborhood using conductive and insulating dough, LEDs, and hand-crank generators. Provide each participant with a handful (~5 oz.) of conductive dough in any color(s), about 1 tablespoon of insulating dough, and two LEDs.

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- Add the structures to the "streets" to test them with the hand-crank generators.
- Invite participants to iteratively change one aspect of their structures at a time to make improvements or try new ideas

4. Conclude.

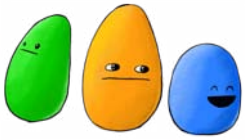
Optional: Have each participant describe their contribution to the model community. Celebrate the participants' efforts and persistence in working with the materials to iterate on their designs.

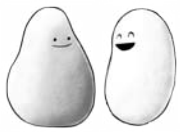
Tips for Creative Circuits

1. Keep safe!

- Connect metal to dough, NOT metal to metal.
  - Keep the wires/terminals of battery packs (or other sources of electricity) from touching each other.
  - Do not connect LEDs directly to battery packs.

- Turn the hand crank generator with a smooth and steady motion to keep the gears from breaking.





2. There are two types of dough.

- One type lets electricity flow through it ("conductive" dough).

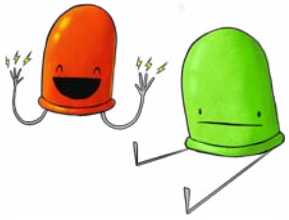
- The other type stops electricity from flowing ("insulating" dough).

3. Connect the dough, an LED, and a power source together so that electricity can flow in a loop (or circle or circuit).

4. Instead of using batteries, use a hand crank generator as a source of clean, Green energy!

A child in Haiti uses a hand-crank generator to power a radio. Credit: United States Navy

5. If the LED won't light, try these tips.



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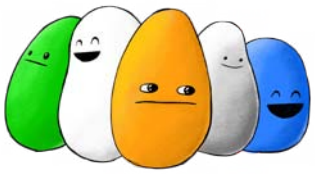
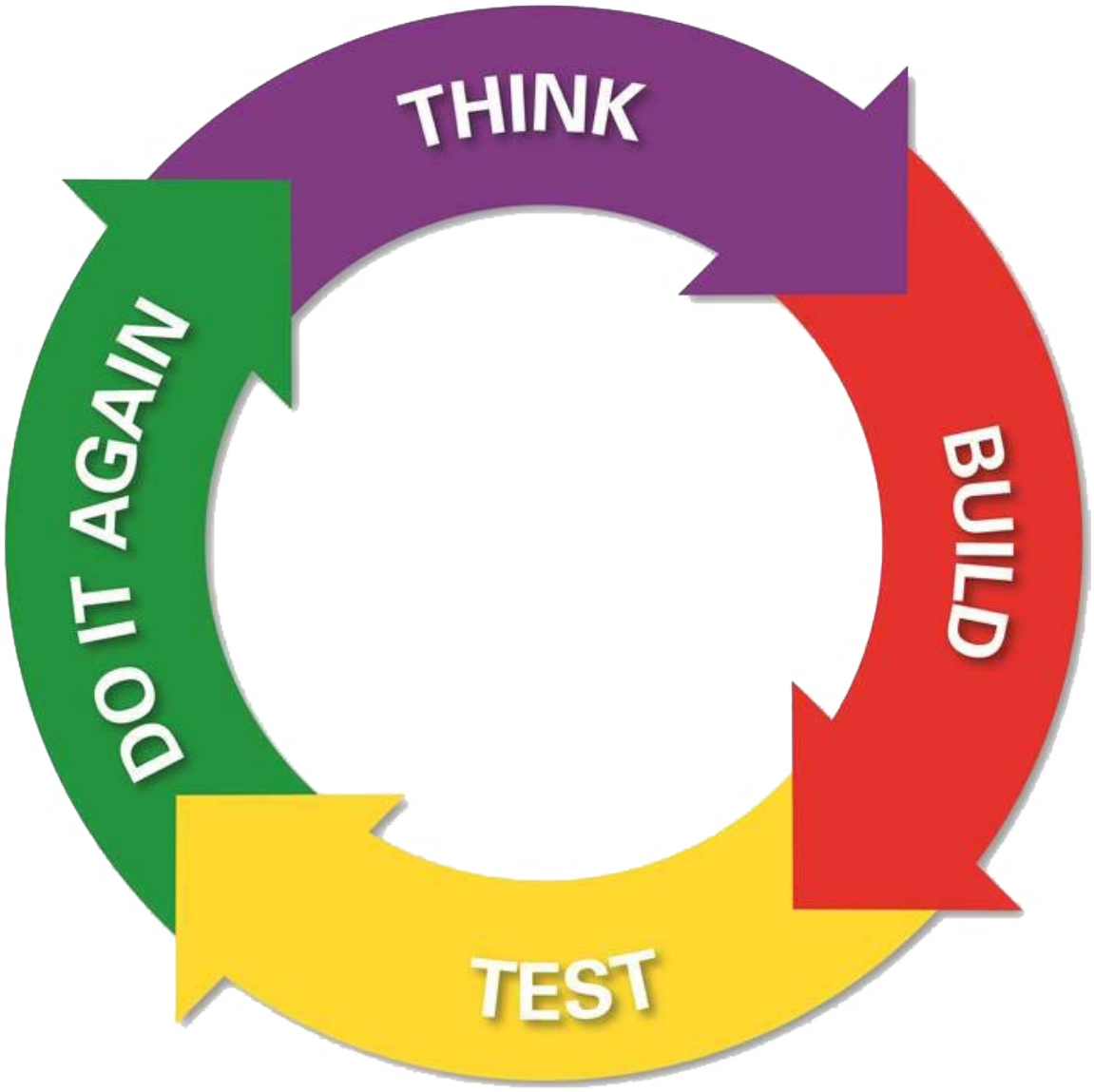


- Check the connections on the hand crank generator to make sure nothing is loose.

- Try turning the hand crank generator in the opposite direction.

- Try using a battery pack instead of the hand crank generator.

Engineering Design Process

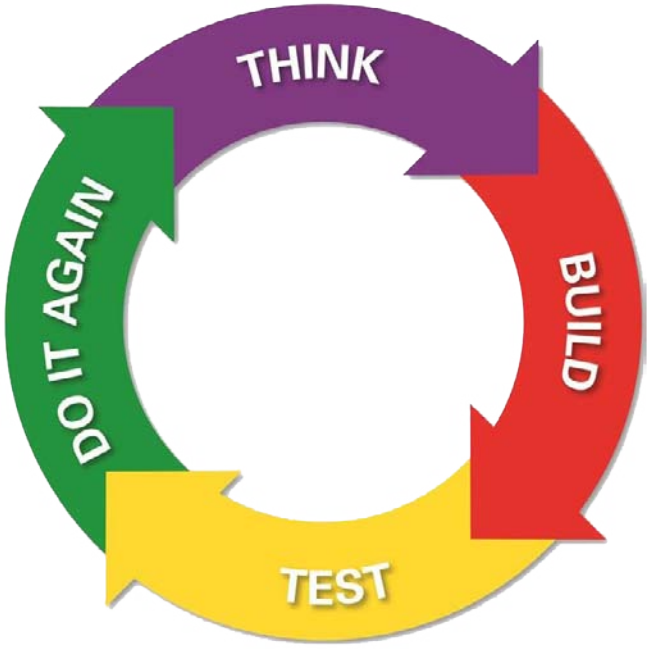


Engineering Design Process

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.



It Takes a Lot of Back and Forth

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.

Sometimes, engineers will focus on one specific step, and when complete, pass the project off to another team with a different skill set.

Engineers are Creative Problem Solvers!