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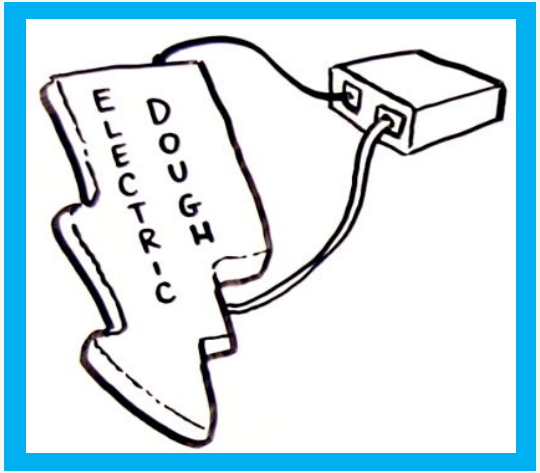
TRY Engineering

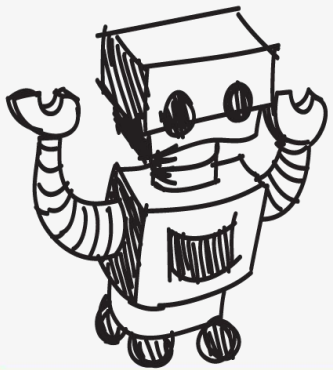
Lesson Plan:

Electric Dough Challenge



IEEE

Real-World Application



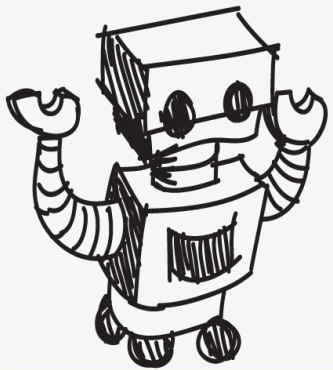
TED Talk: AnnMarie Thomas

Source: TED YouTube Channel

Squishy Circuit Sculpture of AnnMarie Thomas

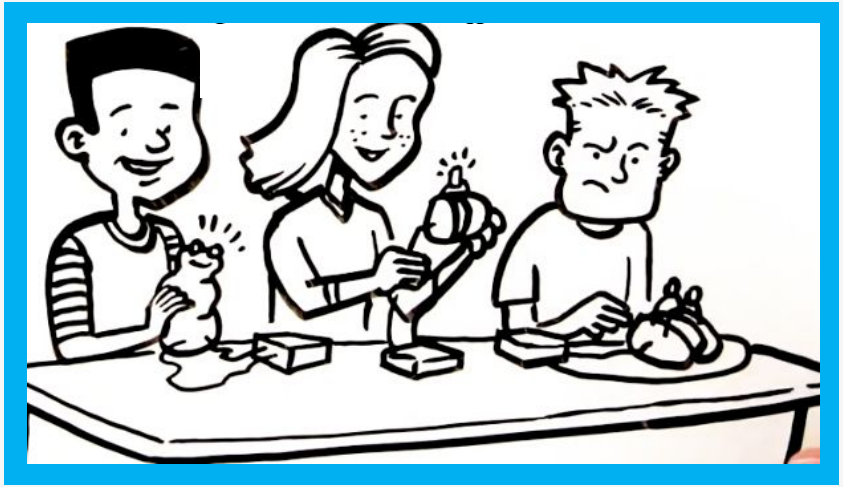
Source: University of St. Thomas YouTube Channel

The Design Challenge

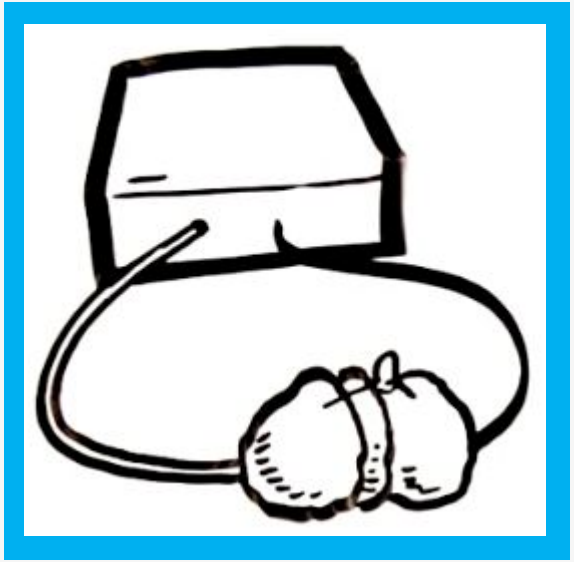


The Design Challenge

- You are an engineer working to design and build electricity conducting creations out of dough.



Defining the Challenge: Criteria & Constraints



Criteria

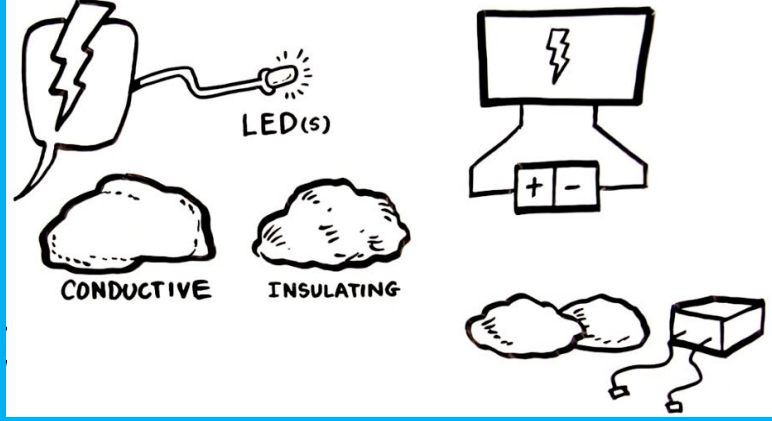
Must use two types of dough (conductive and non-conductive) to power LED(s).

Constraints

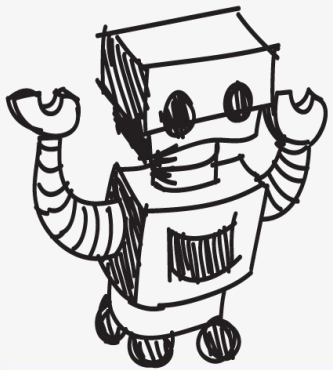
Complete your sculpture within the given time.

Materials

- Required
  - Conductive dough (see recipe)
  - Non-Conductive dough (see recipe)
  - AA batteries
  - Battery packs with terminals
  - LEDs (10mm size recommended)
  - Wire with alligator clips
- Optional (on the Table of Possibilities)
  - Mini DC electric hobby motors
  - Fans, buzzers, and other components



Dig Deeper



Vocabulary

- Conductor: Material that allows electricity to flow through it.
- Insulator: Material that does not allow electricity to flow through it.
- Resistance: Insulation is measured in resistance. The more insulating a material, the more resistance it has.
- Circuit: The loop that electricity flows through. A circuit begins at a power source, such as a battery, and flows through wires and electrical components (such as lights, motors, etc.).
- Series Circuit: Allows one path for electricity to flow through.

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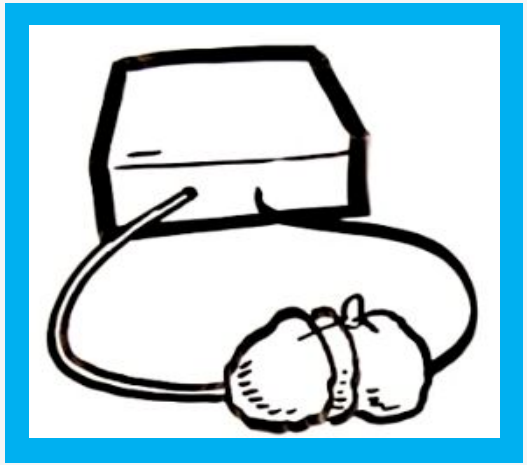
Vocabulary

- Parallel Circuit: Allows multiple paths for electricity to flow through.
- Short Circuit: When wires that are not supposed to come in contact with each other touch.
- Polarity: The direction electricity flows in a circuit.

Learning Circuits

- The loop that electricity flows through is called a **circuit**. A circuit begins at a power source, such as a battery, and flows through wires and electrical components (such as lights, motors, etc.). There are two kinds of circuits - series circuits and parallel circuits.

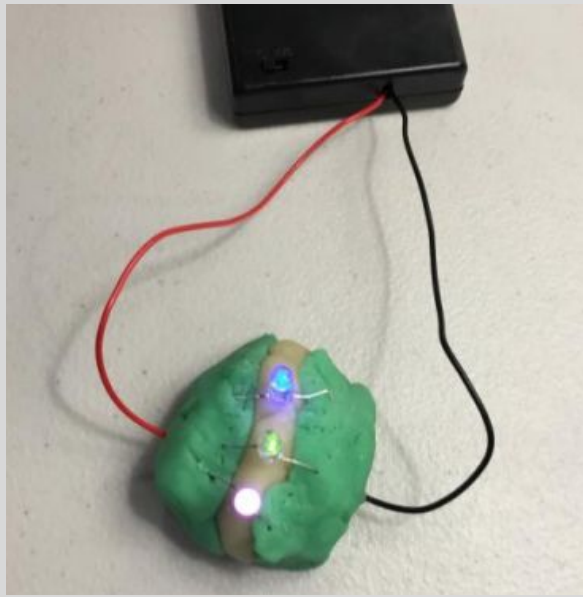


Learning Circuits: Series

- **Series circuits** only allow one path for electricity to flow through. In a series circuit with LEDs, the LEDs further from the power source will appear dimmer, because less electricity is available to power them. If a LED were to burn out or be removed in a series circuit, all the lights following it would go out as well, because the one path to the remaining lights would be disconnected.

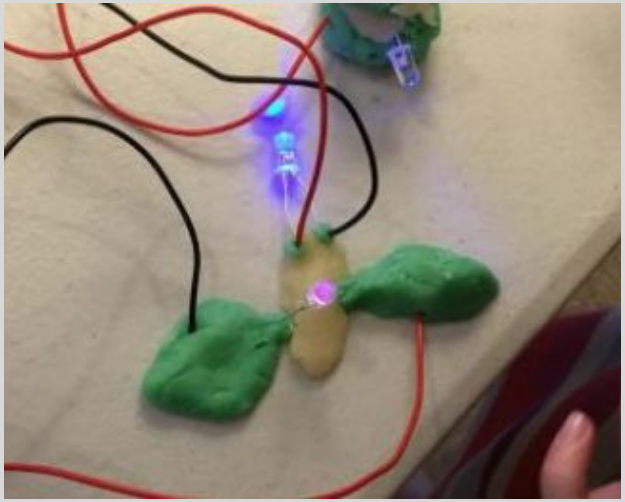
Learning Circuits: Parallel

- **Parallel circuits** allow multiple paths for electricity to flow through. In a parallel circuit with LEDs, each LED has electricity flowing directly to it along its own path. Each LED can shine brightly no matter where it is, because the electricity is reaching each LED directly. Also, in a parallel circuit, if one light burns out or is removed, the others will continue to shine.



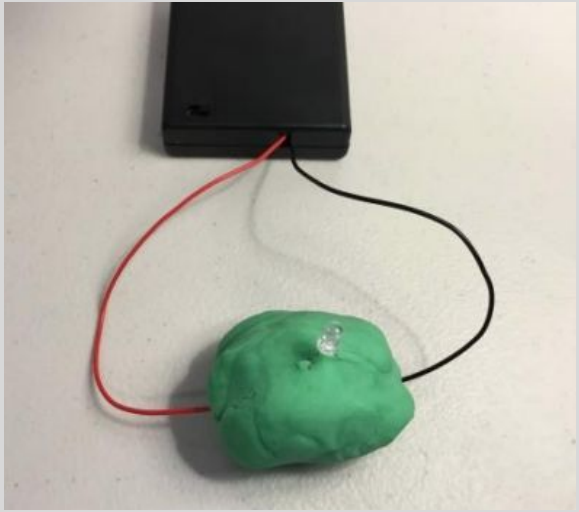
Conductive & Insulating Materials

- **Conductive** Materials: allow electricity to flow through them. Can you think of some materials that conduct electricity?
- **Insulating** Materials: don't allow electricity to flow through them. Can you think of some insulating materials?
  - Insulation is measured in resistance. The more insulating a material, the more resistance it has. The insulating dough you will be working with is resistive, meaning little electricity can flow through it. Insulators act as a wall which blocks electricity.



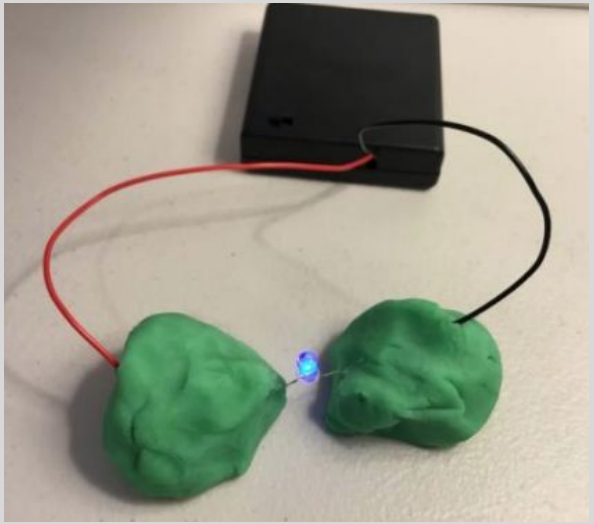
Short Circuit

- A **short circuit** happens when wires that are not supposed to come in contact with each other touch. This is why an LED will not light up when it is inserted into a single piece of conductive dough or into two pieces of conductive dough that then touch one another.

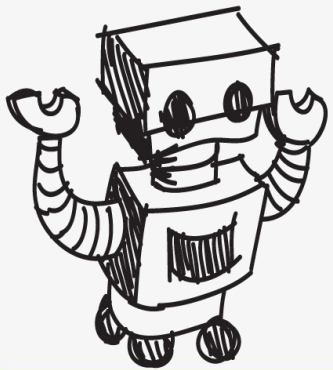


Polarity

- The direction of current flow in a circuit is called **polarity**. In this activity, the red wire from the battery pack is the positive pole and the black wire is the negative pole. Some electronic components also have a positive and negative side and must be attached in the correct direction in order to work.
- The LEDs in this activity each have two leads, one short, and one long. The longer lead goes to the positive side and the shorter lead goes to the negative side.



The Engineering Design Process



The Engineering Design Process

Learn about the engineering design process (EDP). The process engineers use to solve problems.

Source: TeachEngineering YouTube Channel

Engineering Design Process

- Divide into teams of two (or up to 4 max)
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

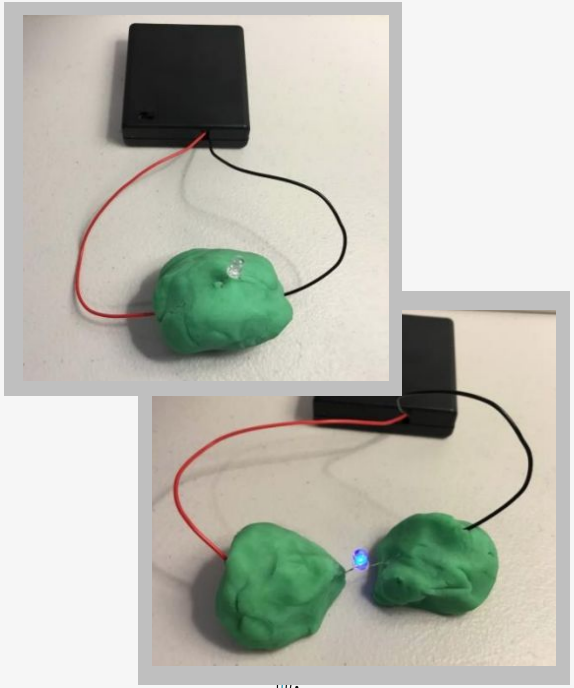
Productive Failure

- The engineering design process involves productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.

- It's also important to showcase the fact that there can be multiple solutions to the same problem. There's no one "right" solution.

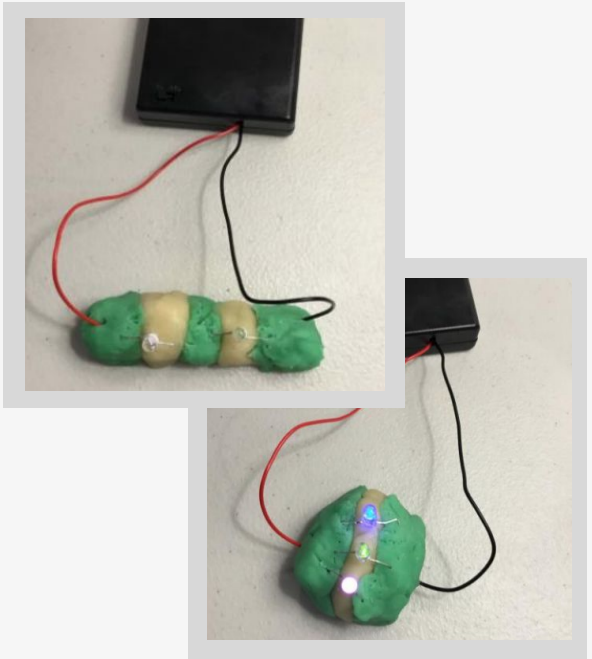
Get to Know your Conductive Dough

- Start with a ball of the conductive dough. Insert the battery pack wires into opposite sides of the dough. Insert a LED into the dough. What happens?
- Next, separate the conductive dough into two pieces. Insert one battery pack wire into one piece of dough and the other into the other piece of dough. Now, insert the LED with one lead in one piece of the dough and the other lead in the second piece of dough. What happens?
- Next, remove the LED and turn it around, with the leads in the opposite direction. What happens? Why do you think this happened?
- With the LED in the lighted position, touch the two pieces of dough together. What happens? Why do you think this happened?

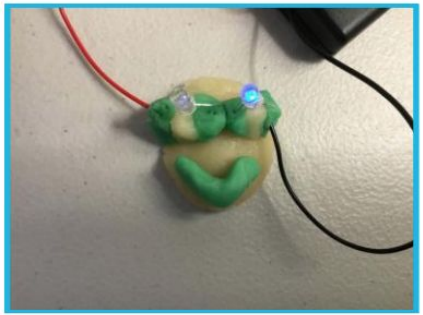
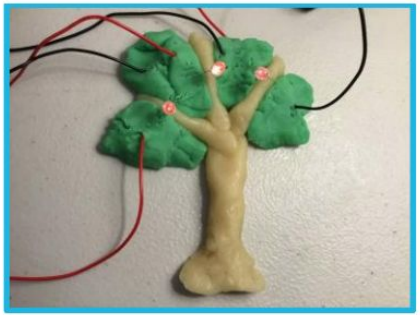
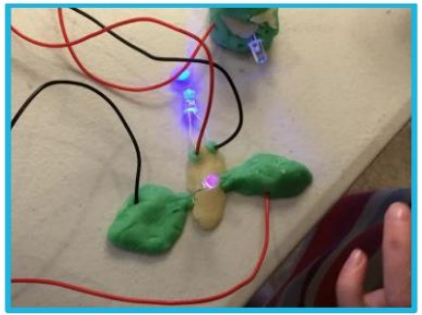
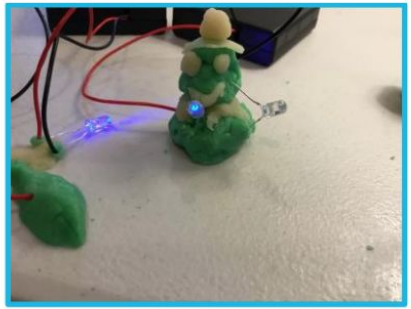


Get to know your Insulating Dough

- Add a piece of insulating dough in between the two pieces of conductive dough and attach them so they are touching. With the LED straddling the insulating dough and inserted in the two sections of conductive dough. Is the LED lighting up?
- Use the conductive and insulating dough to create a series circuit with two or more LEDs. What do you notice about the lights? Why do you think that is?
- Use the conductive and insulating dough to create a parallel circuit with three LEDs. What do you notice about the lights? How are they different from the lights in the series circuit? Why do you think that is?

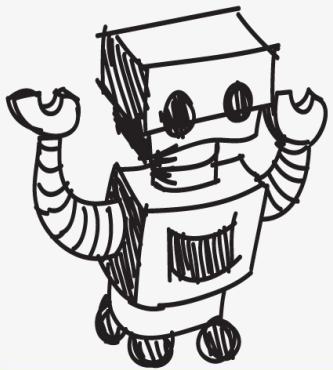


Get Creative!

You can use LEDs, motors, buzzers, fans, or any other materials provided to get creative!

Engineering Fields



What is Engineering?

Source: TeachEngineering YouTube Channel

Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.

Related Engineering Fields

- There are many different types of engineering fields that involve electrical circuits. Here are just some of the related engineering fields.
  - Electrical Engineering
  - Materials Engineering
  - Industrial Engineering
- Download the Engineering Fields Infographic How will YOU change the world?

Engineering Habits of Mind (EHM)

- EHM is about how engineers think everyday. The core of the engineering mind is about making things that work and making them work better.
  - Systems thinking: Seeing whole systems and parts and how they connect.
  - Problem-finding: identifying and defining a problem.
  - Visualising: manipulating materials and sketching. Mental rehearsal of practical design solutions

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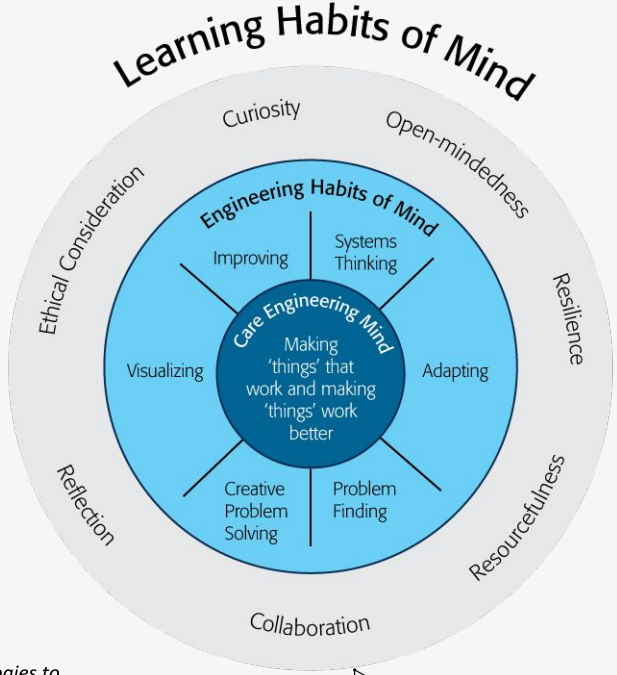


Source: B. Lucas and J. Hanson, Thinking Like an Engineer: Using Engineering Habits of Mind and Signature Pedagogies to Redesign Engineering Education. (International Journal of Engineering Pedagogy, Vol 6, No. 2 (2016): https://online-journals.org/index.php/i-jep/article/view/5366)

Engineering Habits of Mind (EHM)

- Improving: Persistently trying to make things better by experimenting, designing, sketching, and prototyping
- Creative problem-solving: generating ideas and solutions with others with many iterations.
- Adapting: Testing, analysing, reflecting, & rethinking

Greatest Engineering Achievements of 20th Century

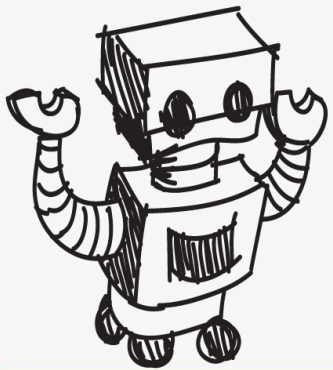
- Electrification
- Automobile
- Airplane
- Water Supply and Distribution
- Electronics
- Radio and Television
- Agricultural Mechanization
- Computers
- Telephone
- Air Conditioning and Refrigeration
- Highways
- Spacecraft
- Internet
- Imaging
- Household Appliances
- Health Technologies
- Petroleum/Petrochemical Technologies
- Laser and Fiber Optics
- Nuclear Technologies
- High-performance Material

Source: http://www.greatachievements.org/

Do you know any Engineers?

- How many engineers do you know? Your teammates? Your class?
- What do they do? What engineering degrees do they have?
- What items in your classroom and your school did engineers help design?
- Check out the NAE Grand Challenges for Engineering to help you learn more about how engineers make the world a better place:
  - NAE Grand Challenge for Engineering

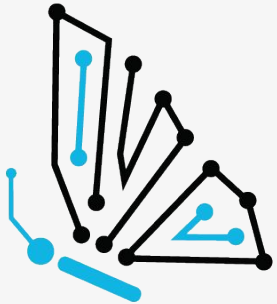
Reflection & Debrief



Reflection

- Electricity always takes the path of least resistance. Why do you think the LED didn't light up when it was inserted in one piece of conductive dough?
- Why do you think the LED turned off when the two pieces of conductive dough touched one another?
- The conductive dough is made of water, flour, salt, cream of tartar, and vegetable oil. The insulating dough is made of water, flour, sugar, and vegetable oil. What do you think makes one dough conduct electricity and the other not?

For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE's TryEngineering.org



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