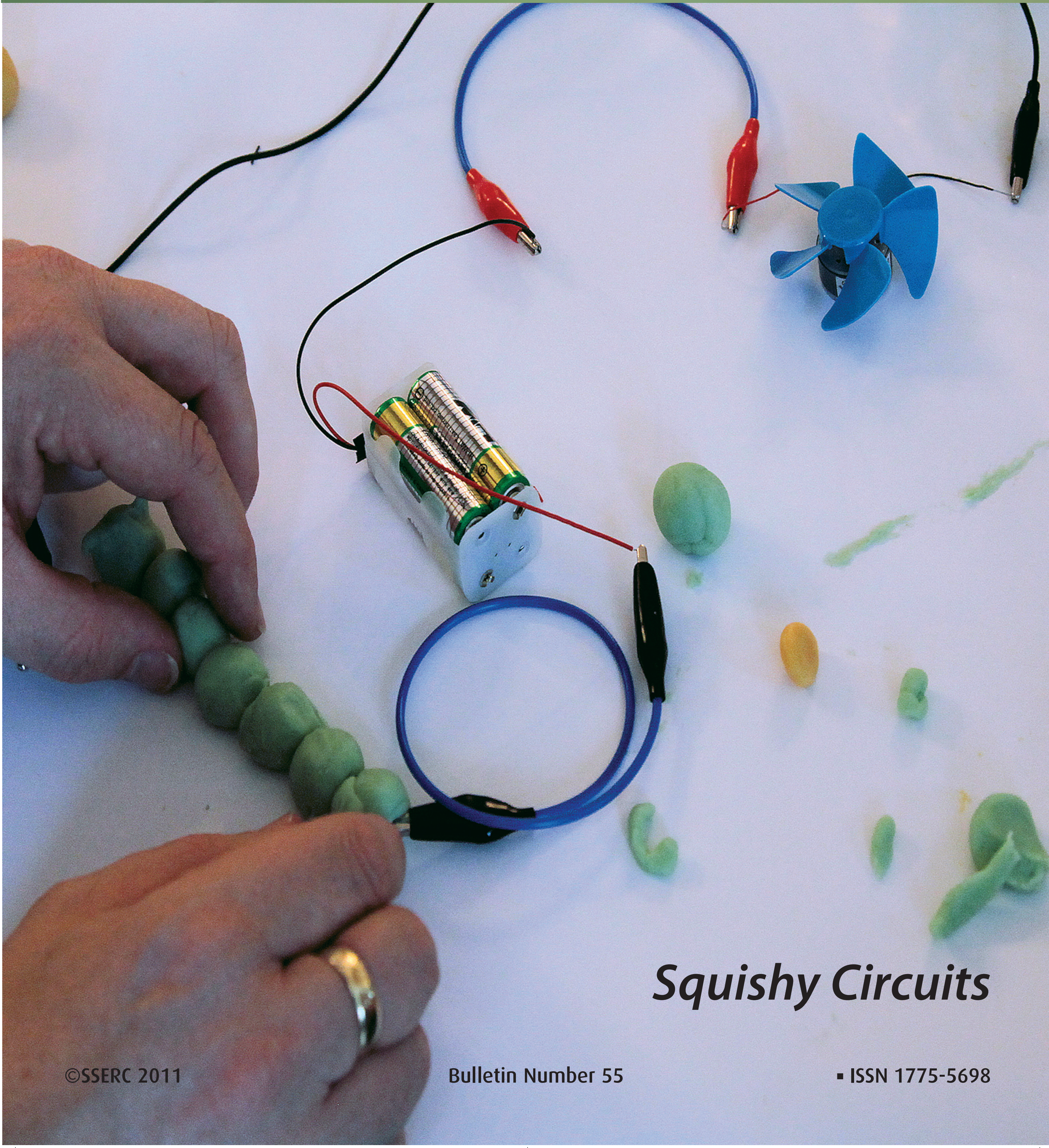
Primary Science & Technology Bulletin

Ideas and Inspiration for teachers in Primary Schools & S1/S2



Squishy Circuits

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Squishy Circuits

These circuits were originally developed by Dr. Ann Marie Thomas and Samuel Johnson of The University of St Thomas [1]. The US quantities were converted courtesy of *Delia* [2]. The squishy circuits provide opportunities for taking a novel look at electrical circuits through the use of home-made modelling dough, which just happens to conduct electricity. When rolled out into sausage or other shapes they act like wires and/or resistors in a circuit. First we need to point out a few important things about LEDs.

LEDs (light emitting diodes)

These are used in place of bulbs which were often used in such circuits. Although much cheaper than bulbs you have to be careful how you connect LEDs in circuits. There are two things to look out for:

- Make sure the long leg is always connected to the positive side of the battery. Traditionally a red wire is used for such a connection. The shorter leg should always be connected towards the negative side of the battery (usually with a black wire) with the following important proviso:
- Never connect an LED directly across the terminals, i.e. the positive [+] and negative [-], without having something in the circuit which limits the flow of electricity (the current) to the LED. This can be done in all kinds of circuits, from the simplest to the most complex by using a component called a resistor. This drops the current flowing to a level that the delicate wee LED can cope with. You will also see later on that a sausage of conductive dough in a squishy circuit can serve the same purpose.

Therefore if an LED is connected the 'wrong' way round it will simply not work, and if it is connected directly across a battery it will be damaged.

A simple circuit

Figures 2 and 3 show the simplest circuit diagram with a battery, LED, wires, crocodile clips and resistor. A suitable value of resistor has a value of 330 ohms. Contact SSERC if you want to buy some (10 for a £1 incl. p & p). Try connecting the components as shown in Figure 2 and see if the LED lights.

We now go on to use the dough, battery, motor and LEDs to build and demonstrate the workings of some other circuits. Firstly we need to make the conductive dough and test it in place of the resistor in Figures 2 and 3. As an extension exercise perhaps you may want to work out which of the ingredients contributes most to the conducting properties.

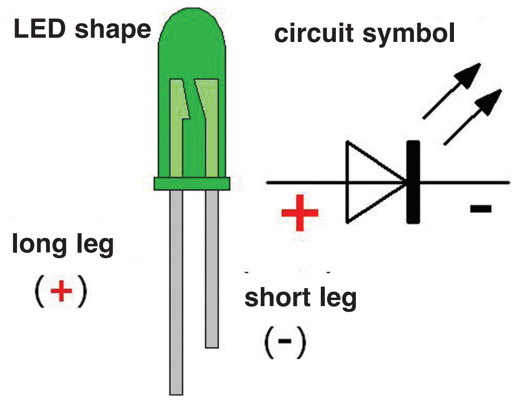

Figure 1 - LED shape & circuit symbol.

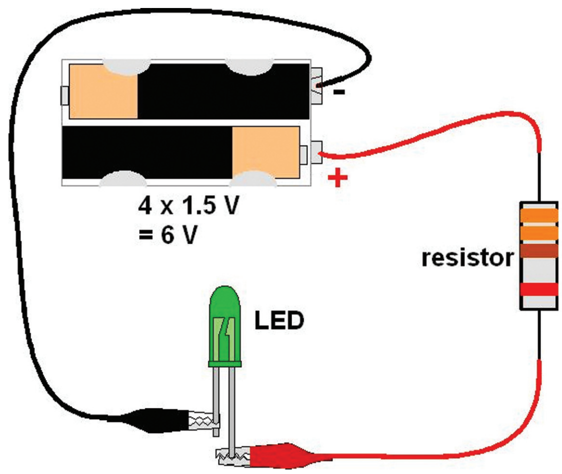

Figure 2 - Simple circuit (schematic).

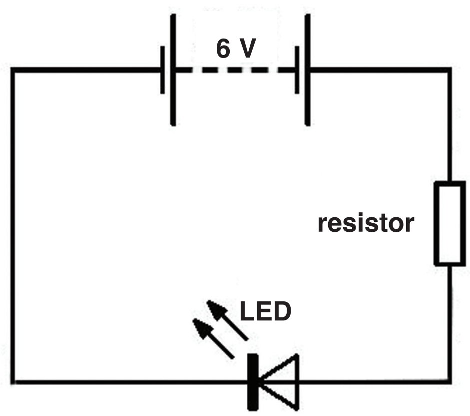

Figure 3 - Simple circuit (diagram).

Recipe for conductive dough

Materials:

water, 240 cm³
plain flour, 225 g
salt, 55 g
cream of tartar, 3 tablespoons (45 cm³)
vegetable oil, 1 tablespoon (15 cm³)
food colouring (optional)

Procedure:

1. Mix the water, 150 g of flour, salt, vegetable oil, cream of tartar, and food colouring in a medium sized pot.
2. Cook over medium heat and stir continuously.
3. The mixture will begin to boil and start to get thick.
4. Keep stirring the mixture until it forms a ball in the center of the pot.
5. Once a ball forms, place the ball on a lightly-floured, flat work surface.

WARNING: The ball will be very hot. Flatten it out and let it cool for a couple minutes before handling.

6. Slowly knead the remaining flour (~ 75 g) into the ball until you've reached a consistency which can be easily moulded.
7. Store in an airtight container or plastic bag. While in the bag, water from the dough will create condensation. This is normal. Just knead the dough after removing it from the bag, and it will be as good as new. If stored properly, the dough should keep for several weeks.

Simple Circuit with conductive dough (Figure 4)

Here the resistor in Figures 2 and 3 has been replaced by a dough sausage. We don't need the resistor to protect the LED as the flow of electricity (current) is partially limited by the conductive dough.

Ask the children how the dough in circuit (Figure 4) might be adapted to vary the brightness of the LED. Think also about varying the position along the dough of the bottom red croc-clip. There should always be at least 1 cm of dough between the long leg of the LED and the red (positive) connection to the battery.

They may suggest making a long-thin sausage, a wee-fat one or some other weird and wonderful shape. This should lead nicely into investigations and circuits where it is possible to vary the flow of electricity in a circuit, namely speed controllers and dimmer switches.

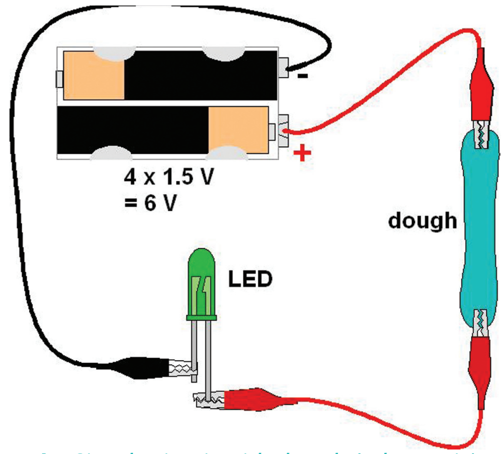

Figure 4 - Simple circuit with dough (schematic).

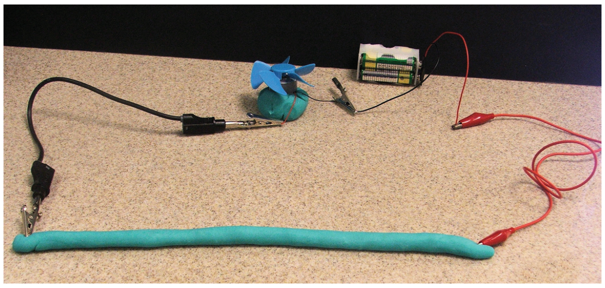

Figure 5a - Long "wire" – motor not turning.

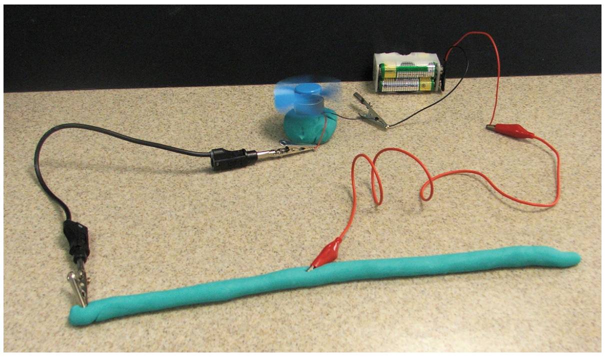

Figure 5b - As the connection moves up the wire, the motor turns more quickly.

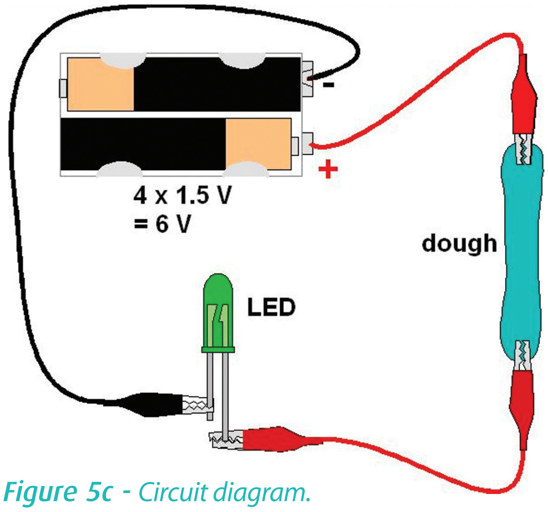

Figure 5c - Circuit diagram.

Squishy Circuits

Speed controller dough

The principle of a speed controller / dimmer switch can be shown using the conductive dough in place of a wire but may be more effective if a motor, fitted with a propellor, is used. Over a long length of dough the motor does not turn but there is a point at which the motor begins to turn and then the speed of the motor increases as the length of dough in the circuit decreases. See Figures 5a, 5b & 5c.

Care is required when making these comparisons. Increasing the contact between the crocodile clip or wire and the dough can have a marked effect on the brightness of the LED or the speed of the motor.

What effect does the thickness of the dough have?

In this case the lengths of the pieces of dough are the same but the thickness is varied (Figure 6c). Figure 6a shows that with the thin wire the motor does not operate but it does with the thicker wire (Figure 6b).

Do longer wires mean a dimmer LED – a parallel circuit?

Although many children may intuitively say that the LED will become less bright as the length of the wires in the circuit is increased, it is not easy to see . However, using a length of dough as a wire it is much more plainly visible (Figure 7a). Make sure the long leg of the LEDs is connected to the dough. There should be at least 1 cm of dough between the long leg of the LED and the red (positive) connection to the battery. If an LED is connected straight across the terminals of a battery it will be damaged.

As shown in Figure 7b, we have a parallel circuit where one path is significantly longer than the other. The red lead is connected to one end of the dough and the LED which is attached to the blue lead is inserted in the dough close to where the red lead connects to the dough thus representing a very short piece of "wire." The other LED (connected to the black lead) is placed much further from the red connector and a difference in brightness of the LEDs is clearly visible.

These activities could be used to help meet the following Experiences and Outcomes in CfE.

> I can describe an electrical circuit as a continuous loop of conducting materials. I can combine simple components in a series circuit to make a game or model. **SCN 1-09a**
>
> I have used a range of electrical components to help to make a variety of circuits for differing purposes. I can represent my circuit using symbols and describe the transfer of energy around the circuit. **SCN 2-09a**

References

[1] http://courseweb.stthomas.edu/apthomas/SquishyCircuits/index.htm
[2] http://www.deliaonline.com/conversion-tables.html

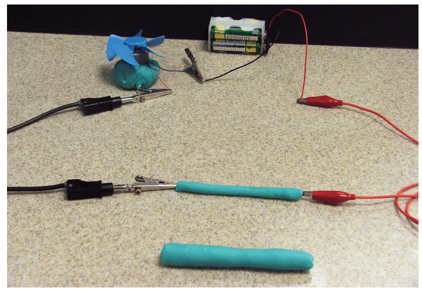

Figure 6a - Thin wire

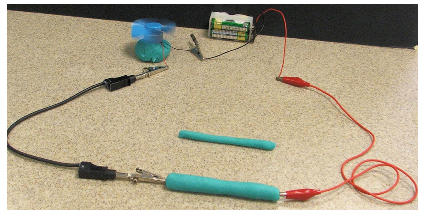

Figure 6b - Thick wire – motor turns

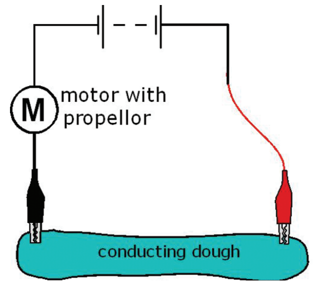

Figure 6c - Circuit diagram.

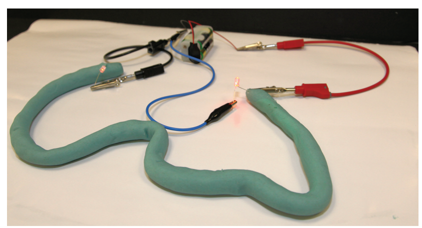

Figure 7a - Short "wires" & long "wires" in circuit

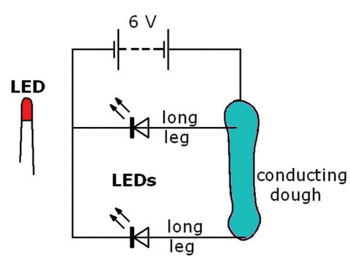

Figure 7b - Parallel circuit with LED & dough.

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