A Kit-of-No-Parts

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By Hannah Perner-Wilson

www.kit-of-no-parts.at

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Advisor:
Leah Buechley
AT&T Career Development Professor
Program in Media Arts and Sciences, MIT

Introduction

In my work I look at how we build electronics and at the materials and tools we build with. With a Kit-of-No-Parts I propose a new approach to building electronics that emphasizes the expressive qualities of diverse materials as well as the skill and creativity of the builder. This approach is represented here through a set of examples that include ways to sculpt and plate electrical connections, cut paper speakers, carve wooden dials and paint color-changing pixels.

The following examples showcase electrical circuits made using a variety of materials and techniques. Most of these examples are functional and many are based on the same circuit which includes a microcontroller, a coin-cell battery, surface-mount LED lights and two exposed parallel wires that make for a skin-resistance sensor. The microcontroller has been programmed to detect touch on the parallel wires, and for every touch to toggle on and off between the three LED lights.

Carved Traces

Carved Traces demonstrates how circuit connections can be carved from a sheet of plywood that has been coated with a layer of conductive silver paint. The conductive paint layer can be carved away with a variety of tools, revealing the wood structure beneath. Small grooves can be carved out for the smaller components to recede into, such as the surface mount LEDs. The components are glued to the surface and additional silver paint is applied to bridge the connection between the painted wood trace and the component lead. The coin-cell battery holder was made by screwing two small screws into the wood, making contact with the conductive paint. The screws are spaced so that the battery press-fits between them.

Carved Traces

wood, primer, silver paint

Carved Pixels

Carved Pixels shows how a carved circuit (see previous example) can be designed to heat selective areas that have been coated with thermochromic paint. The thermochromic pigments in the paint become transparent when heated and can be mixed with regular paint colors to achieve a variety of color-change effects. The circuit in this example was designed with a dial in the center, that directs the current to different parts of the circuit. Depending on which way the dial is turned, different parts of the circuit heat up, revealing the carved pixels one at a time.

Carved Pixels

wood, copper paint, thermochromic ink

Cast Traces

Cast Traces are made from a silver paint and latex blend. Unfortunately it was not possible to mix the conductive paint with the latex at a ratio that yielded both conductive and stretchy results, making this example purely demonstrative of what castable stretchy conductors could be. This example was made by first casting a thin layer of latex and letting it cure. On the cured latex surface, the microcontroller, LEDs and battery were laid-out and the conductive latex blend applied through the tip of a squeeze bottle to create the connections between the component leads. Once the cast traces had cured, additional latex was used to coat the components and keep them in place.

Cast Traces

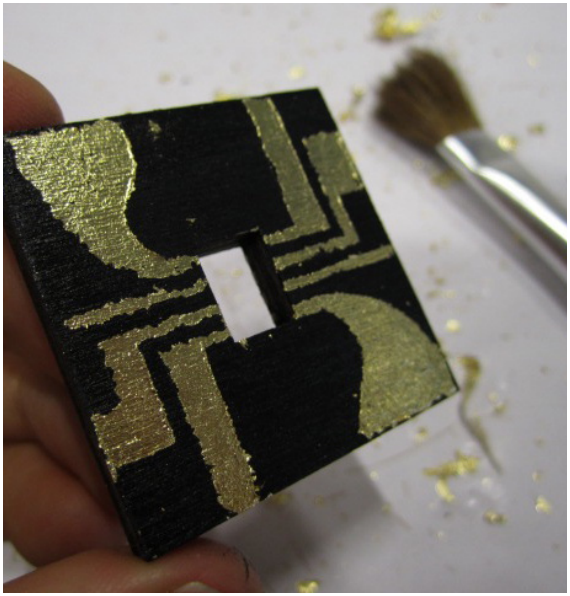
latex, silver paint

Etched Traces

Etched Traces demonstrates the process of selectively etching copper fabric to create conductive fabric circuits. To etch this circuit, first a mask was cut from masking tape and transferred to a square of copper plated fabric. Vaseline was applied to the cutouts of the stencil and the masking tape removed. The water repellent properties of the Vaseline work as a resist in the etching bath, protecting the copper fabric in the places where the Vaseline is applied. The fabric was then submerged in a bath of one tablespoon of salt and one cup of distilled vinegar. Within four hours, most of the copper, except for that protected by the Vaseline, had been etched away. Ironing the etched fabric circuit between layers of tissue paper removes the Vaseline.

Etched Traces

copper fabric, vaseline, salt and vinegar

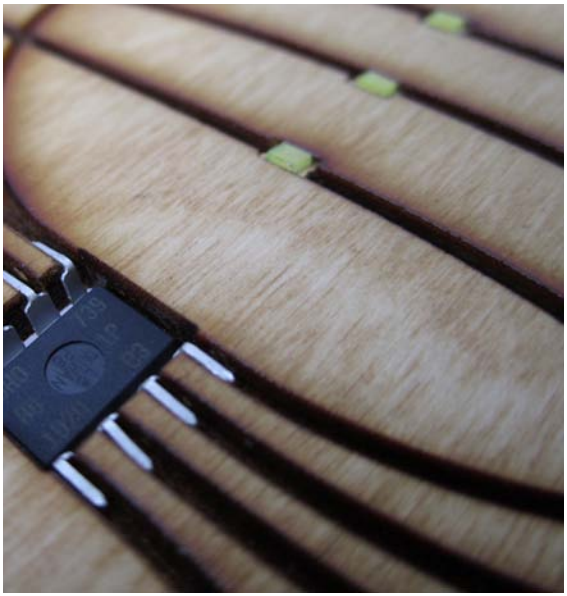


Gilded Traces

Gilded Traces showcases the ornamental and decorative properties of gold leaf as well as its conductive properties. First a sheet of plywood is sanded and painted with filler and black acrylic to create a smooth surface. To selectively adhere the thin sheets of gold leaf, gilding size, an adhesive, is applied and let dry until it is tacky. Then the sheets of gold leaf are applied and excess brushed away. The components can be super-glued to the wood for stability, and then their leads can be soldered to the gold leaf using flux generously.

Gilded Traces

wood, acrylic, adhesive, gold leaf, varnish

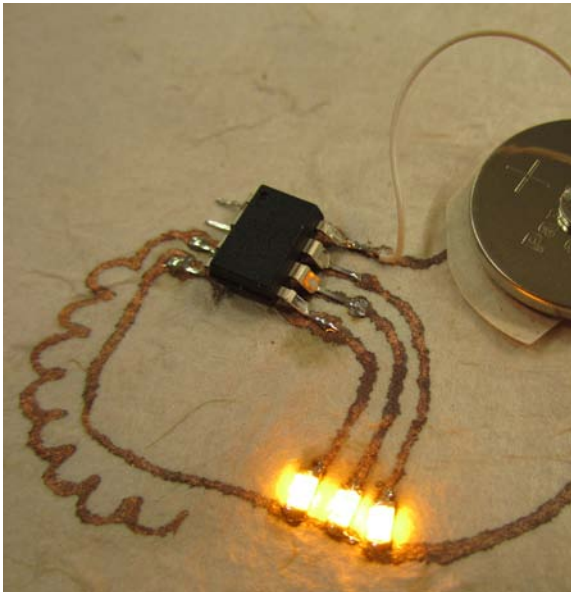


Laser-Engraved Traces

Laser-Engraved Traces illustrates how a lasercutter can be used to engrave channels that connect the different component leads to one another. The lasercutter can also be used to cut press-fit holes for various components such as the coin-cell battery, a microcontroller and a speaker. These cut-outs are just the right size so that the parts press into them and do not fall out. This example has not been completed, but the next step would be to saturate or flood the engraved channels with a conductive paint to complete the electrical connections.

Laser-Engraved Traces

wood, masking tape, copper paint, lasercutter

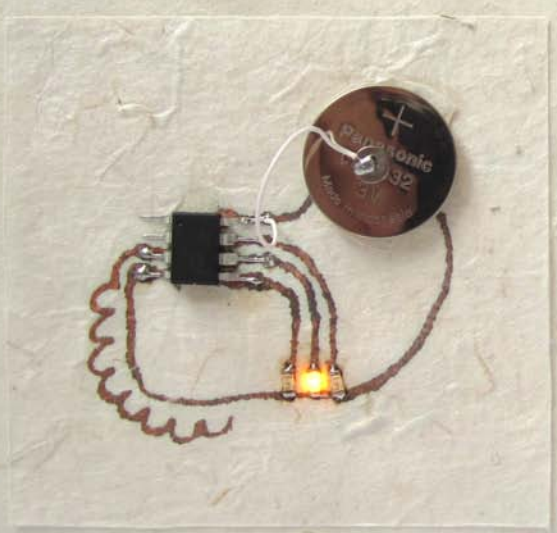


Painted and Plated Traces

Painted and Plated Traces is a tiny circuit that was painted on a piece of paper. Then the whole circuit was electroplated so that a thin layer of copper formed on top of the paint and paper. The plated copper make the traces much more resilient to cracking when the paper is flexed and it also means that the leads of the microcontroller and LEDs can be soldered to the circuit. The coin-cell battery is held in place by a tiny neodymium magnet taped to the back of the paper. The positive lead of the microcontroller connects to the positive side of the battery with another such magnet soldered to the end of a flexible wire.

Painted Traces

paper, silver paint, carbon paint, squeeze bottle, tip, paintbrush

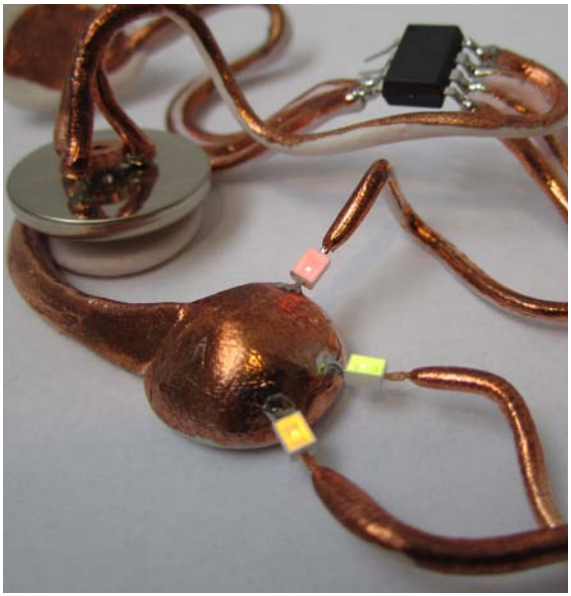


Linocut Traces

Linocut Traces demonstrate how a circuit, carved from a sheet of linoleum, can be used as a stamp to print a circuit multiple times. This carved linoleum circuit is coated in conductive silver paint that has been mixed with block printing base. The paint is applied the linocut with a roller to ensure an even surface. Then a piece of paper is laid on top of the coated linoleum and with the back of a spoon the paper is rubbed down carefully. The paint will only apply to the paper from the areas of the stamp that have not been carved away. When the paper is peeled away, the paint has transferred to it.
Unfortunately in this example the ratio in which the silver paint and printing base were mixed did not achieve good electrical conductivity.

Linocut Traces

linoleum, silver paint



Sculpted and Plated Traces

Plated Traces is a circuit sculpted from acrylic clay and then selectively electroplated to build a robust conductive coating that will not crack when the traces of the sculpture are flexed.
In making the sculpted circuit the acrylic clay was sculpted right around the leads of the various components and everything was fired in a toaster oven for the clay to harden. The components were not damaged by the heat. Then conductive silver paint was selectively applied to make the connections between certain components. When the paint was dry, the circuit was disassembled and the traces electroplated individually. After plating, the circuit was re-assembled and the connections to the leads were soldered.

Plated Traces

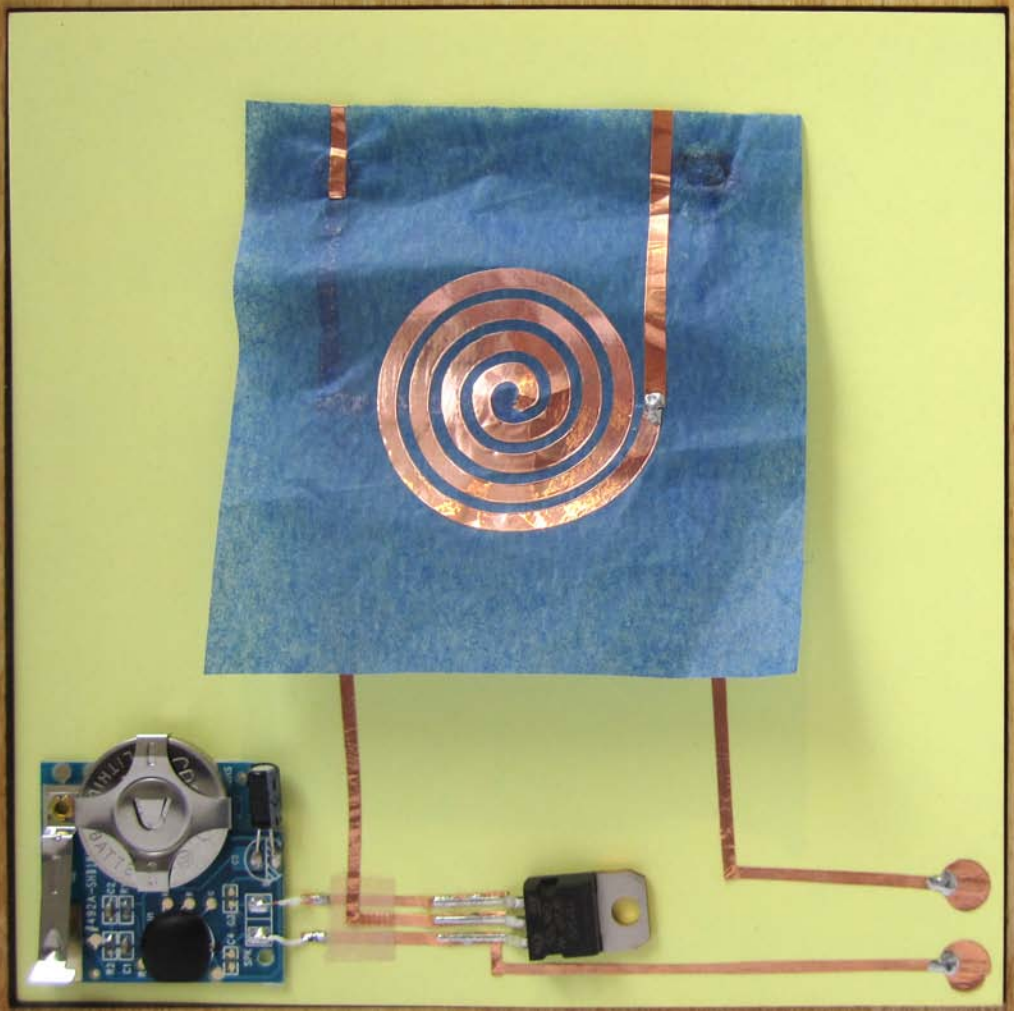
fimo, silver paint, copper sulphate, electrodes

Paper Speakers

Paper Speakers showcases a speaker that has been made on tissue paper, by taping a vinylcut copper coil on top of it. The copper coil was drawn using computer software and cut out by a vinylcutter. Behind the piece of tissue paper a small neodymium magnet is glued to the larger square of yellow paper. In the lower left corner a small circuit taken from a greeting card has been mounted and a transistor added so that the audio signal coming from the sound circuit can be amplified with an external power source. A 9V battery is connected to the two leads at the bottom right of the example and when the button on the sound card is pressed, the speaker plays music and you can hear the tissue paper membrane rustle.

Paper Speakers

paper, copper tape, silver paint, conductive fabric, gold leaf

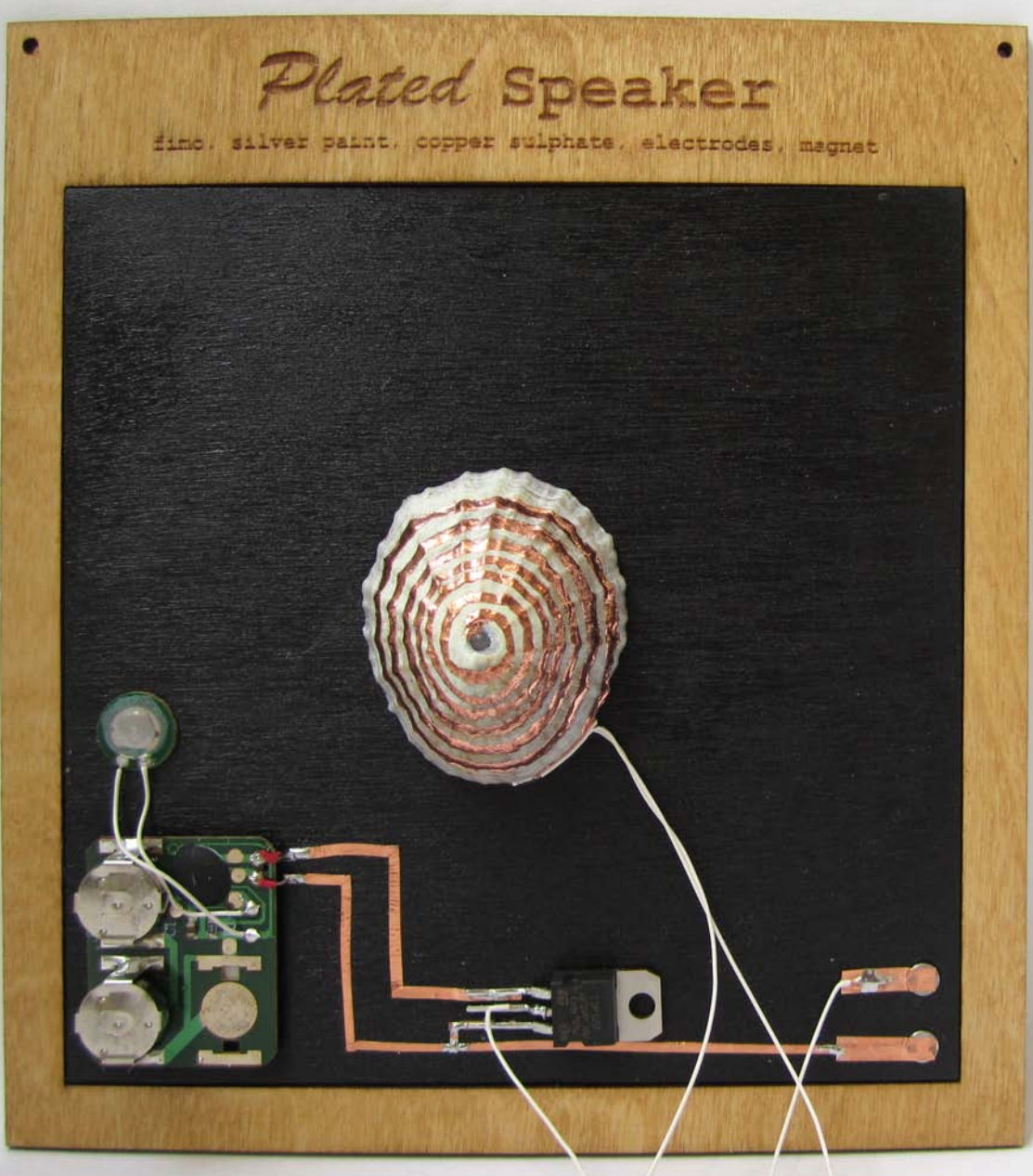


Plated Speaker

Plated Speaker is an example that demonstrates how a limpet seashell can be made into a speaker by plating a copper coil around its exterior and interior with a hole in the tip that connects the two. Because the shell is a much thicker membrane than the tissue paper used in the paper speaker example, it's vibrations move less air and so it is much quieter. But if one holds the seashell up to one's ear, one can hear it play music. The speaker coil was plated onto the seashell, by first painting the coil with conductive silver paint and then submerging it in the electroplating bath.

Plated Speaker

fimo, silver paint, copper sulphate, electrodes, magnet

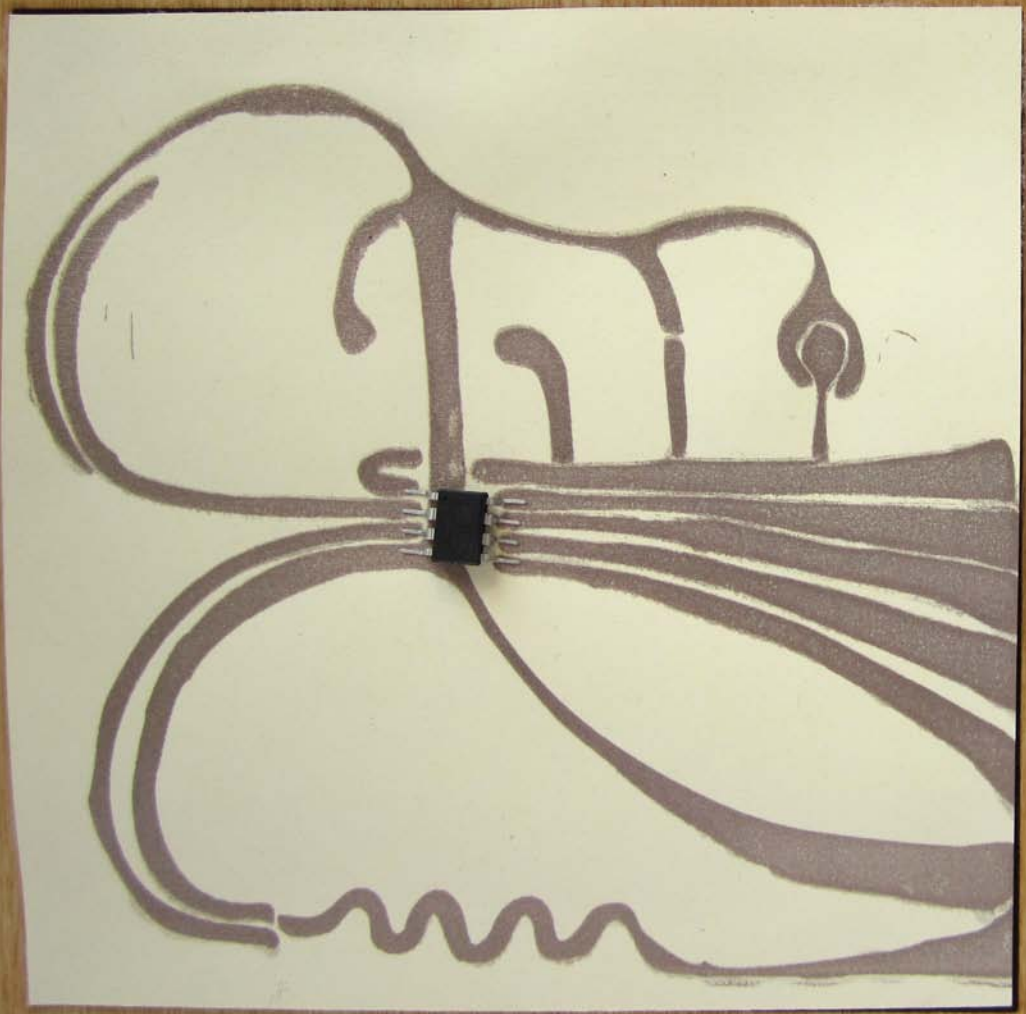


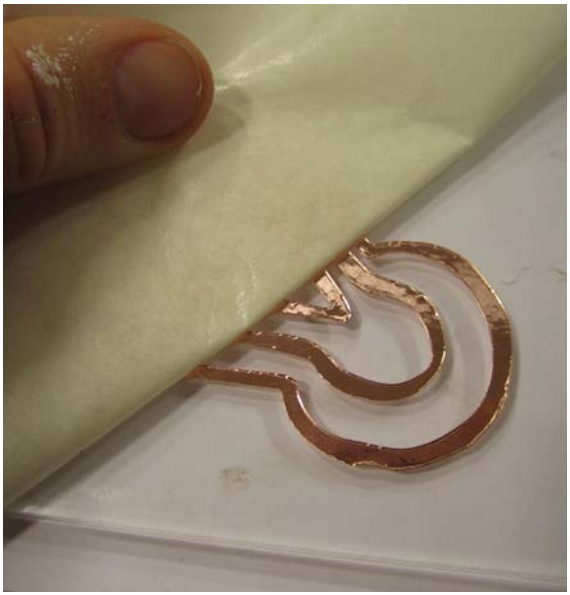
Screen-Printed Traces

Screen-Printed Traces is an example that shows how you can use traditional silk-screen printing to create circuitry. The circuit in the example was hand-drawn and then scanned into the computer and translated into vector graphics. The mask for the screen was lasercut out of masking tape and then applied to the back of the screen. Copper paint was mixed with a transparent screen-printing base and evenly distributed into the pores of the silk screen with a squeegee. Then the screen was laid down on a piece of paper and the squeegee was used to pressure the conductive paint from the screen onto the paper. Two to three layers of paint were necessary to create good electrical connections.

Screen-Printed Traces

paper, medium, silver paint, carbon paint, screen, squeegee



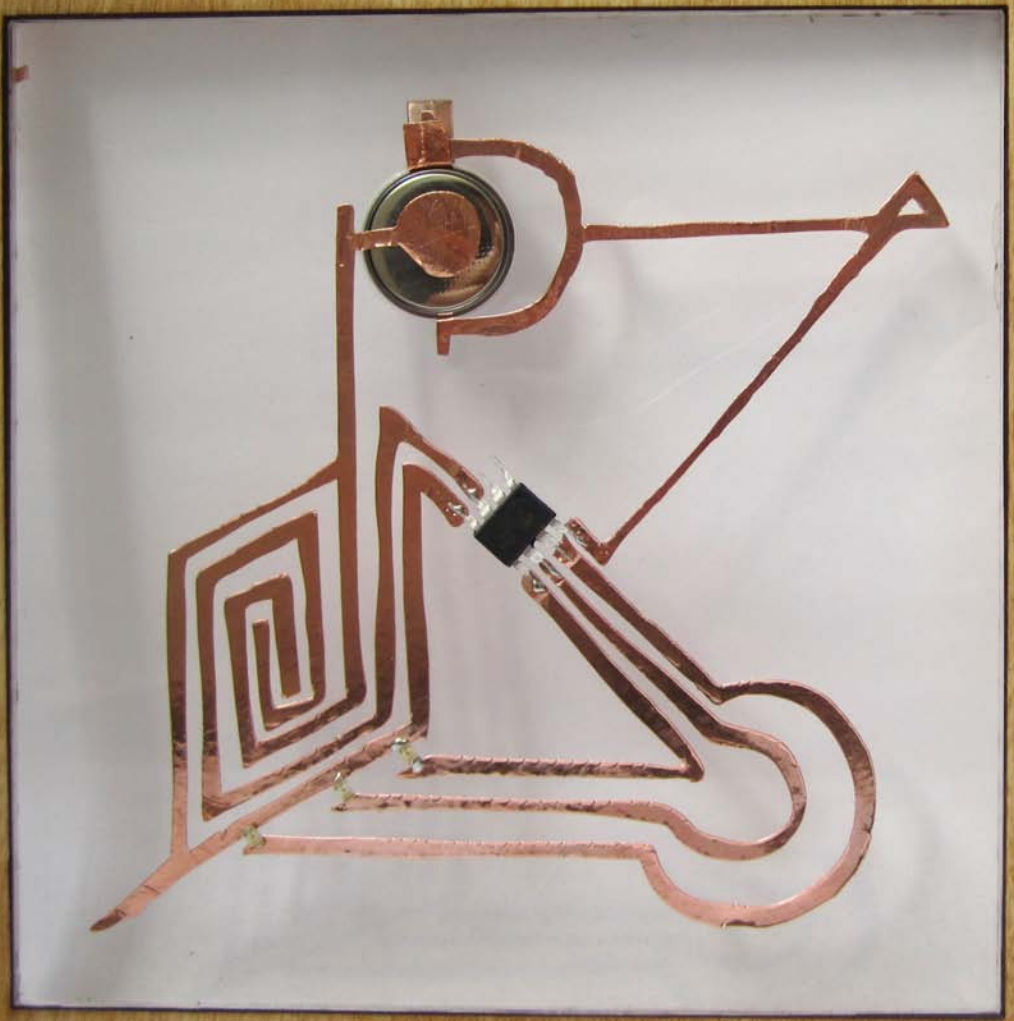


Vinylcut Traces

Vinylcut Traces demonstrate circuit connections that have been cut using a vinylcutter from a copper adhesive sheet. The design for the circuit was hand-drawn and scanned. The scan was then translated into vectors and sent to a vinylcutter which then cut it out from a sheet of adhesive copper tape. The cutout circuit was transferred to the acrylic using masking tape, to ensure that all the traces stayed in place. A hole for the coin-cell battery was lasercut out of the acrylic. The connection to the positive side of the battery extends over the edge of this hole. The negative side of the battery is connected simply by sticking the negative lead of copper tape to the bottom of the battery.

Vinylcut Traces

acrylic, copper tape, vinylcutter



Sculpted Motor

Sculpted Motor is a basic motor design has been assembled from a variety of materials such as toothpicks and custom shaped Fimo fixtures. The assembly has then been electroplated, forming a conductive layer of copper metal. When a 9 Volt battery is shorted across the two connections, forcing the current through the wire wrap coil that is suspended between the two poles, it creates a magnetic field around the coil that repels itself from a stack of magnets mounted beneath. The motor begins to spin and the images of the bird and the cage merge into one.

Sculpted Motor

wire, magnet, battery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B