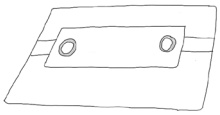
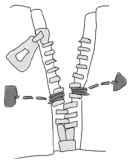
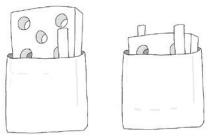
Switches GET STITCHES



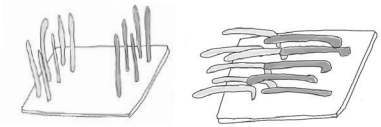
SNAPS



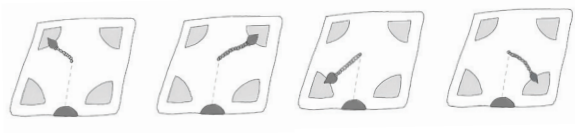
ZIPS



PUSHES



STROKES



TILTS

With this zine you will be able to...

- Describe how a basic switch works in a circuit.
- Make two types of soft switches using a step-by-step guide and patterns.
- Brainstorm ideas for a custom switch.

The Electrical Switch: A Short History

is a modest concept with a colossal historical legacy. Once upon a time, in the 1930s, Claude Shannon produced a paper proving that Boolean logic could apply to electrical switches. The binary nature of switches means that they can be ON or OFF, 1 or 0, TRUE or FALSE. Two switches act as the input (information introduced into a system) to a logic circuit, an AND gate. In this case, switch 1 AND switch 2 must be on for the circuit to output a value of TRUE. For an OR gate, only one has to be on for it to be true, but if both are on, it will be false!

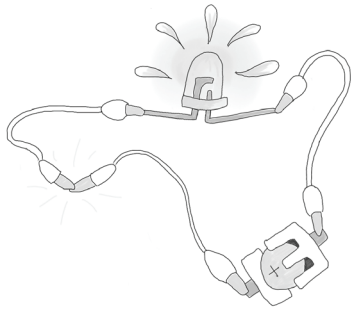
By encoding meaning into the state of switch, these gates can process information and automate decisions that make sense to humans. Switches become more than just the flow or stoppage of electrons. They represent ideas, observations, and arguments. Shannon's interdisciplinary juxtaposition rooted us in a new era of digital computation. Perhaps it also deepened a trust in the binary and a discomfort with gray space between and around 0 and 1. Not long after, William Shockley, a racist, pro-eugenics physicist, invented the transistor: a semiconductor that switches on and off using electricity instead of mechanically. The miniaturization and efficiency of this electrically controlled switch incited a computational revolution.

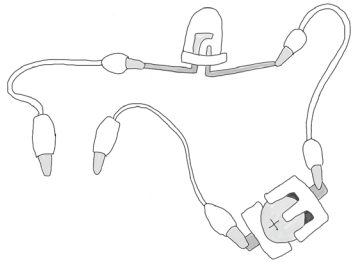
While most of us may inhabit a digital world reliant on the binary thinking of switches, there are other potential worlds to explore. This zine is a provocation to imagine new switching narratives with materials and craft as our fellow travellers.

Switches

A switch is a break in a circuit.

Since the circuit is not complete, no electricity can flow to the components. The simplest type involves 2 conductors making electrical contact when a physical action brings them together. A switch is CLOSED when they make contact and OPEN when they are not connected. The state of a switch is binary: ON or OFF, 1 or 0, HIGH or LOW.

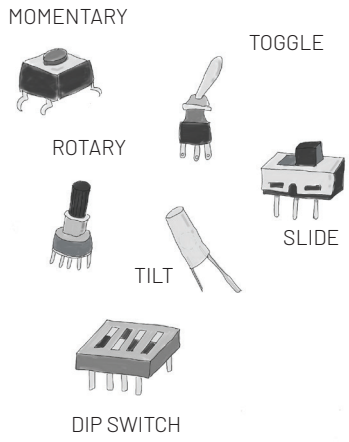


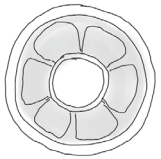


There are many types of switches.

We can classify different types of switches based on the conditions that opens or closes it. For example, mechanical switches are operated by physical action, automatic switches are controlled by certain stimuli (e.g. temperature), electrical switches, and semiconductor switches are controlled by a change in electrica signals like voltage or current. We will focus on mechar ical.These also have different configurations based on pole and throw.

Check out the zine *An Instructive Appreciation of Buttons and Switches* by Lee Cyborg for a deep dive into all the different types.





A **soft switch** uses conductive textiles and craft techniques to control the flow of electricity in a circuit.

Fabric Push Button

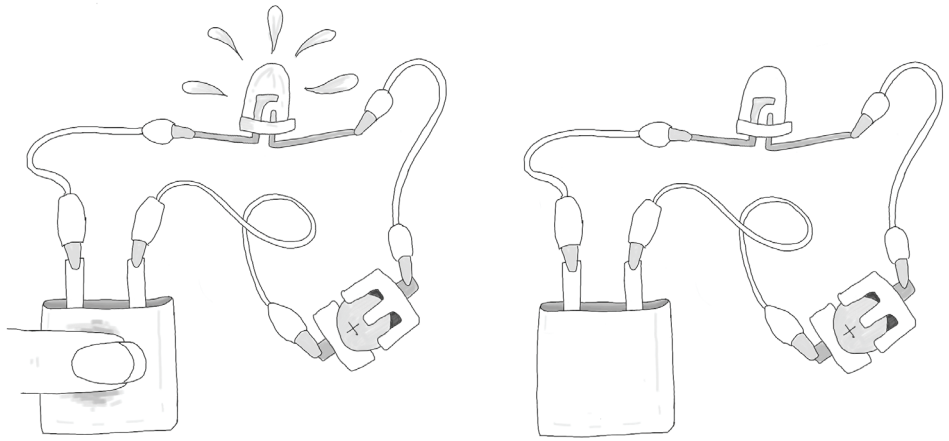
Push buttons are activated by pressing the button. They stay closed as long as you hold them by pressing conductive materials into contact.

This fabric button uses foam to separate the two copper fabric patches. The foam has strategically positioned holes that allow the patches to make contact when pressed and allow electricity to flow.

As you customize your own design, here are the variables to keep in mind: size of button, size of foam hole, form, desired interaction, aesthetics, materials, desired ease of use, etc.

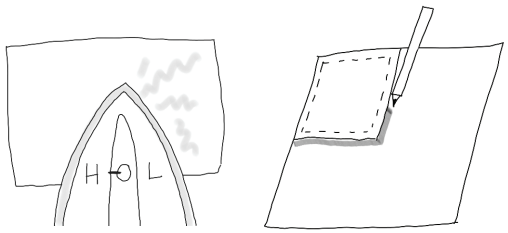
Tools & Materials

- Woven (non-stretch) Fabric
- Conductive Fabric
- 1/2" Foam
- Scissors
- Needle
- Straight Pins
- Regular Thread
- Iron
- Ironing Mat or Board
- Heat'N'Bond
- Optional: Ruler, Rotary Cutter, Mat

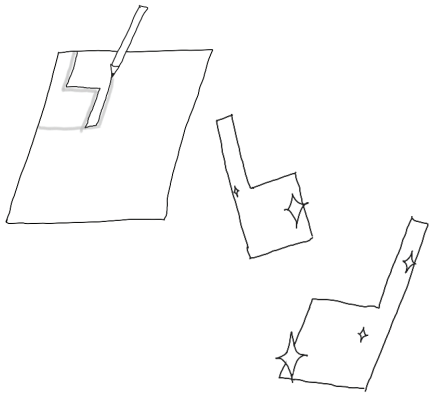


1. Prep your patterns and materials

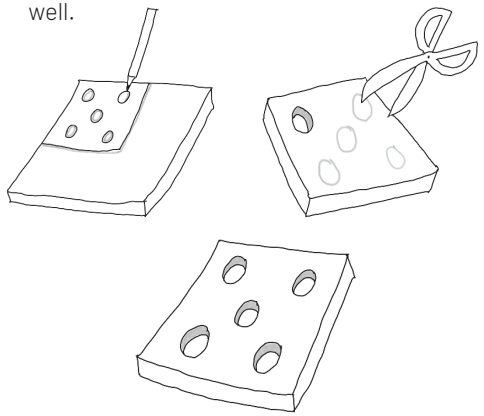
To get started, iron the woven fabric and cut out the templates below. Trace 2 of the button pattern onto the woven fabric, then cut them out.



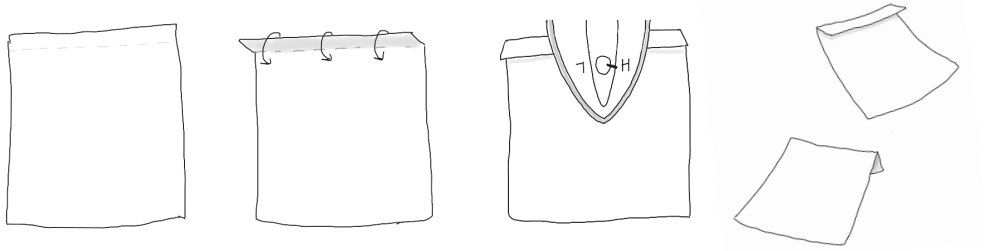
Trace 2 of the conductive fabric pattern on the conductive fabric, then cut them out.



Trace the foam pattern onto ~1/2" wide foam and cut it out. Trace and cut out the holes as well.



Now it's time to iron the top seam of the button fabric. First, put the fabric so the wrong side is up. Then fold the 1/4" top seam over so you can see the right side of the fabric.



Press the low heat iron and hold for 10 seconds. Repeat the whole process for the other piece.

2. Apply heat'n'bond to the conductive fabric

Cut two small squares of Heat'N'Bond, about 1/2". Find the shiny side and place it face down in the center of the conductive fabric.

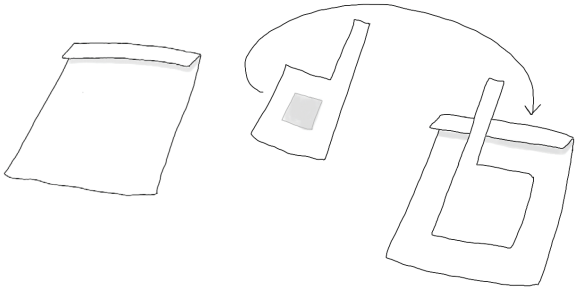
Apply a low heat iron for 5 seconds. Let it cool and peel off the paper.

Grab the other conductive fabric. Position it so it is a mirror image of the other one - fuse the square to this side.

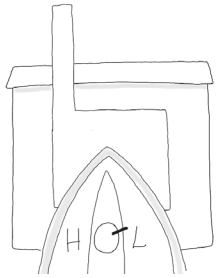
3. Bond the conductive fabric to the regular fabric

Lay down the button fabric so the ironed top seam is facing you.

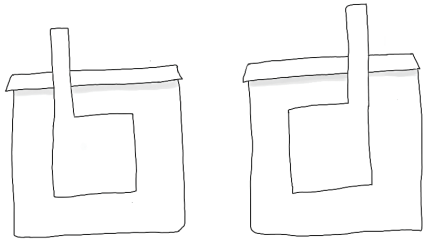
With the heat'n'bond side facing down, center one of the conductive fabric pieces on the button fabric.



Apply the low heat iron.



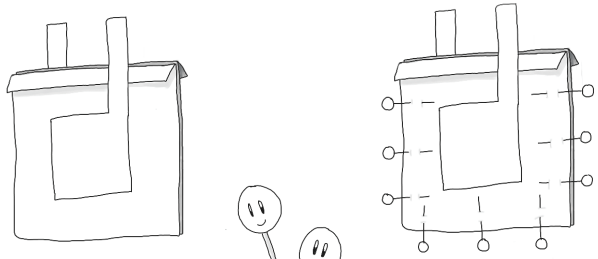
Repeat for the other side



4. Get ready to sew

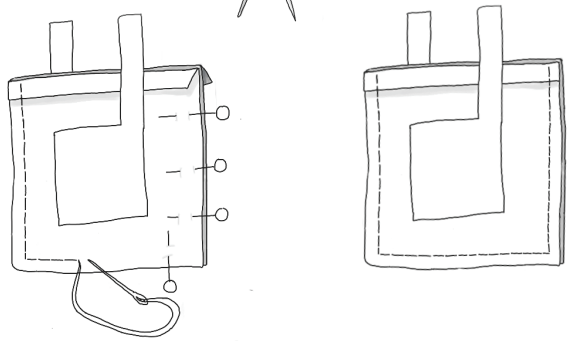
Put one button piece on top of the other with the conductive fabric facing out. Line up the edges - make sure the top seams align too!

Insert straight pins around the left, bottom, and right sides, but not the top.



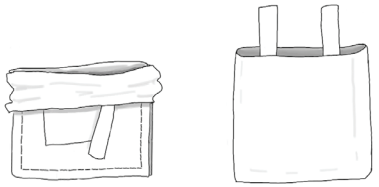
Double thread your needle with your fav color and tie a knot.

Sew a back stitch slowly around the first side, bottom, and final side. Knot off at the top. You can sew the sides of the top seam down if you like.

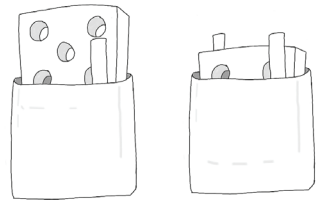


5. Add the foam to make the button

Carefully turn it inside out and press down your seams. You have a switch pocket!

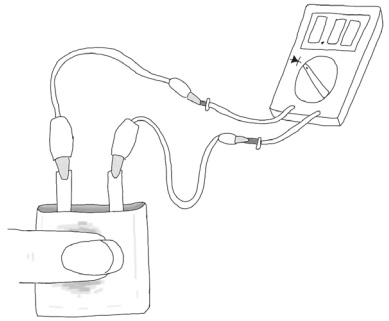


Gently insert the foam square into the pocket so it separates the two conductive elements completely.

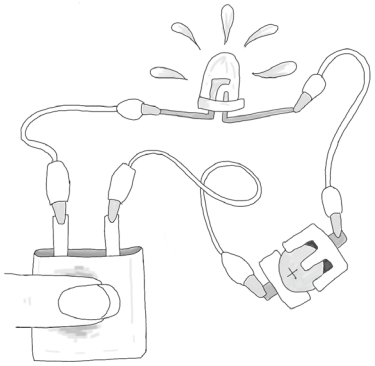


6. Test it

Connect 2 alligator clips to each of the **multimeter** leads. Connect the other ends to the switch leads. Turn the setting to continuity, then press. If you see 0 only when you press, you have a working switch! If not, go to step 7.



You can also test with a simple **LED circuit.** Use an alligator clip to connect one end of the switch and the ground LED lead. Connect another clip between the positive LED lead and power of the 3 volt battery. Use a third clip to connect the battery to the other side of the switch. It should light up only when you press it. If not, go to step 7.



7. Debug it

Is the LED always on?

- Check to see if your conductive fabric is making contact somewhere you can't see.
- Your foam holes may be too big, allowing even the slightest pressure to make unexpected contact.

Is the LED not turning on consistently?

- Your foam holes may be too small. Take the foam out and make some bigger holes!

8. Close it

Once you have tested and feel good about the behavior, you can sew up the top seam with regular thread.

Textile Snap Switch

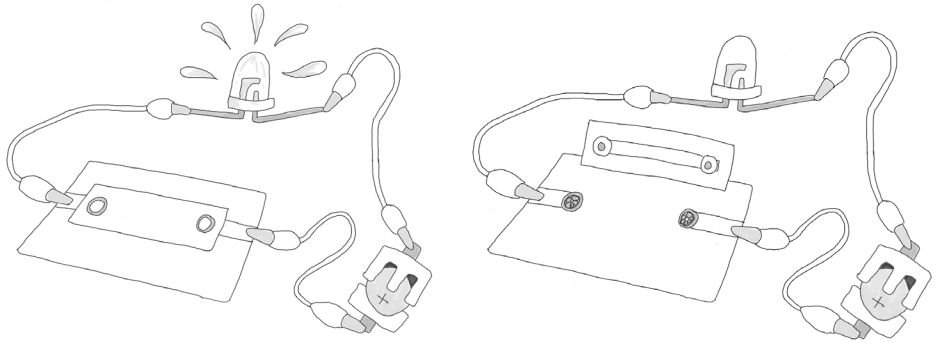
Snap switches are activated by pressing one side of the snap into its mate. They stay closed until you physically disconnect them.

A snap switch is most closely related to toggle or slide switches: moving a lever or slider or other mechanism to flip between two or more states, usually on or off. This design breaks the flow of electricity in a trace of conductive fabric, separating it into two parts with a snap on each end. A "bridge" connector snaps into either end, closing the circuit and allowing electricity to flow.

As you customize your own design, here are the variables to keep in mind: length of bridge/base, number of snaps, frequency and type of use, form, aesthetics, material

Tools & Materials

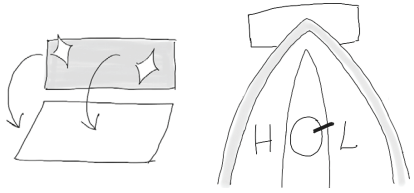
- Neoprene or Felt
- Conductive Fabric
- Option 1: Conductive Thread, Needle, Sewable Snaps
- Option 2: Snap Press, Snaps
- Scissors
- Iron
- Ironing Mat or Board
- Heat'N'Bond
- Optional: Ruler, Rotary Cutter, Mat



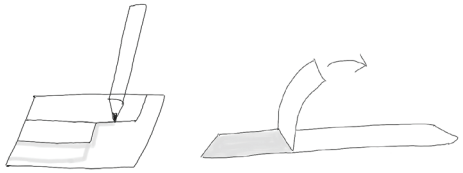
1. Prep your patterns and materials

Cut out the templates below. Trace the base and bridge patterns onto felt or neoprene, then cut them out.

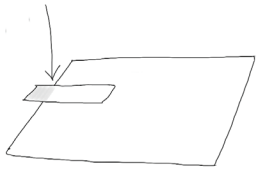
Cut a piece of conductive fabric and a piece of heat'n'bond that are about 1.5" x 2.5". Use an iron to fuse heat'n'bond to one side of the conductive fabric.



Trace the patterns for the conductive strips onto the conductive fabric, then cut them out. Peel off the heat'n'bond paper.

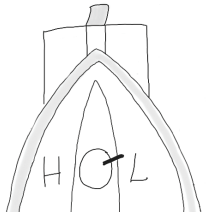


Place one of the base conductive traces on the left side of the base fabric. The shiny adhesive side should be facing down and about 1/4" should be hanging off the edge.

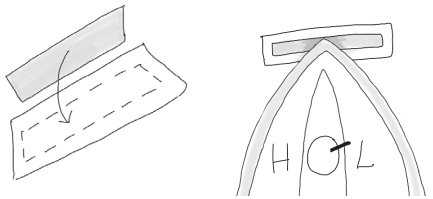


Fold the rest of the conductive trace to the back. Iron it down to secure it. Repeat for the right side.

Apply a low heat iron to the base conductive trace until the edge of the base fabric.



Center the bridge trace (adhesive face down) on the bridge fabric. Use a low heat iron to fuse them together.



2. Sew on the snaps | OPTION 1

To start, thread a needle with a single strand of conductive thread (10-12 inches), knot off, and put it to the side.

Now, there are two parts to the snaps: the **socket** and the **stud**. Center a **socket** on the inner end of the bridge trace.

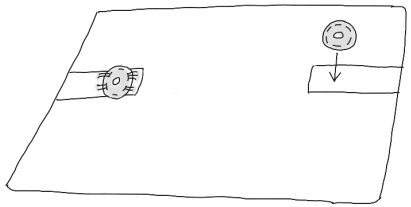
Using the conductive thread, sew at least 2 times into all the holes touching the conductive fabric. We want as much contact as possible. Knot off and repeat for the other side.

Next, sew a **stud** to the end of the bridge conductive trace using the same process. Repeat for the other side.

Secure the loose ends of the conductive thread with fabric glue, then trim the ends when dry.

SOCKET

STUD



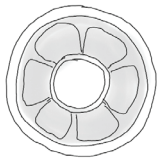
BRIDGE

BASE

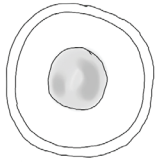
2. Apply snaps with a snap press | OPTION 2

There are three parts to the snaps: the post, the socket, and the stud. The press pushes the post into the socket or stud to secure it in the fabric. Notice how the post has little semicircle indentations on one side that look like a flower. This is up.

POST

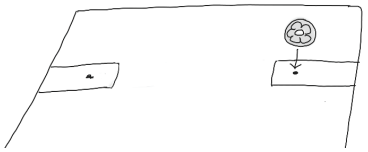


SOCKET

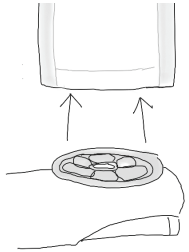


STUD

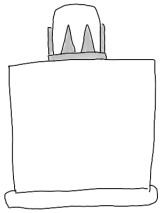
Position your **base** fabric so that the longer two conductive traces are facing up. We will add a snap on the inner end of each trace. The snap should completely cover the trace to make a strong connection. Use a pen to mark where you want the snap to go.



Move your attention to the press. Grab a **socket** and determine up. Firmly push the socket in the top rubber piece, flower side up.

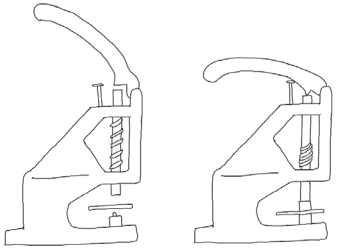


Place a **post** in the bottom with the teeth facing up.

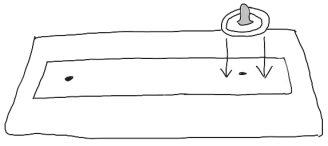


BOUNCY METAL BOTTOM POINT

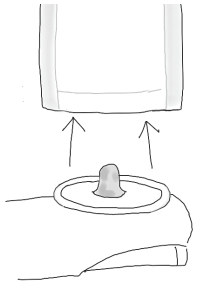
Slide the base fabric over the bouncy metal bottom point with your fabric mark facing up. Center the fabric mark over the bouncy metal point and hold it in place with two fingers as best you can. There is no science to this. Press the lever down with force, then pull it up and gently remove the fabric. Repeat for the other side.



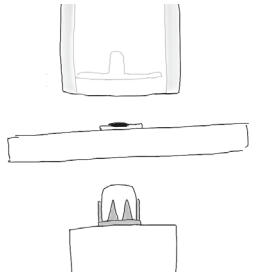
Position your **bridge** fabric strip so that the conductive trace is facing up. We'll add a snap to both sides. Use a pen to mark where you want the snap to go. It should completely cover the trace.



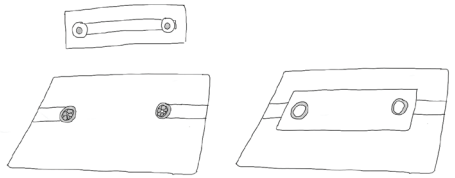
Place the **stud** in the top, pointy side up. Make sure it fits is snuggly in the rubber. Then add a **post** on the bottom.



Slide the bridge fabric strip into the press. Center the pen mark over the bouncy metal point and hold it in place.

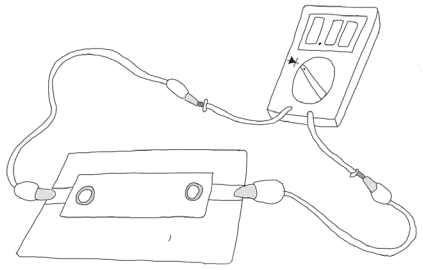


Press the lever down with force, then pull it up and gently remove the fabric. Repeat for the other side. Snap the bridge onto the base. Time to test!

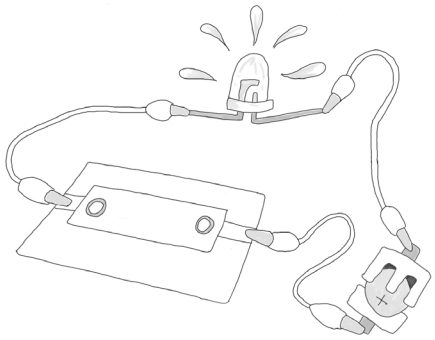


3. Test it

Connect 2 alligator clips to each of the **multimeter** leads. Connect the other ends to the switch leads. Turn the setting to continuity, then press. If you see 0 only when you press, you have a working switch! If not, go to step 7.



You can also test with a simple **LED circuit.** Use an alligator clip to connect one end of the switch and the ground LED lead. Connect another clip between the positive LED lead and power of the 3 volt battery. Use a third clip to connect the battery to the other side of the switch. It should light up only when you press it. If not, go to step 7.



4. Debugging

Is the LED always on?

- Check to see if your conductive fabric or snaps are making contact somewhere you can't see.

Is the LED not turning on consistently?

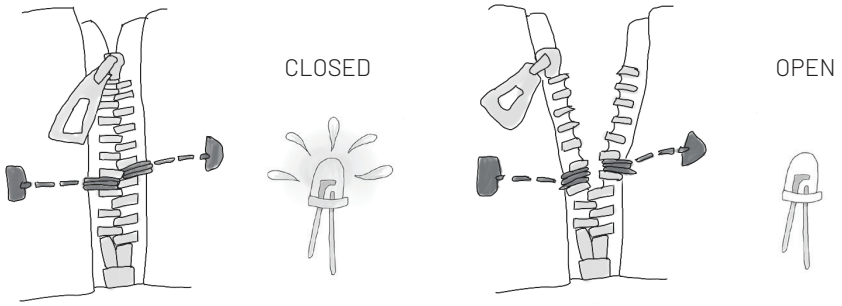
- Check that your snaps are making a strong electrical connection with the conductive thread or fabric.

More Switches

There are so many variations you can try to create a switch. Check out the adaptations below, then design and prototype your own.

Zipper Switch

Open and close the zipper to make momentary or sustained contact between the two traces of conductive thread. This works best with zippers that have metal teeth. If you want more sustained contact, try expanding this area. Keep in mind that this technique creates friction and could eventually degrade the conductive thread with frequent use.

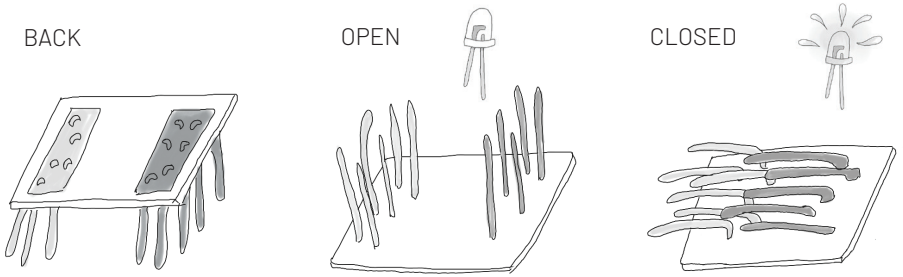


Sew the conductive thread around the teeth that make direct contact (i.e. right above or below each other).

Open the zipper to stop the flow of electricity, then close it to start the flow through the circuit.

Stroke Switch

Close the circuit by pressing conductive materials into contact. In this configuration, two sides of conductive material are separated by space or other non-conductive material. This example uses conductive thread and sewing, but you can achieve a similar effect with conductive yarn and crochet, tufting, etc. or other conductive fibers.



Fuse on two pieces of conductive fabric to the back of the fabric. Sew in mulitple strands of conductive thread in these two channels.

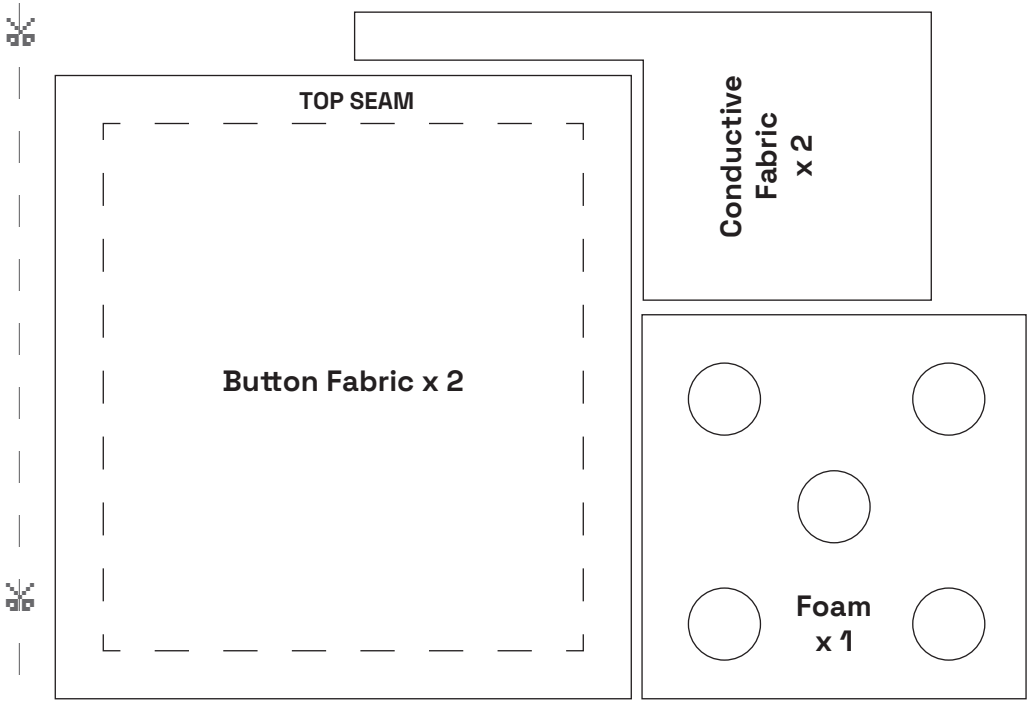
Press or stroke the surface to make a momentary connection between the two sides.

In your design phase, make sure that the materials overlap to make a strong electrical connection when you press them together.

Patterns

Cut out the page first, the patterns to create your switches.

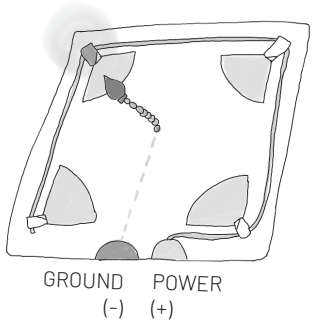
Fabric Push Button



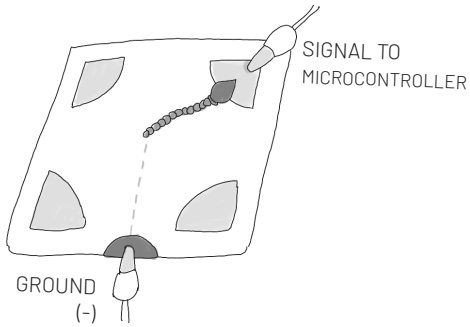
Textile Snap Switch

Tilt Switch

A conductive bead or pompom makes contact with conductive fabric patches based on its position. The metal bead is connected to ground via conductive thread that is insulated with beads. The patches are connected to power or pins on a microcontroller. When the bead makes contact with patch, it closes the circuit and allows electricity to flow.



The bead is connected to ground. The conductive fabric patches are connected to power. When the bead makes contact with the upper left patch, it closes the circuit and turns on the LED.



The bead is connected to ground. The conductive fabric patches are connected to microcontroller pins. When the bead makes contact with the upper right patch, it closes the circuit and sends the pin to high.

Design Your Own

These switches and patterns are good starting places, but the real fun lies in creating soft switches for your own projects! Games, wearables, installations, and more are all great design contexts for exploring the possibilities of soft switches. As you brainstorm, here are some questions to consider:

- What will the switch control in your interactive system? What action do you want people to take to complete a task?
- What is the intended output? Does it need to turn on only when it is activated? Or should it stay on consistently?
- Who will use it? What parts of their body will interact with the switch?
- What conductive materials do you have access to? What are your tools?
- How would you describe the look and feel you want to see? What materials would support that?
- Is there a particular emotion you want to evoke to support the interaction? How do you want someone to feel when they touch it?
- How big will it be? What is the scale? What is the shape or form? How do you see it fitting in with other components of your interface?
- How often will people use it? Do you need to account for people mashing it or will they be delicate? How easy or difficult should it be to open and close the switch?
- Where will it be used? What environmental elements do you need to account for?

Interfaces mediate how we interact with our world: knobs, handles, levers, pulleys, etc.Their forms, materials, and functionality are designed to be invisible, allowing us to silently glide through our routines and tasks. Switches are often the most overlooked, our fingers lazily flicking a light or unconsciously snapping on another device as we direct our attention elsewhere. The plastic feels familiar, the sonic feedback satisfying.

But how might our daily routines (and the stories that flow from them) tilt when our switch requires a gentle stroke over soft fibers or a playful smash into a pillow-sized controller. What might we gain from a conceptual and material rearrangement of this ubitquitous interface?

Much of this work is inspired by or adapted from work made by other members of the eTextile community, including eTextile Summer Camp and electronic textile camp. A special shout out to Kobakant for their ongoing commitment to joyful and open documentation practices.

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