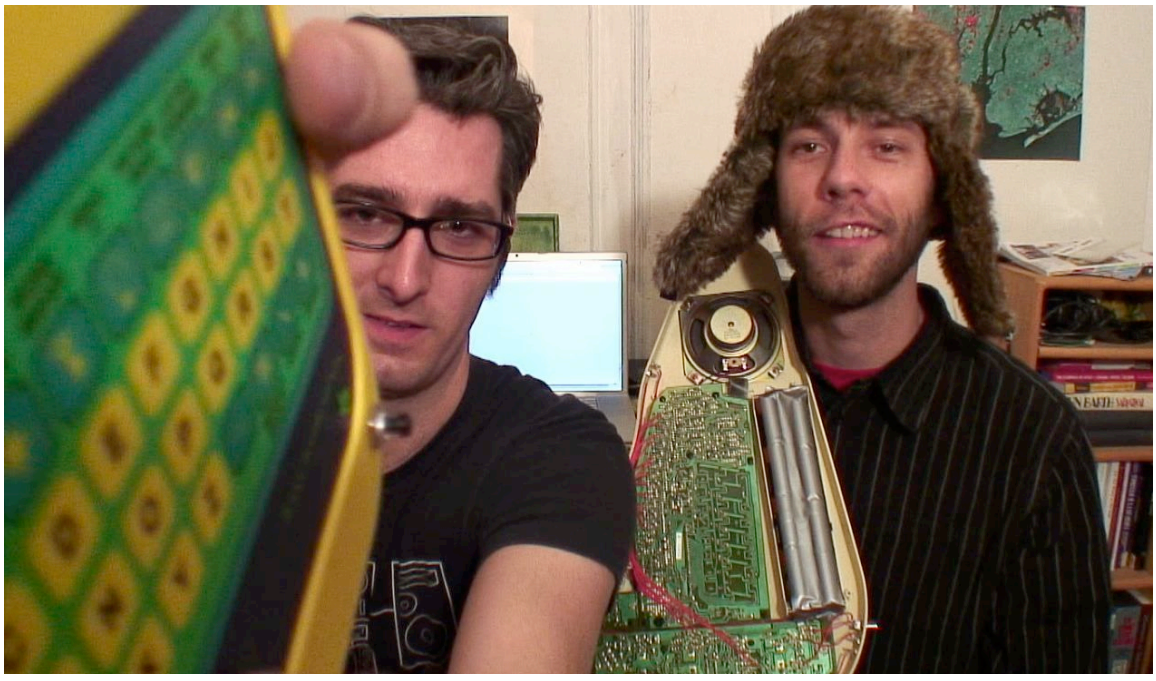
Circuit Bending: Speak and Read and Omnichord!

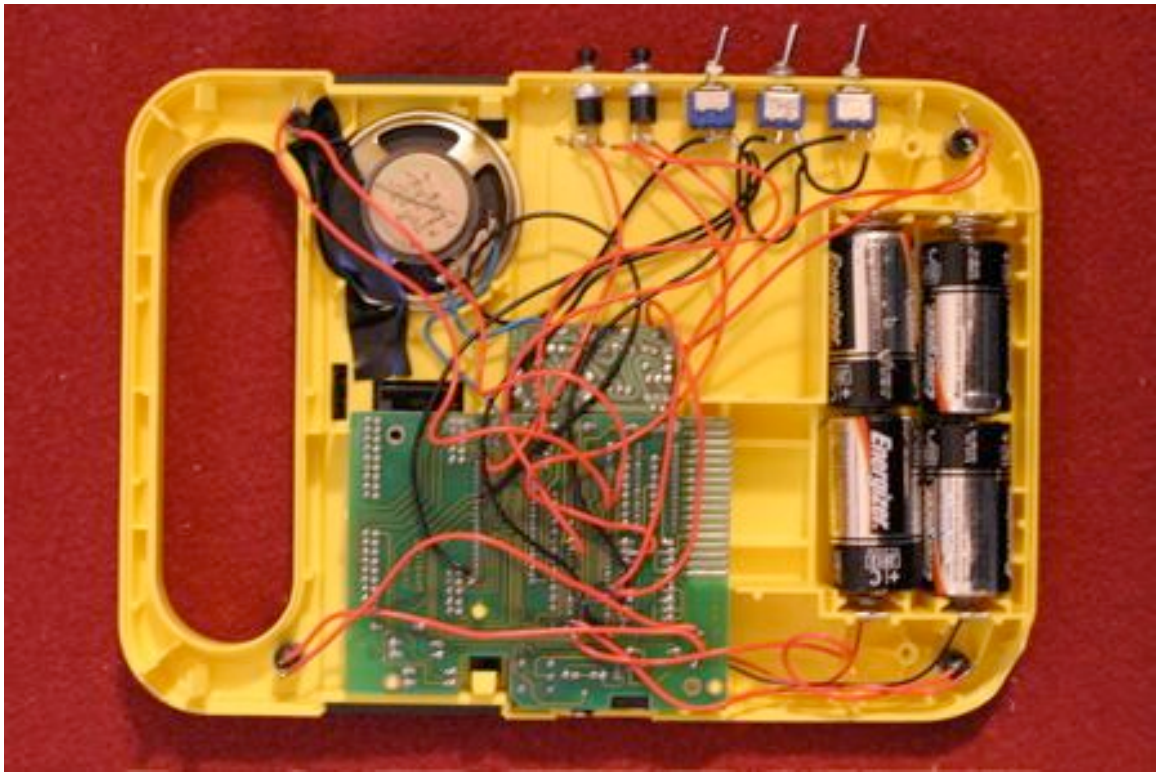
This week, I joined forces with Justin Gerardy and we had a circuit bending marathon! We bent up a Speak and Read, which is in the Speak and Spell family and added all sorts of glitches, bends, and loopers. Then we bent up an Omnichord, which is a synthesized autoharp from the 1980's. Here are the high rez photos, followed by an article written by Reed Ghazala that appeared online to accompany Make: 04 which had a focus on circuit bending.



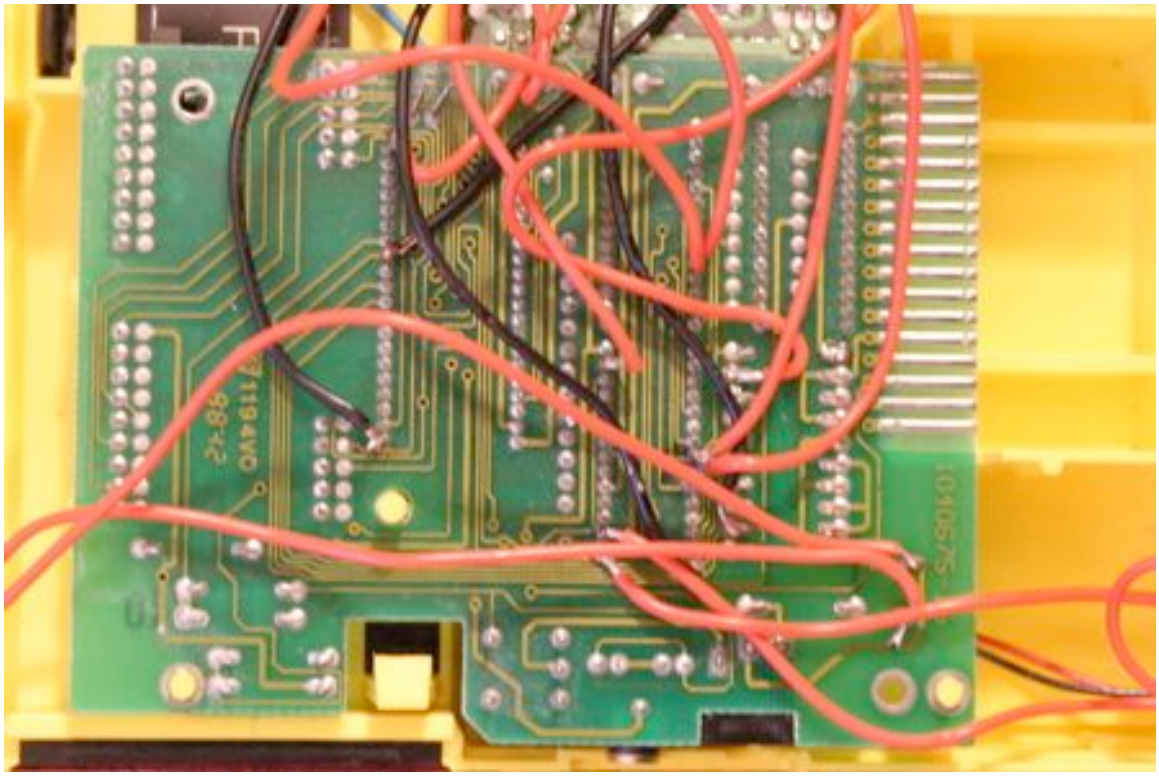
Besides the excellent article in Make: 04 about circuit bending a Casio Keyboard, Reed Ghazala also wrote an awesome book on Circuit Bending that goes into detail and should have a place on every circuit bender's bookshelf.

First my documentary photos of my tools, the Speak and Read and the Omnichord.

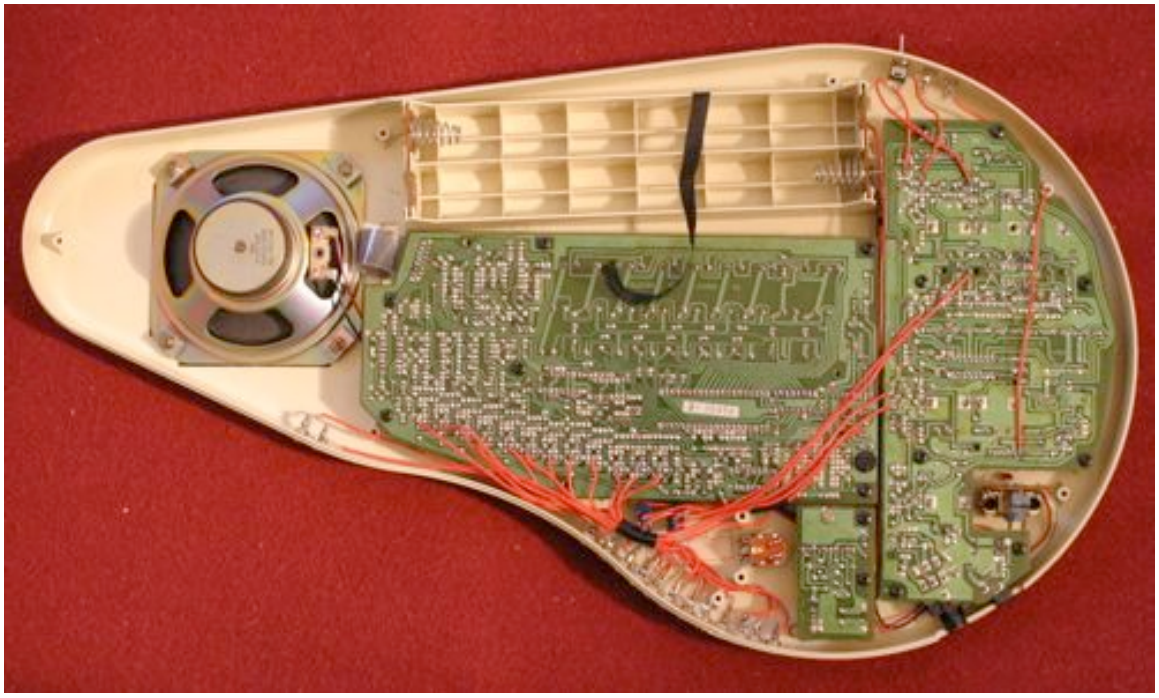
Here are the tools that I travel with when doing electronics projects. When I'm home, I have a fancier drill and a fancier soldering iron, but all of this stuff worked great.



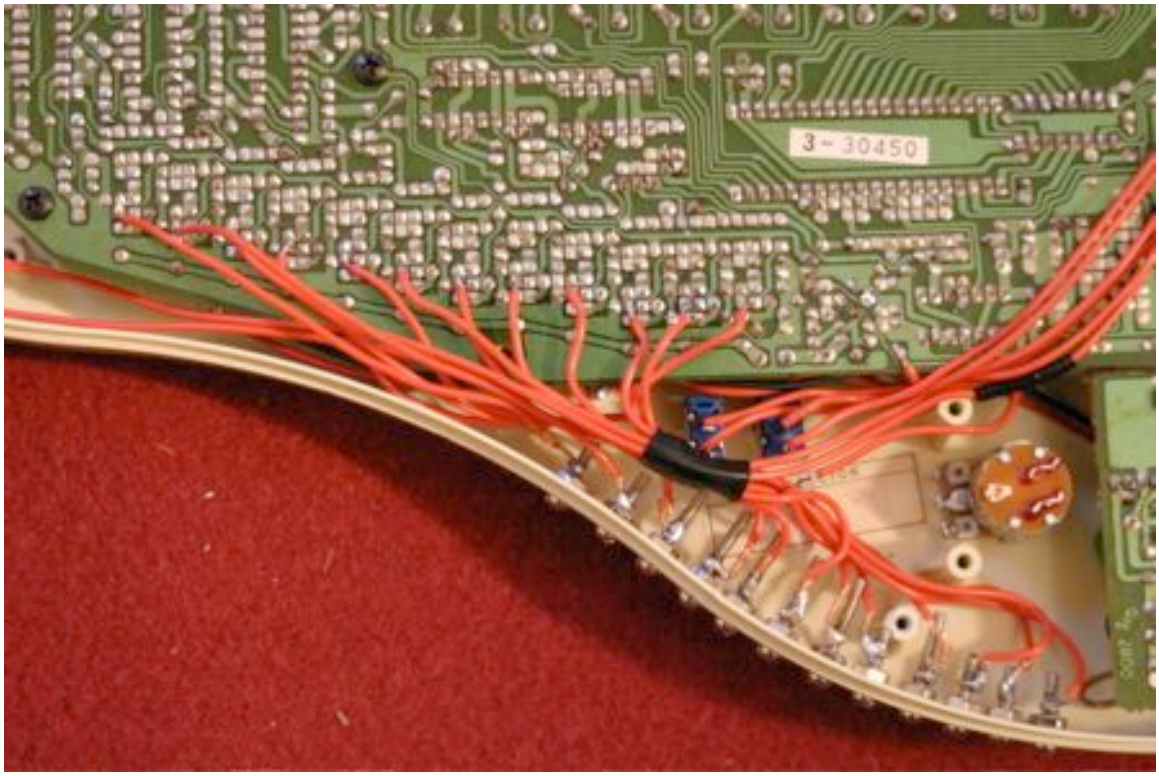
Here's the layout of the Speak and Read. You can see it's a bit of a mess.



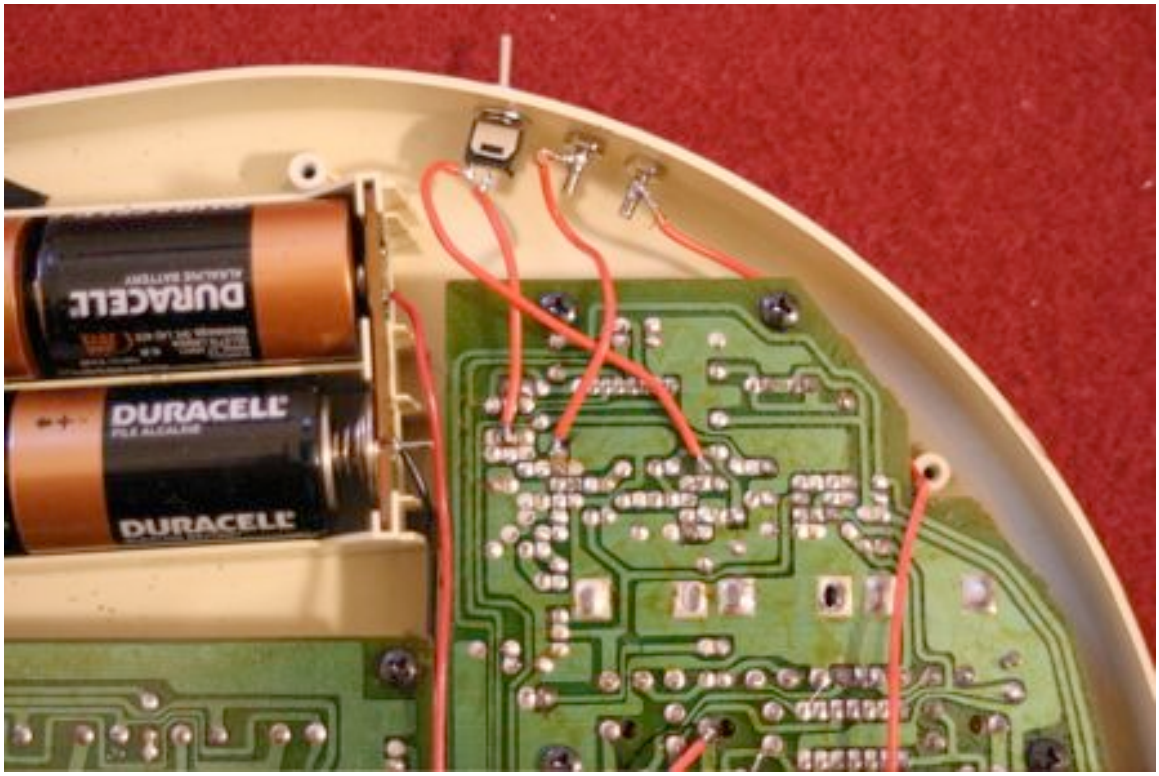
Despite being a mess, you can see which points we messed with and this will give you some places to start messing around.



Here is the omnichord layout. I'm confident that there are LOTS more places to add bends here. We installed a potentiometer, but I haven't found a use for it yet.



Here are the body contacts. When you touch one of these and another bolt on the top of the instrument, it plays single notes. If you touch more than one, you can make chords.



Circuit-Bending: Build an Incantor

by Reed Ghazala

Today, many musicians are forgoing the music store and heading straight to second-hand shops instead, spending pocket change, and leaving with electronic toys. By utilizing the anti-theory of circuit-bending, anyone can now creatively short-circuit an audio device and produce, in one easy evening, an experimental musical instrument that makes sounds that no one else has ever heard.

Circuit-bending is the act of placing a wire from anywhere to anywhere else on a circuit board and listening to the results. For safety, only do this with battery-powered devices; short-circuiting plug-in circuitry by hand can be harmful or fatal. But there are countless portable audio toys, old and new, that you can unlock to create bent instruments.

The following Incantor project uses a Speak & Read toy, from Texas Instruments' Speak & Spell series. The Speak & Read's wide vocabulary and hi-fi voice invite bending, and the toy has proven to be among the strongest examples of bending's potential, along with the other models in the series, the Speak & Spell and the Speak & Math.

But circuit-bending is about exploration, not about following a fixed recipe. All of the specific "bends" (short-circuit routes) in this project were discovered by chance, and are just good examples of what anyone can find by probing around on the circuit board themselves. So consider this Incantor project as nothing more than a guide, and remember that your own original discoveries are within easy reach.

You can listen to sample sounds from this Incantor at anti-theory.com/bentsound.

SET UP:
Parts

While I've listed RadioShack part numbers, better quality and prices are always available in surplus. Case in point: the RadioShack normally closed, miniature, push-button switch is deplorable (I've listed an alternate). Use the part numbers for cross-referencing surplus items wherever possible! And always buy in quantity when you find a good thing (I buy switches and the like by the hundreds if not thousands from surplus, sometimes by weight).

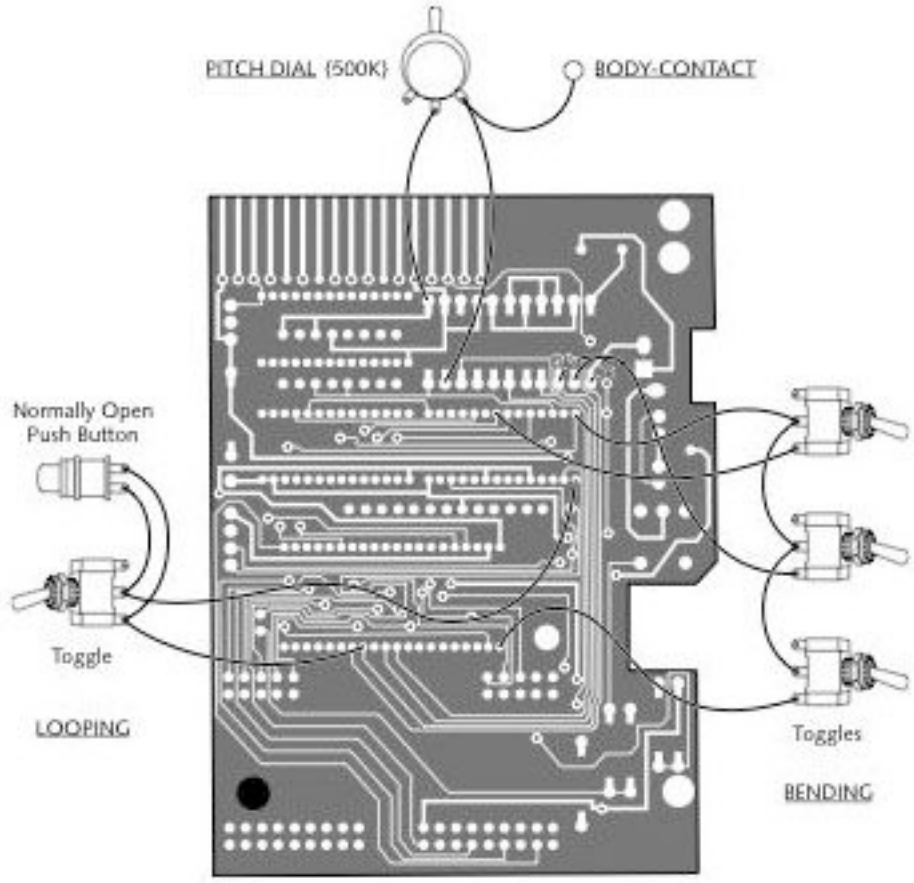
* Speak & Read talking game (search second-hand outlets, yard sales, and Ebay)
* Wire wrap wire (RS #278-501)
* Four mini toggle switches (RS #275-613)
* Sub-mini NO (normally open) push-button switch (RS #275-1547)
* Mini NC (normally closed) push-button switch (#GC 35-3458-- order by the dozen from Pembleton Electronics, fax: 260-484-0163… don't get the RadioShack version)
* Body contact with short matching bolt (Westinghouse part #70660, available in the lighting section of hardware stores)
* 8-inch wire with eyelet on the end (eyelet to fit body-contact bolt; make or buy where available)
* Mini (16mm) 500K potentiometer (part #R-VAM-500KA, from CE Distribution, cedist.com)

Tools

* Low watt (25-40W) soldering iron with tiny tip (I recommend using the Weller WTC 100 with the optional ST6 tip; the supplied tip is too large for the precision required in bending)
* Solder
* Wire clipper/stripper
* Small crescent wrenches
* Phillips or Torx screwdriver (depending upon your Speak & Read model)
* Small standard screwdriver
* Hobby drill with small spiral and burr bits
* Hand bore and de-burrer (optional but nice)

MAKE IT:

The wiring diagram for the Incantor (below) shows the Speak & Read's circuit board and one arrangement that works well for hooking up control components such as switches. You can build an Incantor by referring to this diagram, or vary the control placement.



Incantor wiring diagram (reprinted, with permission, from Circuit Bending, see below).

1. Open the case.

First, open your Speak & Read by removing the two screws on the back of the case (Phillips or Torx). Next, place your fingers inside the battery compartment to pry the halves apart while also prying the little tabs in the small rectangular holes back with a small screwdriver.

2. Remove the lens.

Pry the plastic display lens away from the front. You won't need it.

3. Mark the contacts.

Once you have the back off, mark all the spots on the circuit that wires will attach to (refer to the wiring diagram above). Don't worry if your circuit traces don't match those seen in the diagram. That's common, because Speak & Reads were manufactured with several board designs. But the overall layout of the components remained the same throughout production. What's important is that you identify the correct points on the diagram (mostly IC pins from the other side of the board), regardless of the printed circuit trace variations. So count the pins from the ends of their rows with care, and you'll be all right.

4. Drill the holes.

Drill the holes for your controls to mount into, in the front of the Speak & Read's case. I usually put the pitch dial and looping components on either side of the handle, the body contact at the edge of the case below the speaker, and the three bending toggles between the speaker and the display.

Be sure to allow clearance for the bending toggles as well as the two looping switches above the display. Hold all switches in position to be sure of placement; mark the positions on the plastic with a sharp pencil.

Using a 1/8" drill bit, and drill all pilot holes. Bring these holes up to component size with either a hand bore or the correct burr bit. (Remember that the body-contact hole is small--just the diameter of the bolt that threads into the contact itself).

5. Mount the controls.

Mount all controls onto the case. For the body-contact, thread the bolt through the eyelet wire, then through the case from the inside, and finally screw it into the body contact knob on the outside. Tighten all hardware well.

6. Wire the controls.

Fire up your soldering iron and use wire-wrap wire to connect the controls, as shown in the wiring diagram. For the reset button (not shown in diagram), splice into either one of the wires coming from the battery compartment, and solder in the normally closed pushbutton switch.

Note which soldering lugs are used on the potentiometer. Also, note that the middle of the three bending switches shown in the diagram connects to one of three possible neighboring points on the board. Try all three, and see which one results in the best bent behavior while also not interfering with the toy's standard start-up or game functions.

There's nothing tricky here, and no particular order in which you need to wire things. I tend to wire the common middle leads of the three bending toggle switches together first. Then I finish the rest of the bending set, the looping set, the pitch dial and body-contact, and finally the reset switch.

7. Close the case, and you're done!

USE IT:

Give your Incantor a test run!

1. Turn the pitch dial all the way up, and switch all toggles off.
2. Install fresh batteries.
3. Holding the batteries in, press the Speak's ON button. If all's gone well, you should hear the usual start-up sequence. If not, check that you didn't reverse the normally open and normally closed pushbuttons, and that you wired the pots and toggles correctly. You can diagnose these wiring problems by starting up the Speak while holding the reset button in, and with the pitch dial turned all the way down. Also, make sure the batteries are installed properly and making good contact. Once you hear the start-up sequence and the instrument is operating normally, you can proceed with testing.
4. Test the reset switch. Start using the toy, and press the reset switch while it is speaking to confirm power supply interruption.
5. Try all of the Speak & Read's game functions. While the Speak is in the middle of a routine, press and hold down the looping pushbutton. If it's in the right routine, the sounds should begin to loop. Press and hold again for another loop, restarting a game routine if necessary, should the Speak fall silent (or quickly hit the reset switch if the Speak crashes).
6. Once you hit a good loop, flip the looping toggle switch to lock that loop in place.
7. Try slowly turning the pitch dial down. Be careful when you see the display begin to shudder. This means you're at the bottom end of the pitch range and turning the dial further will result in a crash (or add a 500K trim pot to one wire, turned to just pre-crash, and the main dial will crash no more).
8. Last to test are the three bending switches. With pitch turned all the way up and the Speak doing one of its normal routines, try flipping one of the three bending switches. If nothing happens, try another of the Speak's routines. If you're on the right routine, the instrument should begin to

produce streams of wild sound elements, some lasting a little while, some going on and on. These switches should all produce similar disruptions, singly or in combination.

Bent instruments may be lead or solo instruments. Or they might be active in the background only, to create an alien ambiance for other instruments to perform within. A group of similar instruments might be created, considered like a "section" of the orchestra. Once a collection of bent instruments is completed, you may discover that you have the same range and timbres as covered by an orchestra! Composing an all-bent symphony for an alien orchestra seems unnaturally natural, doesn't it?

Because Incantors are new to the landscape, I'm really reluctant to peg their uses. Truth is, Incantors, like other aleatoric (chance) instruments, present phrases of music rather than the more traditional single notes, or pitches, that a standard instrument is designed to make. And this presents hurdles to traditional composition. So… think untraditionally, and see what happens. Anything goes!

Several illustrations in this article were borrowed from Ghazala's new book, Circuit-Bending, Build Your Own Alien Instruments, Wiley Press. The book outlines 20 step-by-step projects as well as everything you'll ever need to know to become a master bender. Available from wiley.com or amazon.com.

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