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FOREWORD BY
BRIAN DEWAN

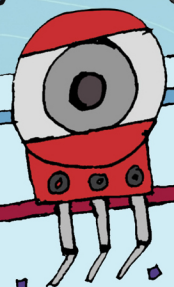


ELECTRONIC MUSIC

FROM SCRATCH

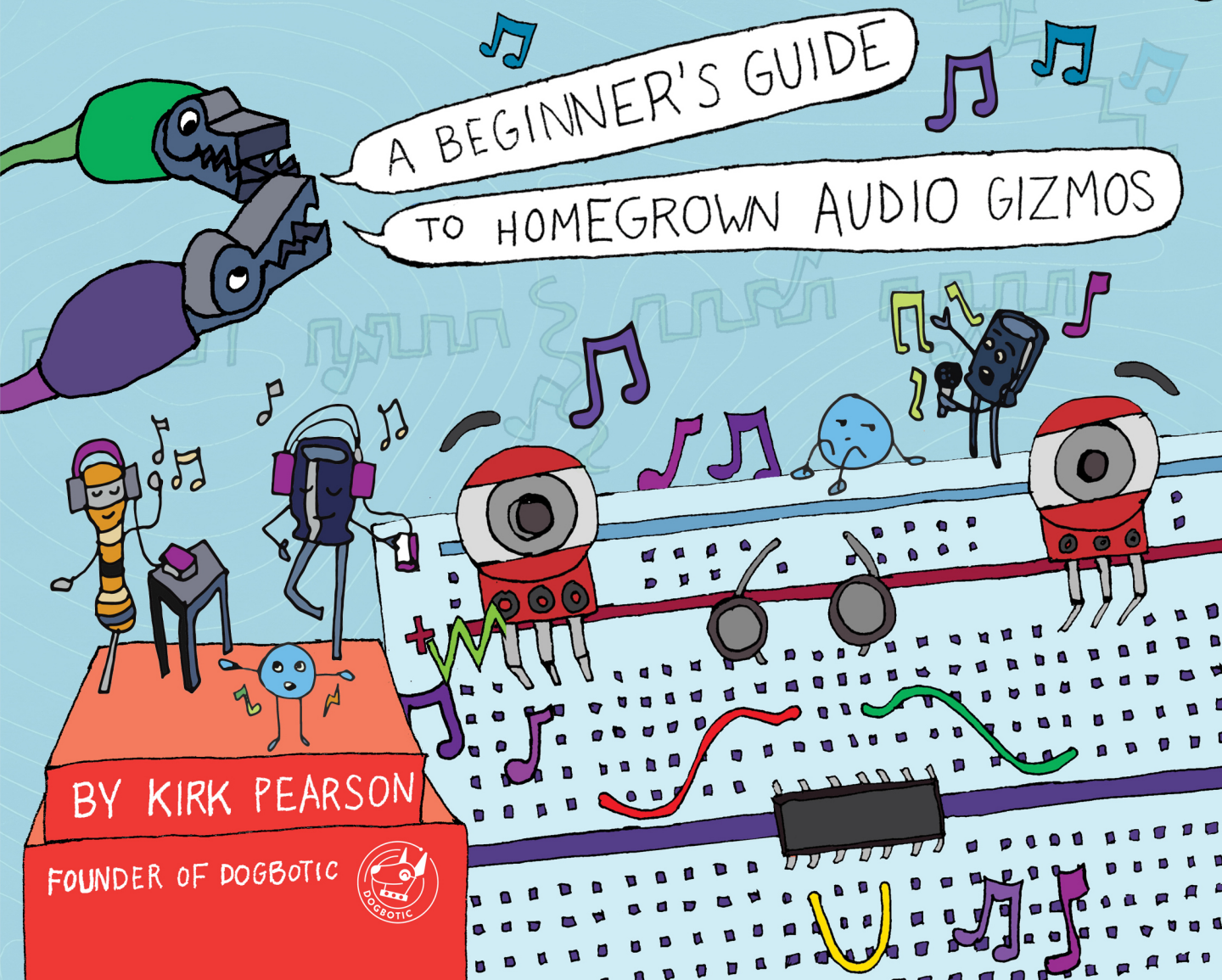
A BEGINNER'S GUIDE

TO HOMEGROWN AUDIO GIZMOS



BY KIRK PEARSON

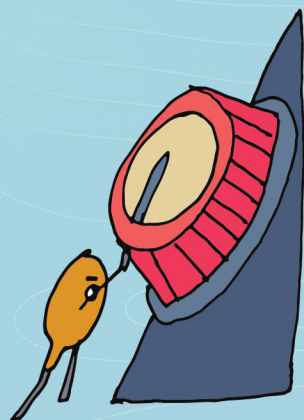
FOUNDER OF DOGBOTIC



Make: ELECTRONIC MUSIC FROM SCRATCH

Don't just play music—*make* music!

Make: Electronic Music from Scratch is a crash course in the joys of musical circuitry that teaches makers to become musicians, and musicians to become makers. Written for total beginners, this guide uses more than 40 hands-on experiments and projects to build whimsical, wild, and just plain weird gizmos, including:



- Fruit-controlled oscillators
- Analog filters (in many flavors)
- Sequencers that compose for themselves
- Talkboxes for robot impersonation
- Plate reverbs for cave impersonation
- Automatic harmonizing doohickeys
- Light-sensitive modulators
- Amplifiers to annoy your neighbors
- Drum machines to get you dancing
- ... and so much more!



Be warned: This is not a boring, inaccessible engineering book for academics! *Make: Electronic Music from Scratch* is a fun, humorous introduction to music for even the biggest electrophobes that teaches how to build real, usable instruments. With more than 400 full-color images and step-by-step instructions, this is the music book you've always wanted.

Prepare to discover sounds you never knew existed!

ILLUSTRATED BY MAISY BYERLY



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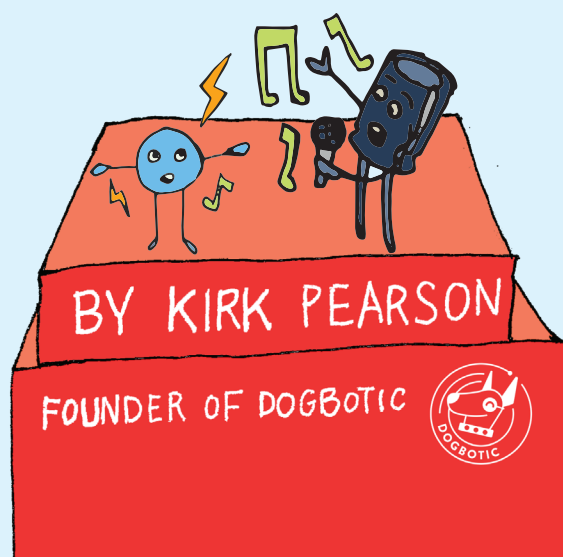
Make:

ELECTRONIC MUSIC

FROM SCRATCH

A Beginner's Guide to
Homegrown Audio Gizmos

Foreword by Brian Dewan



Make: **ELECTRONIC MUSIC FROM SCRATCH**

By Kirk Pearson

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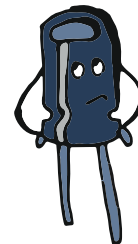
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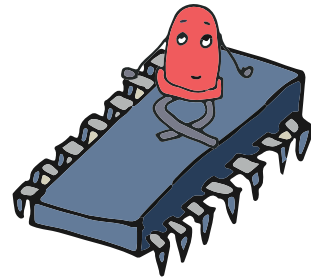
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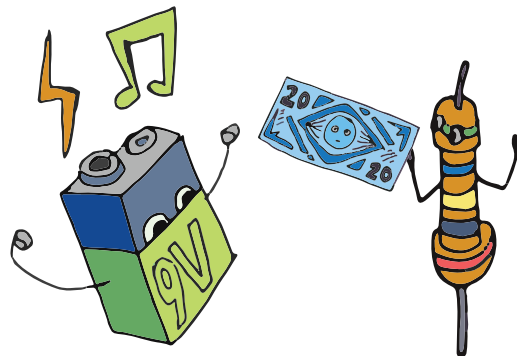
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FOREWORD

By BRIAN DEWAN

Popular Recreational Electronics

If it's not one thing it's another
And there's more'n one way to flip a pancake
Home made, home grown, made by hand
Which hand

You can splice tape with the whole family
In your garage
Helps to have a workbench
Upside down garbage can'll do

If you cob together
Electronic entrails
They'll wanna have a box or something
To put them in

Or a board
Or a few boards or trays
Stacked up
Like a theater organ

A body without a skeleton
Will slip and slide
Exoskeleton or regular skeleton
Will keep you out of trouble

A lunch box full of parts
Oscillators and small loudspeakers
Discreetly tucked away
In scenery for model railroads

Good luck, and have fun
Deploying the stuff you and your friends make
For exciting sonic purposes
Or other purposes

Back issues of *Electronaut* magazine
Loaded with nifty ideas and plans
For people who want to make
Their own TV set or test equipment

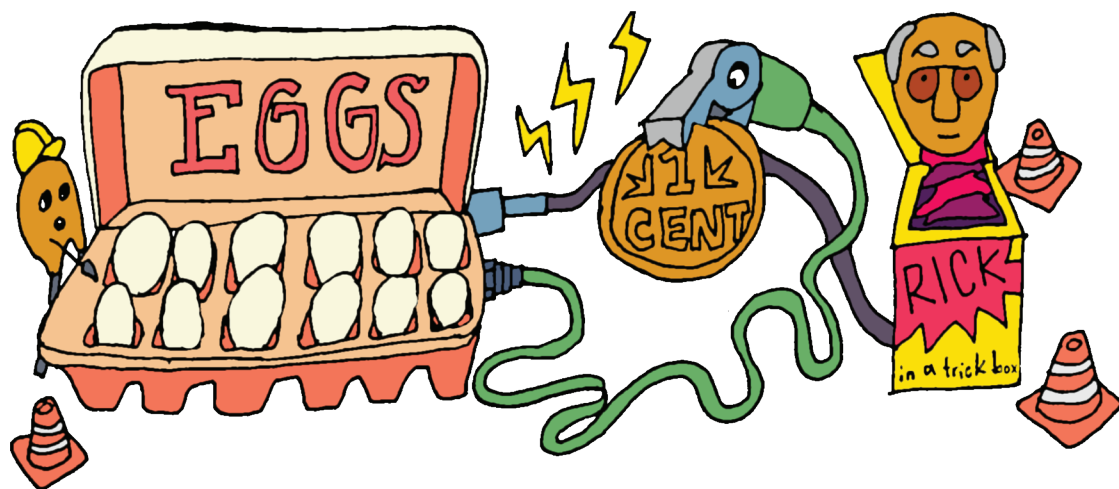
Radios, theremins, VCAs
VCOs, white noise, pink noise
Filters, impeters, and preventers
Frequency generating doodads

Unloved microphones
Put to good use once more
A splendid gift
For future generations

No one can stop you
Unless you're too loud
Unnecessarily loud
Enough to draw cops

But then they'll dig
The thing you concocted
Tell you to turn it down
And have a good night

Brian Dewan is a musician, inventor, instrument maker, and performance artist. He and his cousin Leon Dewan perform as the electronic music duo Dewanatron, and their original electronic music instruments have been displayed (and played) at the Armory International Art Fair in New York and Steve Allen Theater in Los Angeles. Their handmade Swarmatron instrument was used by Trent Reznor in the musical score of *The Social Network*. Brian lives in Catskill, New York.



Part

I

ELECTRONIC MUSIC
FUNDAMENTALS



You can draw the shape of a sound through electricity.

That's a simple but powerful statement! By creating a pattern of electrical flow, we can recreate any sound you've ever heard, or even make a sound that's never existed before. This discovery was met with enthusiasm by engineers and eccentric noise makers with equal vigor. Building electronic instruments is a great way to learn how sound works on a very technical level, a little like what a scientist does. It's also a great way to make really weird sounds that will perplex all your friends, a little like what an artist does.

The first section of this book is dedicated to understanding *what* electronic music is culturally and *how* it works scientifically. And though you don't really have to know what you're doing to make your way through this book, we think it's handy to understand the simple background of the social and scientific legacy you're now a part of. What are you going to make? And how are you going to use it?

The practice you're about to take part in has a rich history filled with characters that—in all seriousness—started out right where you are right now. The greatest innovations in electronic music were often birthed out of accidents—a lot of times by a person that only kinda-sorta knew how to use the equipment. Now, dear reader, it's your turn to join that history.

Which brings me to my first question: When did electronic music *begin*?



01

A PEOPLE'S HISTORY OF ELECTRONIC MUSIC



Nobody knows how old electronic music is.

Or, at least, that's what eleven-year-old me read on a webpage at some point in the mid-aughts. The page, Ishkur's Guide to Electronic Music 2.0, absolutely broke my mind as a child. It was a seemingly endless clickable timeline of electronic music history that jumped from genre to baffling genre. This glorious artifact of the Web 1.0 era eventually went the way of most electronic music: obsolescence. After Flash support was dropped in the mid-2010s, the webpage fell into disrepair, and eventually, linking to it resulted in a 404 error.¹ I will present Ishkur's argument as best as I can remember.

Humans have a great track record when it comes to doing amusing things their survival isn't contingent on. To learn the craft of electronic music is to learn the history of how people misuse existing technology for their own groovy benefits. To study electronic music is to study how people tinker with the world around them—how people reappropriate technologies, sounds, and interfaces to create something of cultural value. The aesthetics of electronic music are ever mutating, which is why it sounds quite different today than it did even thirty years ago. However, the approach and attitude toward electronic music are still the same.

If you're among our younger generations of readers, there's a nonzero chance you might think electronic music came of age in the late 1970s, which isn't the craziest thought. The 1980s were when electronic instruments were inexplicably pushed into the mainstream, suddenly becoming a symbol of popular culture itself. Bands that you might have heard of such as Devo, Kraftwerk, and Parliament somehow captured the popular imagination, turning a previously geeky subculture into something, dare I say, cool?

Programmable drum machines came into existence around then, too, and quickly replaced many a drummer by the decade's end. Another development in the '80s was the birth of MIDI, a fancy system that allows various electronic instruments to communicate with each other, even if they are built by different companies in different parts of the world.

But you, a distinguished and worldly reader, probably know electronic music came long before the '80s. In fact, there's a good chance you've heard of one Robert Moog, a brilliant engineer and synth pioneer who in the late 1960s created the first commercially successful synthesizer. Moog, though not a musician, became good buddies with keyboardist Wendy Carlos, who gave Moog practical suggestions on features that would make his instrument intuitively playable for traditionally educated musicians.

For the first time, you didn't have to have an engineer's mind to learn how to

1. A contemporary version of this website—albeit a less fun, less snarky version—exists. The original historical treasure, however, remains lost.



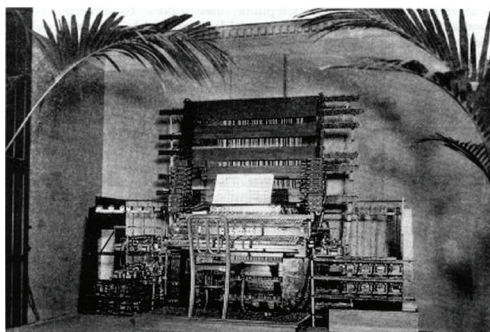
play electronic music—Moog and Carlos brought synthesis out of the lab and onto the pop charts. These instruments became so popular that *Moog* became synonymous with *synthesizer* throughout the early 1970s.

Oh, right, but then there was that curious Russian kid with an aptitude for the cello. Leon Theremin made his mark on the world through an instrument perfect for germaphobes. His 1920 invention, the theremin (what a narcissist), consists of two radio antennae positioned perpendicular to each other. They are proximity sensitive, allowing the performer to play it by waving their hands as if conducting a ghost orchestra. Typically, the left hand controls volume, while the right controls pitch. The theremin was an instant icon, somewhat thanks to its touch-free interface, but chiefly because the sounds it created were so dang *otherworldly* to people of the time. (Even Robert Moog got his start building theremin kits in his garage!)

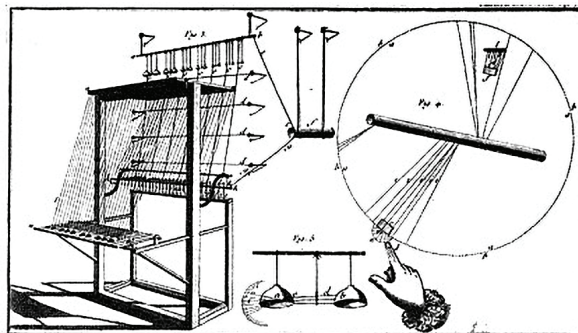
So, electronic music is about a hundred years old, then. We can't possibly go back further than this, right?

As it turns out, someone else got the jump on Theremin a good quarter-century prior. In 1835, the enterprising Thaddeus Cahill constructed an instrument that even I—a professional ridiculous person—will call truly ridiculous. The Telharmonium was a 200-ton colossus of spinning rods and wheels attached to a musical keyboard. As the keyboardist played, electric motors would spin huge shish kabobs of perforated metal disks. On the perimeter of each disk sat a ring of magnets. If you could spin those disks quickly enough, the changing magnetic fields would move fast enough to produce a musical tone.

Cahill's enterprising plan was to run wires all around New York City, connecting a centrally located Telharmonic Hall (we are not making



The Telharmonium console (hardly pocket-sized)



The clavécin électrique (a big hit at parties)

this up) to the houses of New York's wealthiest. The Telharmonium is, in no uncertain terms, an example of streaming media in the late nineteenth century. Unfortunately, the sheer number of wires crammed into such a small space proved too much to handle, as Telharmonium subscribers started to complain about crosstalk with other people's phone calls. Weighed down with the energy costs of operating a 700-watt instrument, the Telharmonium project shut down. No recordings of the Telharmonium were ever made, and the instrument itself was sold for scrap parts in the 1960s.

That's got to be the earliest artifact in electronic music history, right? Well, perhaps you're like my college professor, who claimed that electronic music was invented in 1760 by a priest named Jean-Baptiste Thillaie Delaborde. His gizmo, the *clavécin électrique* ("electric harpsichord"), consisted of several bells on rods that would shake when hooked up to a source of electric charge. Obviously, this wasn't the kind of instrument that would plug into a wall, but it did use static electricity to make a bell ring, so I guess there's something there. Right?

But wait—what about Gottfried Leibniz? In 1665, the brilliant German polymath demonstrated a wild machine called a *staffelwalze* ("stepped reckoner"): the first calculator that could do all of the four classic mathematical operations you know and love. This machine could play around with numeric data by representing numbers as mechanical components. While Leibniz probably didn't think of his creation as a musical invention, the ability to number-crunch on a machine with reproducible results was the first step in producing digital algorithms to produce ideas we could call "musical."

In fact, to hell with it all—electronic music was probably invented by some Cro-Magnon nerd who was struck by lightning and let out a scream that would have made Little Richard weep.

Electronic music is hard to pin down because it's not a very robust classification. "Electronic music" is a *phenomenally* stupid term. It says absolutely nothing about what the music sounds like, or even how it was created.

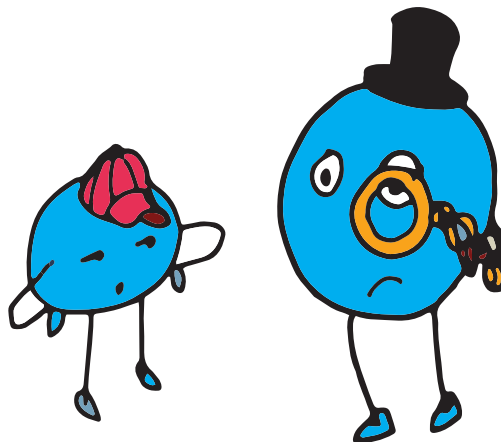
Almost all music today is amplified with electric microphones, and processed in ways that you can only do electronically. So isn't *everything you hear* nowadays electronic music?

Even worse, what about the term "music technology"? That's a confusing term because it takes two very hard-to-define concepts and throws them into a catch-all phrase. But it doesn't really tell you anything about what a person does to produce music. In fact, "music technology" mysteriously tends to conjure images of rich people. What comes to your mind? Academics? Corporations? People with knowledge that seems just out of grasp for the rest of us?

While "music technology" does very little to describe what an artist actually does, it succeeds wildly at something else: *excluding scores of people from believing they can participate in it*. The phrase has been weaponized to kick people out of an amorphous, exclusive club, a result that is of particular annoyance to us.

It's ironic that we don't call nylon a "dance technology", although wearing nylon fabric certainly allows dancers to do things they couldn't easily do before. Similarly, we don't tend to think of kids building paper-plate maracas as a technology. Truthfully, in music, there is little distinction between technique and technology. Each is simply a means of exploring a new frontier in your musical journey. We believe that a paper-plate maraca and an expensive 500-speaker diffusion array are equally serious experiments in music.

While we have not arrived at a perfect definition for "music technology," we've come up with one that serves us pretty well: Music technology is the act of finding musical applications for apparently nonmusical things. Banging on an empty tuna can is as much music technology as programming a fancy piece of sampling software, providing you've found a new way to bang on it.





NOBODY TRUSTS ELECTRONIC MUSIC

A unique trait of electronic music—and, especially, the types of instruments we’ll be building together to produce it—is that there’s no one right way to make it or to build the instruments. The violin hasn’t had any significant upgrades in several centuries, yet electronic instruments are *always* changing and being chained together in new ways. Adding a single filter or modulation source to an existing synthesizer can existentially change what that instrument is. Whole genres of music have been birthed into existence due to a small modification of something else.

There is, however, one thing all music technology has in common: people are skeptical of it. Every single innovation in music technology has resulted in the proverbial hurling of tomatoes, dating back to prehistory.

Consider the last time you heard someone say, “A DJ isn’t a real musician” or, “All electronic musicians do is push buttons onstage.” Next time you hear this, don’t curse the darkness. Just tell your confused friend that they are part of a long line of skeptics. The piano, when first invented, was derided as a simplistic button-pushing machine: how could a row of eighty-eight EZ-press buttons possibly compete with the artistic nuance of, say, the flute? More comically, I can promise you that when the first Neanderthal hollowed out a bone and blew into it, there was some schmuck behind them saying, “What a horrible replacement for the human voice,” and music innovators have suffered similar criticisms ever since.

Though I dislike the term “music technology,” the thing it (imperfectly) describes is always ahead of its time. If your music technology experiments aren’t pissing anyone off, you’re probably not doing them right. This posits something particularly exciting about electronic music: It’s *inherently political*. Every piece of electronic music—just through the act of calling it *music*—makes a statement on what music is and can be. It makes a statement on who (or what) a musician is, and who in that present moment has the privilege of being called a musician.

On that note, what does it mean to be human? Can a machine perform with a human? Is the human just controlling the machine, or is the machine leading the human? What’s the difference between an art object and an art-making device? For that matter, what is beauty, and when does it become noise? What does your definition say about your own biases and preferences? Every piece of electronic music poses these queries to an audience, and probably quite a few more. No matter what era you’re making music in, none of these

questions is trivial.

Creating your own instruments is an amazingly symbolic act. In some unwritten way, you're expanding the definition of music in order to accommodate your own work. Furthermore, you're building an original idea specifically to suit the need you're making it for. Every piece of technology ships free with its own technological code of conduct, which may or may not actually suit the end user's needs.

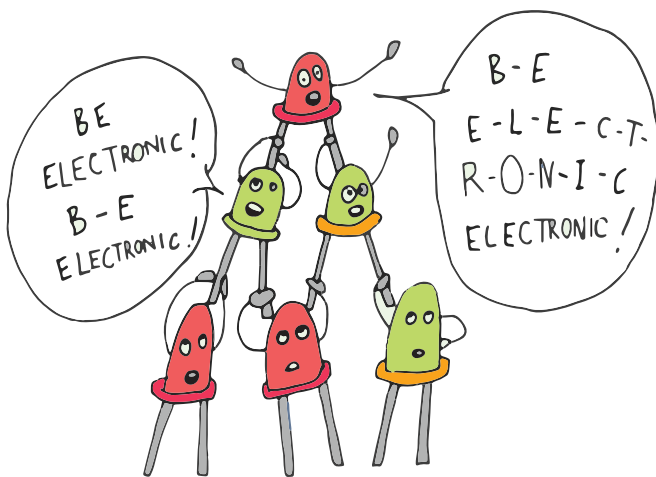
These days, you're not encouraged to figure out how products work. Devices are designed to be thrown away instead of repaired—often built so they cannot even be taken apart. In recent years, companies have been threatening to file copyright lawsuits against anyone who dares to take their own phone apart, because they could conceivably reverse-engineer it. Consider for a minute just how crazy you'd have to be to try to build something of your own in a world that really encourages you to *please not do that*.

SYNTHESIZERS AS PRODUCTS

Synthesizers aren't much better when it comes to the influence of corporate overlords. Since the early 1970s, companies have put a lot of effort into redefining synths foremost as *products*. Consider the image in your head! A synth is an expensive object made by a team of engineers, put together in an industrial factory, and shipped to wealthy, bespectacled hipsters named Klaus. This is an unfortunate stereotype—one that's been amplified for decades by countless great (and not-so-great) electronics companies. Fortunately, however, a synth does not have to be made in a factory by professionals, and you do not need to

rename yourself Klaus to build one.

The truth is that synthesizers are folk instruments played by normal, everyday people and have such a storied history that their inventors are almost always unknown. People tend to forget that for the first eighty years the term *synthesizer* was thrown around, there was practically no commercial market for them. Electronic instruments were seen as novelties—giant, complex toys that were considerably more a scientific marvel than a great-sounding instrument. For well over half a century, a synthesizer was a homemade, raucous, somewhat unpredictable instrument almost always made on a dining room table or



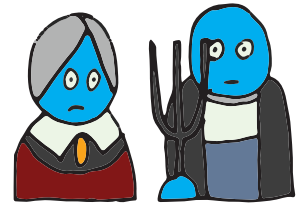


Adobe Stock-Ludovic

The ARP 2600 is a classic synthesizer, made and sold by a corporation. Not all synthesizers are like that.

in the shed of a budding amateur (such as yourself).

And to this day, synthesizers are *still* folk instruments. Go to any small town virtually anywhere in the world, and I promise you there's some eccentric character soldering capacitors in their spare time. Does this person build synths for convenience? Absolutely not. They make instruments because doing so is *awesome*.



Building your own electronic instrument can be a really empowering experience. If nothing else, it's a fresh reminder that the Korgs and Rolands and Teenage Engineerings of the world, while well budgeted, are hardly the arbiters of new sounds. With surprisingly little up-front learning, you'll have the godlike ability to conjure new sounds out of nowhere—sounds that no preset can make. Better yet, you'll have the knowledge that unless someone else has constructed a circuit exactly like yours, with the exact nuances of the parts you grabbed and stuck together, you'll have the world's only copy of that synthesizer. And that's really cool.