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A Brief History of the 'Backwards Electric Guitar'
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Background

As a kid nurtured on the Pop music of the 1960s who drifted into “serious” music in high school, I felt not entirely at ease trying to root my composition within the confines of the Western European canon. Hearing Alvin Lucier’s *I am sitting in a room*¹ for the first time, in his course I took my first year at Wesleyan, was a transformative experience. Here was music that took as its subject matter not the accumulated wisdom of a few centuries of titans, but rather the very physical reality of sound. As the son of two architectural historians, I was strongly affected by the fact that the piece made music out of architectural acoustics. Smitten by *I am sitting in a room* and related works that Lucier played that year (his *Vespers*², Gordon Mumma’s *Hornpipe*³, David Behrman’s *Wavetrain*⁴), I started using audio feedback as a tool for articulating the acoustical properties of rooms, culverts, tables, wind and brass instruments⁵.

I got around to string acoustics toward the end of my undergraduate days. In 1976 I created my first audio installation piece, *Under The Sun – A Pythagorean Experiment*: a long steel wire is stretched across a room at an incline; a solenoid taps the wire every few seconds; a small loop of Teflon is hung from the wire, and jiggles down the incline a few centimeters with each jolt from the solenoid; the resulting boinging sound is picked up and amplified through a speaker; as the Teflon loop shifts down the wire it reveals a changing series of overtones, much like a violinist or guitarist does by resting a finger very lightly on a string to elicit a harmonic. I exhibited this piece several times during the course of the year I spent in Europe after college (1976-77) as a Thomas J. Watson Fellow (Centre Culturel Américain in Paris, Spectro Arts Workshop in Newcastle, Butler’s Wharf in London).

The First Instruments

Moving back to New York in 1980 I was belatedly struck by the realization that the electric guitar could be the perfect instrument to combine my Pop roots with my interest in acoustic experimentation, wrapped up in a package appropriate to the burgeoning “New Wave” club scene (much as Rhys Chatham had been inspired in 1978 to write *Guitar Trio*⁶ as a way to extend his work with LaMonte Young to the bar stage.) I built my first “backwards electric guitar” the next year. The premise was simple: reasoning that speakers and dynamic microphones displayed a certain symmetry (one can sing into a headphone earpiece if a microphone is not at hand, and many a PA engineer has used an SM57 mike as an emergency earphone for monitoring), I connected the pickup on a cheap pawnshop guitar to the *output* of a small amplifier. Sure enough, the pickups electromagnetically induced the strings to vibrate slightly in response to a radio plugged into the amplifier. I wedged piezo discs under the guitar’s bridge to pick up the string vibrations, and connected these to my sound system.

The result was similar to shouting into a grand piano while holding down the sustain pedal: an ethereal wash of overtones within which one could hear elements of the original sound. The guitar combined characteristics of a spring reverb (in the way that it sustain sounds) and a six-band resonant filter or vocoder whose pitching was a function of the strings' tuning, within which there always lurked an essential "stringiness." Some sounds remained quite identifiable through the string processing, while others were rendered completely unintelligible. The transformation of speech was particularly vivid – the guitar seemed to talk. By fretting and damping the strings one could manipulate the sound processing. Alligator clips clamped to the strings yielded gamelan-style sounds. Post-processing of the guitar output by typical rock effects such as distortion served to emphasize the overtones. The backwards guitar took a range of sound processing – some of it familiar, some of it quite novel for the time (this was before Digital Signal Processing became commonplace) – and shifted its control from the knobs and faders of a traditional synthesizer to the domain of guitarist's technique; it made for a more playable, more visceral instrument. And it looked cool on stage.

Vibrating strings electromagnetically has its antecedent in the EBow (invented in 1967, and first marketed in 1976), which utilizes pickup and driver coils embedded together in a small handheld device to set up a feedback loop that drives a string at its resonant frequency with an attack-free bowing sound (hence its name.)⁷ More recently, the Fernandes company has marketed "Sustainer" guitars and after-market kits which produce a similar effect across all six strings.⁸ (Both of these techniques have their roots, in turn, in the Behrman composition *Wavetrain* -- mentioned earlier – in which piano strings are resonated by feedback between loose guitar pickups lying on the strings and guitar amplifiers underneath the piano. But I doubt the developers of either product were aware of Behrman's work.) My goal, however, was not to elicit "pure" string tones, but to inject outside sounds into the strings in pursuit of unusual, performable analog signal processing.

In the first piece I wrote for this instrument, *Killed In A Bar When He Was Only Three*⁹, the guitarist presses switches on the pickguard to call up different sounds to drive the strings: a scanning radio whose station he can change; six drumming panda bears. He uses his left hand to change the filtering and sustain of these sources. Robert Poss, later of Band of Susans fame, premiered this piece at The Kitchen in 1982; later that year I performed it on the stage of CBGBs, opening for Rhys Chatham.

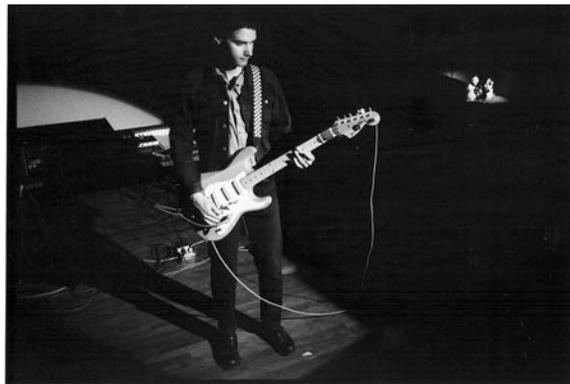


Figure 1: Robert Poss performs *Killed In A Bar When He Was Only Three* at The Kitchen, NYC, 1982.

I created an audio installation (*Killed In A Bar*, 1982) using similar technology: a guitar hung on the wall with two transistor radios, each tuned to a different station and connected to one of the two pickups. An electric clock motor turned a cam that moved the whammy bar in and out, causing the pitch of the filtering to sweep up and down in a slightly queasy manner. This was first shown in "Sound Corridor", an early exhibition of Sound Art curated by William Hellermann at PS1 in Long Island City. A multi-guitar variant was installed in the steam rooms of the legendary empty swimming pool at Media Study Buffalo in 1983¹⁰.

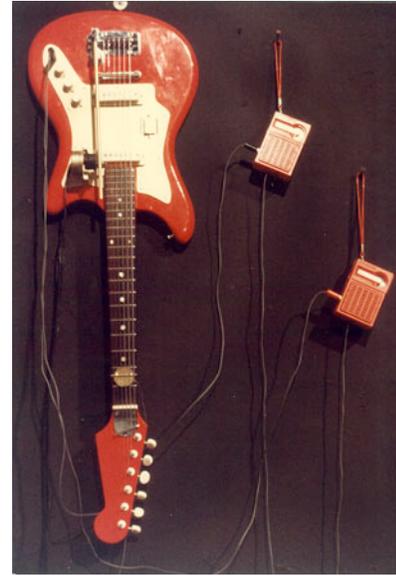


Figure 2: Installation of *Killed In A Bar* at PS1, NYC, 1982.



Figure 3: Installation of *A Clearing of Deadness At One Hoarse Pool*, Media Study Buffalo, 1983.

I built a backwards bass and another guitar and formed a band. Via a computer-controlled matrix switcher the players could call up a range of driving signals, from radios and prepared cassette tapes, to microphones into which they could talk or sing. The major piece done with this group was *A Letter From My Uncle* (1984).¹¹



Figure 4: Susan Lyall, Robert Poss and Susan Tallman rehearse *A Letter From My Uncle*, Airshaft Studio, NYC, 1983.

Second Generation

My technology was pretty crude. I inserted an output transformer wired backwards between a low-power (1 watt) amplifier and the pickup, which boosted the output signal from less than 1 volt peak-to-peak to around 100 volts (albeit at miniscule, harmless current) and optimized the coupling of the amplifier to the high-impedance of the guitar pickup.¹² This trick, which I learned from Ralph Jones (in David Tudor's "Composers Inside Electronics"

ensemble) increased the strength of the string vibration, but they were still much quieter than when strummed -- if a player's hand brushed against the strings by accident the ensuing racket was pretty deafening. In pursuit of a more efficient energy transfer I looked for electromagnetic coils whose impedance was closer to that of an ordinary speaker (8 ohms) than that of a guitar pickup (c. 200 ohms.) I found some relays whose coils fit the specification: fed directly from a 10-watt amplifier chip (meant for car radios), with no need for the transformer, the relay coil induced a strong vibration in the nearest string.

I began designing a new instrument for me to use as a soloist. I had grown tired of schlepping a guitar case in addition to my usual heavy suitcase of electronics. Moreover, having never been a "proper" guitarist, I was not entirely comfortable slinging one on stage (hence my preference for hiring rock musicians like Poss.) A tabletop instrument seemed attractive, since it would make it easier for me to wrangle all the other electronics connected to the guitar, so I bought a lap-steel Hawaiian guitar short enough to fit in a suitcase.¹³



Figure 5: Backwards Hawaiian guitar, 1987.

Initially I played the instrument with a single relay coil that I passed over the various strings with my right hand as I worked the slide with my left. The first piece I performed with this instrument was *Pet Sounds* (1987).¹⁴ But the handheld coil required was a delicate technique that took a lot of concentration (making it difficult for me to do any additional electronic manipulations) and it was often interrupted by as noisy clang as I slipped and bumped the coil against a string. On the other hand, the relay coils were small enough that a separate one could be permanently mounted above or below each string. I built a fingerlike contraption that positioned the coils very precisely over the strings. By connecting each coil to a separate amplifier I could route different signals to resonate different strings without fear of unruly crashes. I also found a commercially available guitar bridge that

incorporated an individual piezo element in each saddle, giving me a separate *output* from each string as well; I mixed the six strings down to stereo, panning adjacent strings to opposite channels. This yielded a rich, enveloping stereo image.

Thus outfitted, the Oahu became the central instrument in *It Was A Dark And Stormy Night* (1990)¹⁵, a large work for spoken word, electronics and small ensemble. The piece begins with a recitation of the old shaggy dog story ("It was a dark and stormy night. We were all seated around the campfire. Mary turned to John and said, "John, tell us a story!" And John proceeded as follows: "it was a dark and stormy night...") The first iteration is sent to resonate the "G" (IV) string, the next to the "D" (III), then the "A" and then "E", creating a descending

pitch cycle that is repeated to become the core musical form of the piece, elaborated by a number of other instruments. I creates subsequent solo works that incorporated elements of the ensemble piece: spoken word, birdcalls, drum machine and trumpet drive the strings in *Sound For Picture (1992)*¹⁶; a glissandoing oscillator does the job in *Lightning Strikes Not Once But Twice (1993)*¹⁷; in *Mortal Coil (2002)*¹⁸ feedback between coils on my fingertips and the drivers on the guitar create Theremin-like sliding pitches that seem to “overblow” the string harmonics like one might play a bugle.

The Level Guitar

Glenn Branca notwithstanding, the Hawaiian guitar is not a terribly popular instrument in avant garde circles. Yet one night in Germany in 2001 I found myself sharing a bill with an old friend, Ed Osborn, who was playing the same instrument. Ed is also a Formula 1 racing fanatic. In the bar after the concert that night he was lamenting the weight in wood that we both had to carry: “we should be able to make a lighter Hawaiian guitar with a space-frame chassis, like a race car.” This idea was doubly attractive to me, since I figured I could pack the amplifiers and other electronics inside the open chassis.

Back home in suburban Chicago I bought two cheap levels and some sheet aluminum at Home Depot. After a few weeks of drilling and soldering I had a fully loaded Hawaiian guitar that could still double as a level (at Robert Poss’ suggestion I illuminated the bubble with a pair of bright LEDs.) I mounted the driver coils under the strings on rails, so they could be slid along the strings to shift the overtone balance (similar to the way guitarists shift their picking position to emphasize different harmonics.) This is the loudest (and possibly scariest) backwards guitar I’ve built to date.

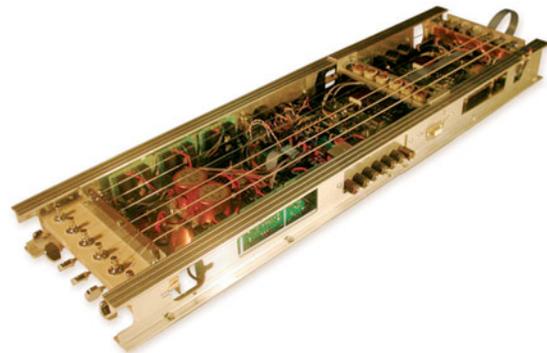


Figure 6: Level Guitar, 2002.

Interest in string transduction has grown in the past few years. In 2005 Edgar Berdahl, Steven Back and Julius O. Smith at the Center for Computer Music research and Acoustics (CCRMA) at Stanford University began developing an electromagnetic driver system similar to mine for the purpose of resonating piano strings with external signals¹⁹. The EBow continues to sell, and – as mentioned above – Fernandes recently introduced a multi-string variant on the same technology.

Related Installation Pieces

At the same time that I was developing the backwards guitars as performance instrument I created a series of installation pieces based on similar interests. After the self-playing guitar of *Killed In A Bar* I returned to the single long string of *Under the Sun* with *Under The Sun II* in 1986. I stretched a steel wire over a length of HO train track, and rigged a mechanism to the reciprocating rod of the locomotive's piston so that the train plucked and banged the wire as it moved. Trundling down the track, the train played overtones of the wire the way a guitarist does by picking at different locations on the string (see Rhys Chatham's aforementioned *Guitar Trio*); the train auto-reversed at each end. The piece was first exhibited at the "Soundwave" show at the City Gallery in New York, and subsequently at Het Apollohuis in Eindhoven (NL) and the So & So Festival in Amsterdam.



Figure 7: *Under The Sun II*, Het Apollohuis, 1987.

For the Sonambiente Festival in Berlin in 1996 I built a variation, *When John Henry Was A Little Baby*, for exhibition in an old single-lane bowling alley: two parallel tracks (in the large scale used by Märklin) ran the length of the tunnel-shaped room, with a wire above each; the pantograph on each engine (I chose model streetcars) scraped the wire above it; each wire was highly amplified and distorted through a Marshall amplifier at one end of the tunnel; the scraping pantographs produced a wonderful racket (like dragging a pick along a string), and every time an engine came to a halt a harmonic rang out. The audience could control the movement of the auto-reversing trains from the opposite end of the tunnel from the amplifiers.

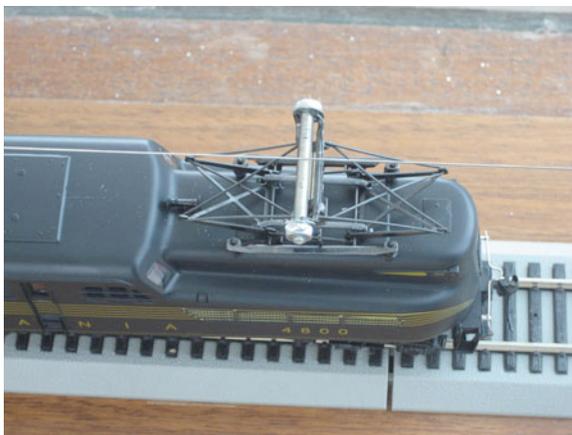


Figure 8: *When John Henry Was A Little Baby*, Le Havre Biennale, France, 2008.

In 2008 I produced a single-track HO scale update of the piece for the LeHavre Biennale.²⁰ The engine had a thin bolt attached across the pantograph. The wire ran at a slight diagonal to the track, so that as the train moved the wire slipped from one groove in the bolt to the next, plucking the wire. The installation turned on with an infrared motion detector whenever a visitor, and the engine auto-reversed at either end.



Figure 9: Figure 9: When John Henry Was A Little Baby, Le Havre Biennale, France, 2008.

¹ Alvin Lucier, *I am sitting in a room*. Lovely Music, 1990

² On Alvin Lucier, *Vespers and Other Early Works*. New World Records, 2002.

³ On Gordon Mumma, *Live Electronic Music*. Tzadik CD, 2002

⁴ On David Behrman, *Wavetrain*, Alga Marghen CD, 1998.

⁵ For more information on my work with feedback see Nicolas Collins, "All This And Brains Too – Thirty Years of Howling Round." *Resonance Magazine*, Vol. 9 No. 2 (2002). Available at

<http://www.nicolascollins.com/texts/allthisandbrains.pdf>.

⁶ On Rhys Chatham, *Die Donnergotter*. Table of the Elements CD, 2006.

⁷ See <http://www.ebow.com/home.php>.

⁸ See <http://www.fernandesguitars.com/sustainer.html>.

⁹ On Nicolas Collins and Ron Kuivila, *Going Out With Slow Smoke*. Lovely Music LP, 1982.

¹⁰ *A Clearing of Deadness at One Hoarse Pool*, a tape composition based on recordings of this installation, can be heard on Nicolas Collins, *Let The State Make The Selection*, Lovely Music LP, 1984.

¹¹ On Nicolas Collins, *Let The State Make The Selection*, Lovely Music LP, 1984.

¹² The technique of the backwards output transformer is described in detail in Nicolas Collins, *Handmade Electronic Music – The Art of Hardware Hacking* (expanded second editions). Routledge, 2009, pp. 45-50.

¹³ When I had been collecting cheap instruments for the first generation of backwards electric guitars I had visited the pawnshops that were still prevalent in New York (mostly along the seedier stretches of 8th avenue), and I was struck by the large number of Hawaiian guitars that hung from their ceilings -- way out of proportion to the amount of Hawaiian music I heard around the city. But now my sweep of the pawnshops yielded nary a one. At the last stop I commented on this and the proprietor mentioned that "some guy named 'Glenn'" had come through a few weeks earlier and bought them all – at this time Glenn Branca was

preparing one of his early “symphonies” for massed electric guitars, and had bought all the Hawaiian guitars he could find to use as sort of electric hammer dulcimers. Just my luck. So I started calling used instrument stores around the country (this was long before the internet.) Elderly Instruments in Lansing, MI came through with a \$50- Oahu in what they dubbed a “mother of toilet seat” finish.

¹⁴ On Robert Poss and Nicolas Collins, *Inverse Guitar*. Trace Elements cassette, 1988.

¹⁵ On Nicolas Collins, *It Was A Dark And Stormy Night*. Trace Elements CD, 1992.

¹⁶ On Nicolas Collins, *Sound Without Picture*. Periplum CD, 1999.

¹⁷ Ibid.

¹⁸ Unreleased as of writing, can be heard at <http://www.nicolascollins.com/otherrecs.htm>.

¹⁹ See their paper “If I Had A Hammer: Design And Theory Of An Electromagnetically-Prepared Piano”, delivered at ICMC 2005. Available at http://ccrma.stanford.edu/~sbacker/empp/berdahl_backer.pdf.

²⁰ See video documentation at <http://www.nicolascollins.com/johnhenry.htm> or <http://www.youtube.com/watch?v=F3AB4hWJyg0>.