CLIP ART
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Sound examples and photographs related to this article are available at <www.philarcher.net>.

I was initially unsure whether these glorified strips of wire were worthy of the title “gizmo,” but my reliance on them in my work outweighed any doubts in the end. The “crocodile clip” or “alligator clip” is possibly one of the most useful and elemental pieces of equipment in my toolbox, employed in various ways during the creation of a work.

My practice is heavily centered on circuit-bending and hardware hacking—the creative modification and appropriation of existing objects to entice the unexpected from the familiar. In such hands-on electronics, the ability to make and break connections between components quickly and easily is crucial; this is something crocodile clips are very good for.

When building (admittedly very simple) circuits from scratch, I instinctively prefer to employ a Peter Vogel [1] approach, in which components are soldered together directly, bypassing any breadboard or circuit board. Moving all the necessary components from breadboard to circuit board has always seemed too much like hard work, and I worry that my euphoria at creating a working circuit will cause a lapse in concentration as I attempt to rebuild it.

Instead, in the prototyping and testing stage of construction, crocodile clips hold all the elements in place, often gripping multiple components in their maw. Elements can be exchanged, points can be bridged and even entire separate circuits integrated in a snap. These works in progress are fragile and ephemeral constructions, relying on the strength of springs rather than copper tracks to preserve them from collapse.

It is always with a slight sense of sadness (and trepidation) that the clips are removed one by one and the connections soldered. Even at this stage, a set of crocodile clips has its uses. Does a connection need to be held in place while it is soldered? Use crocodile clips. Are components getting too hot for the fingers? Use crocodile clips. Also, when it is time to record the new creation for posterity and that minijack-to-XLR converter cannot be found—break out the crocodile clips and connect them directly.

Circuit-bending requires a similar flexibility—whether in exploring the circuit board in a live performance or searching for bends to permanently build into the device, a crocodile clip or two make useful hunting companions. Once one set of jaws has clamped itself around the leg of a chip, the other head is free to roam (clasping a resistor between its teeth if one is not feeling too reckless), tracking down other interesting points to bridge.

As interrelationships are formed among homemade circuitry, modified consumer electronics and end users, these qualities of flexibility, ephemeral-
ity and fragility also permeate the work produced. A hardware-hacking, circuit-bending approach to music brings with it the realization that no connection, circuit or object is monolithic; nothing is ever “finished” or too sacred to be reworked or incorporated into another system. Any component could easily be connected to any other component, any circuit to another circuit; everything becomes a potential element in a network of new configurations and relationships.

Note
1. Peter Vogel is a pioneer of interactive sculptural electronics whose works emphasize the aesthetic qualities of electronic components and circuits.

Phil Archer completed a Ph.D. in composition at the University of East Anglia in 2004 and is currently working at the Norwich School of Art and Design. His main areas of interest are circuit-bending and hardware hacking, the creation of electro-mechanical musical instruments and interfaces, and the use of these in live performance situations.

Audio Y Connectors: My Secret for Instant Guerrilla Oscillators, Raw Synthesis and Dirty Cross Modulations

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Perhaps I am overly enthusiastic about audio Y connectors, but I have realized that nearly all my performance and research over the last 5 years has been made possible because of them. It is not that I think they are aesthetically pleasing in themselves, even though I have a small collection on every desktop, shelf and workbench in my home and studio. Some have been lying around since the 1980s, when I used to try and squeeze as much action as I could from a few cheap pieces of music technology. Now I use lots of them, as the core configuration element in creating instant non-linear performance instruments and processors that exploit electronic feedback.

Live electronics entered an exciting post-digital phase with the possibilities created by the mixing and matching of any era or technology of audio equipment to create unique modular performance environments. Both live electronics and the use of electronic feedback have received much renewed interest over recent years. For many in the field, the proliferation of cheap audio hardware devices and the potential sonic complexities found in multi-processor DSP chips have opened new possibilities. With the use of cheap molded plastic Y connectors, I have rejuvenated and reinvented just about all my studio equipment new and old and accessed a rich interactive relationship with the resulting electronic feedback.

By wrongly wiring any piece of audio hardware, a sometimes-vast palette of sonic activity can be discovered. Singular dynamic processors or equalizers with the audio output connected to the audio input create what I call “guerrilla oscillators.” My notion of raw synthesis involves either more objects in the loop chain or the out-to-in connection of more complex DSP-based processors, allowing multiple effects to be internally chained and configured. To access the sounds created by such an act, one needs a “tap” out from the closed circuit loop. The use of a Y connector at the output jack stage provides this (Fig. 2). A further connector on the input will also allow an audio line-in if the intention is to process sound through the loop.

An additional sonic feature of the connectors can be described as dirty cross modulation. It relies on the non-linear modulations that occur when the output of two or more of the above setups are squashed into the same input of another piece of hardware (amplifier, mixer, EQ, etc.) through Y connectors. The level of interference from each signal, and the resultant mix of the composite signal, is an unstable balance of the input signal levels. Varying connector formats are available to accommodate different jack sizes, but added spectral coloration can be gained when using stereo versions, as they sometimes cause comb filtering or other phase-related artifacts, or simply confuse balanced in/outputs.

Of course it is possible to use the Tudoresque approach of running the inputs and outputs of many objects into a mixing matrix that can create and access a number of potential feedback loop points and routings to a master output. Another option is to use a

Fig. 2. A three-band parametric equalizer and a simple distortion pedal each create guerrilla oscillators by connecting output to input, using Y connectors to access resulting sonic activity. (Photo © Andy Keep) Both outputs are combined in a further Y connector at the input to a mini amplifier, creating potential dirty cross modulation in this small modular feedback instrument.
soldering iron and create custom hard-wired looping components or objects. However, the Y connector offers access to any discrete loops for modular performance or any interrelated configurations. This allows for fluid potential topologies of electronic feedback instruments that can be explored, configured and reconfigured easily during performance. It is also a really quick way to assess potential instrumentalization of any piece of hardware when searching through old equipment that has been stored in the back of the studio or garage for years. Used surreptitiously, this method can be very useful when looking to purchase any bargain or second-hand equipment, so I recommend: Always keep a short jack lead and a Y connector in one’s pocket.

Andy Keep is a U.K.-based performer of live electronics, in the closing stage of practice-led doctoral research into “Responsive Performance Strategies with Electronic Feedback.” He is also a senior lecturer and teaching fellow at Bath Spa University, designing and teaching fluid approaches to performance and composition using a wide range of audio technologies and sounding objects. He is currently a director of the U.K.’s Sonic Arts Network.

HEARING LOSS


Transferring the emphasis from hearing to loss in the title of this installation results in an interesting shift from a medical or factual orientation to an emotional or philosophical one. Hearing loss is a routine, progressive physical disability; hearing loss is something altogether more nebulous and poetic.

My father died in 2006, leaving behind three pairs of hearing aids (Fig. 3) and a typically extensive supply of batteries. Hearing aids, like false glasses or some other magnification, are not only used daily but are actually inserted into bodily orifices. One of the first things that struck me when I began to work with them is that they are made in the shape of my father’s ear canals, giving a positive shape to a negative, internal and intimate space that no longer exists. It was literally through these objects that he heard the world no longer exists. It was through internal and intimate space that no longer exists. It was through internal and intimate space that no longer exists.

In my work with auditory warnings of my own design, I have sought to draw attention to an abstract beauty of alarm sounds that is usually ignored because of their overwhelming annoyance factor and their association with danger. Likewise, feedback is most often seen as a nuisance and a potential danger to hearing or to electronic equipment rather than as legitimate material for music or art. There is significant interest in feedback in the experimental music community, as witnessed by Knut Auermann’s special Feedback issue of Resonance magazine (2002), but the general perception of feedback is overwhelmingly negative. In a recent study at Salford University, it took second place only to vomiting in a list of the sounds people found most upsetting or irritating.

The pitch and timbre of the feedback produced by these devices change in ways that are interesting and difficult to predict, depending on their proximity to each other and the direction in which they face, the size and shape of the space which contains them and the presence and movement of the viewer’s hands or body. Integral noise gates in each device, designed to protect the user from ear-damaging build-up of feedback, mean that rather than unchanging tones, the effect is rather like a conversation between the six diminutive objects as feedback builds up and subsides in complex polyphonic patterns.

In most of my installation work, the only visual element is the sound-making technology itself, and here I want to let physics and the emotional associations of these evocative objects speak for themselves, but when I looked through Dad’s meticulously organized and labeled slides just before installing, I came across an image I immediately knew belonged in the piece. It is a shot taken by him somewhere in the middle of the Atlantic. We were on the Home- ric, on our way to the port of Quebec City from Europe: I would have been about 2½ years old and this was my first trip to Canada, where I was to grow up. It was uncharacteristic of him to take a picture of nothing but waves, even more so to give it the arguably poetic title Cold Atlantic, and the empti-
ness of the image speaks of absence or loss in a way that echoes the lack of an active sound source in the piece. And it is an unexpected record of the world seen through my father’s eyes.

*Hearing Loss* addresses the absence of the person for whom these devices were made, and for this purpose, few sound sources could be more suitable than feedback, “the Zen-like infinite amplification of silence.” Its “tautological elegance” [1] and musical potential contradict its status as problem or systemic fault: in this piece, its antagonistic relationship to hearing aids is harnessed to explore the presence of loss [2].

**References and Notes**


**John Wynne has a Ph.D. in Sound Art from Goldsmiths College, University of London and is a Senior Lecturer at the University of the Arts, London. Recent works include* Hearing Voices, an installation and award-winning radio piece based on endangered click-languages in the Kalahari Desert and a huge 17-channel installation, 230 Unwanted Speakers. He is currently artist-in-residence at Harrowden Hospital in Middlesbrough, one of the world’s leading centers for heart and lung transplantation.

**The Davis Instruments Vantage Pro Weather Station**

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Sound examples related to this article are available at <www.weathersong.org/music/raw.htm>.

My favorite piece of equipment has to be the Vantage Pro electronic weather station sitting in my back garden. This unit, built by Davis Instruments of Hayward, California, collects data regarding air temperature, pressure, wind speed, wind direction, humidity and rainfall rate and, every 2 or 3 seconds, transmits them by radio to a computer in my studio. This data then makes up the raw material for composition.

The Vantage Pro (Fig. 4) is completely self-contained; all the sensors and the radio transmitter run off a small camera battery recharged by a tiny photovoltaic cell; and there are no cables running into the house. The receiver can accommodate a data logger that holds days’ or months’ worth of information ready for download. Best of all, the device is very clearly documented. When I first purchased the system, I anticipated that it would be the task of a week or two to get my head around the documentation well enough to write an interface routine for Max/MSP. To my pleasure and surprise, I found the data logger so well written that I was able to get it up and running in about a day and a half.

The Vantage Pro forms the hub of my Weathersongs Project: a real-time installation that composes music from the ever-changing patterns of wind, rain, temperature and pressure that make up the weather here in North Wales. In the installation, a program written in Max sits in a continuous loop making up musical phrases. Each time it needs to choose a new note, it checks out recent data input and selects pitch, intensity and duration based on the values received. Different weather events produce different kinds of sounds but, typically, temperature and humidity provide bass drones; air pressure provides higher-pitched accompaniment; and the wind produces a lead voice whose pitch, intensity and phrasing all change as it shifts direction, ebbs and flows. Rain, when it rains, is heard as random percussive events whose statistical density changes with the rate of fall.

The Vantage Pro is well suited to this work because of its reliability. It is a truly professional instrument and is built to withstand serious weather. In fact, when I first acquired it, it got blown over a couple of times and still worked. So long as one changes the battery once every 2 years, cleans out the rain collector from time to time and evicts spiders from the sensor suite when necessary, it keeps working.

Every day, the Vantage Pro just sits there, a continuous source of nonrandom, highly complex data, probably never repeating itself but always full of patterns. Although I bought it specifi-
I began using tape dictation machines in versions of my modular composition #[unassigned] in 2001. I wanted to work with some simple yet robust sound-processing tools that avoided the use of computers: I needed something that did not crash, did not need lengthy sound checks and was extremely portable and relatively ubiquitous in order to facilitate future performances. My wife had a Sanyo TRC-580M that, in addition to standard volume, record and playback controls, provided the option to play and record at two speeds (2.4 and 1.2 cm/sec), had a voice-activated recording control (which could be calibrated to trigger recording at alterable ambient sound levels) and allowed the tape to be scanned backward or forward using the play and rewind or fast-forward controls simultaneously. The limitations imposed by this functionality defined my initial uses of the machine and to some extent the development of my music in general over the past 5 years.

I bought a second identical model and used them together for the first time in #051201, for cello, clarinet, two radios and two dictation machines. The machines were used to record sections of the music at 2.4 cm/sec and play them back later in the piece at 1.2 cm/sec. This sampling allowed overlaying of material such that an event could be fed back into the piece a number of times, each an octave lower and half the speed, while overdubbing live sound. One of the wonderful characteristics of these devices, however, is the fact that they do not quite play back at exactly half the speed: There is always some slight fluctuation and distortion. This results in some detuning, producing excellent results when recombining the recorded sound with its acoustic source. The sound quality is also naturally lo-fi, and all the more beautiful for it. There is very little bass, and although they only output 150 mW, they have a surprising capacity for projection, even in relatively dense textures.

This simple instrument revolutionized the way I worked and subsequently altered the types of sound materials I employed in my music. Previously I had been drawn to textures that revolved around isolated gestures placed in a field of silence, with occasional drones. Using dictation machines altered this balance significantly by creating denser laminar planes that fused disjunct elements together. Indeed, an interesting characteristic of these devices is their quasi-acoustic sound quality: although it is clear that some processing is taking place (primarily due to the distortion), in some textures the recorded and live sound are relatively hard to distinguish, which is emphasized by their very definite sense of location due to the small speaker size. They can also be repositioned in space or moved around during playback or recording, to diffuse sound in a very direct manner. My compositional interests generally revolve around working with unstable sounds, such as extremely slow bow speeds or minimal breath pressure, and the nature of these instruments is perfectly suited to finding points of contact with such sounds. More recently I have been exploring what happens inside the box. One of my machines has just broken, so I have taken it apart to find out why: A whole new world has just opened up for me.

Although I have generally used dictation machines in small ensemble pieces set in a time structure that encourages echoes of earlier material to return later in the piece, I have also used them in purely electronic setups and, more recently, a month-long installation where visitors operated four machines, recording and playing back parts of the ambient and composed soundscape over an extended timescale (#0505-040606-f), Keith Talent Gallery, London, May–June 2006). In addition to using them in my own compositions, I have also used dictation machines as performance instruments when playing pieces by other composers or improvising. I connect them to more extended electronic networks incorporating homemade electronics and guitar effects pedal (see Fig. 1), or to each other. A simple feedback loop can also be created by joining the headphone and microphone jacks of two machines in a loop and pressing “record”: Movement of the players creates changes of pitch and timbre.

Since 2001 I have collected more machines and currently own 11. I have experimented with models by Sanyo, Ferguson and Sony, but the best for my uses is definitely the Olympus S711 (Fig. 5), principally because of its relatively silent keys, fast rewind speed and reliability. Importantly, however, they are simple to use, and once the cushioning technique for silent button operation has been learned, they are relatively foolproof in performance.

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**THE DICTAPHONE IN MY LIFE**

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Fig. 5. Olympus S711 dictation machines connected to a piezo feedback network. (Photo © James Saunders)
For the moment, dictation machines are also readily available, although the increased use of digital technology for note taking has probably signaled the end of their product life, which is a cause for concern.

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A SONY WALKMAN PRO CASSETTE TAPE DELAY
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Sound examples and additional images related to this article are available at <www.west.asu/rlerman>.

I engineered and built the Sony Walkman Pro tape delay in summer 1983. I still use it in performance, with the same cassettes and Walkman recorders, some 24 years later.

It became really tiresome to arrange for two stereo tape recorders at every gig, and I was determined to find a way to make this delay system. The Walkman was perfect for this purpose because it had very accurate speed control (simply leave the speed tune knob to OFF) and the recorders themselves needed no modification. I know they did not design this feature intentionally, but removing the battery pack leaves exactly enough room for tape to clear the outer edge of the machine. (Thank you, Sony.)

Using the delay is fairly simple—one need only decide how long a delay is wanted. The minimum is about 6 seconds—it takes the recorded sound on the tape that long to move from the recording deck to the playback deck when the units are close together. One can adjust this distance during use by gently pulling the two units apart. Yes, there is tape slippage and a warbling sound as the speed briefly becomes unstable, but it works. Generally, I keep the units in Dolby C mode and always use metal tape.

To build the cassette delay system, the two cassettes must be carefully taken apart—make sure to use the kind that are held together with five screws. The difficulty lies in taking off the thin plastic piece atop the tape hubs. These reduce friction inside the cassette. When this part is off, the very thin tape often curls and twists around.

In any case, one must remove the hubs and file a very narrow slot in the top and bottom halves of both cassette cases. Figure 6 shows where this slot must be. Furthermore, the spines must be removed from the feed hub of the playback (take-up) cassette. Use an Exacto blade or very fine wire cutters. Discard (or save for future use) one spool of the tape. (Leave the leader attached to the take-up spool.) Then take a thin slice of splicing tape or Scotch tape and attach the cassette tape to this leader. (Perhaps cut the leader a bit short so that the splicing tape never touches the heads.)

When finished with these operations, carefully put everything back together. I often use toothpicks or wooden Q-Tips to help guide the tape. Drafting tape can also be used to hold things down—it comes off easily. When the work is done, two cassettes will be spliced together. For storage, fold them on top of one another and take up the slack by winding the record cassette with a pencil.

To rewind the cassette delay:
1. Remove the take-up cassette from the recorder.
2. Hold it at the same height as the Walkman.
3. Push rewind on the recording cassette.
4. The tape will quickly rewind and not bind.

To maximize flexibility from tape delay, I built a 6 x 4 matrix mixer. The schematic appears on my web site [1]. The mixer allowed me to assign inputs to the recorders and send the playback from the left and right channels back into the delay at varying volume levels.

Perhaps the high point in using this delay occurred at the 1986 New Music America Festival in Houston, where my piece A Matter of Scale was performed.
inside the Astrodome. I used the delay and mixer on the pitcher’s mound. Other performers in left, center and right field and at first and third base played small instruments made from piezo disks with harpsichord wire and soda straws with microphones inside. I was intrigued by the combination of small instruments, large sound and large space. My one regret was not recording the unique sound of the stadium trash being swept down the steps after a game at our single 3 AM rehearsal.

Variants
I have tried to hold another playback head somewhere in the middle of the delay to thicken the plot, but another device is needed here that can be properly aligned to the tape.

I did make a video piece in 1972 for four 1⁄2-in video decks that had one tape threaded through all four. I had to make sure that the slower decks were first in line, allowing the faster decks to take up tape slack.

Be sure to clean the tape heads often when using this delay system. Finally, further images detailing this tape delay are found on my web site noted below.

Reference

As an artist, I am interested in elucidating fundamental relationships in nature through the creation of instruments and systems that present themselves as tools of exploration. My works are objects to think “with” rather than to think “of.” The radio has the capacity to be such a device; however, it is usually overlooked as an instrument of discovery. This is in part because of its ubiquity in our lives, having been a major source of information and entertainment in our media diets for many years. However, its reign as a portable entertainment device has been usurped by the advent of Walkmans, Discmans and now iPods. Perhaps this is for the better: As the radio sinks into the backwater of our commercial gadget lust, its aesthetic role in our lives can be reinvented.

I would like to present the radio in the role of translator, mediating the languages of space, time, matter and energy. The vibrations of the physical world, perceived as sound, and those of electromagnetism, conceived as energy, are fundamentally related in terms of their motion. However, these two phenomena inhabit distinct worlds, differing in both their makeup and their media of transmission. Because of these differences, we can directly sense sound, but it may not always be possible to do so with electromagnetism. The radio is a physical object and an electrical circuit that sits between these two worlds, allowing communica-
tion between them. It resonates not only with the movements of the “ether,” but also with the sounds contained within. The radio augments our senses, allowing us to perceive those motions of the environment that we perpetually inhabit that are just beyond our apprehension. Sounds are part of the physicality of a place as much as the objects that define it.

I set out to explore the relationships between tangible and intangible space in my most recent installation, *When Airwaves Swing* (Fig. 7). It consists of a Pathe-Marconi five-tube superhet AM receiver whose antenna not only receives radio signals, but also acts as the radio’s loudspeaker. The radio and audio signals vibrate simultaneously along the long wire antenna. Each signal behaves according to its unique nature even as they occupy the same medium. The resonant properties of the wire antenna allow for the clear reception of the radio signal, but distort the audio signal. The appearance of the installation is similar to a scene one may find in any home. The radio is flanked by two easy chairs that invite the visitors to sit by it, bathed in the intimate glow of a small lamp. The experience of listening to the radio is not, however, what one might expect, due to the sound being “processed” by the physical nature of the wire antenna. The resulting soundscape is without center, and the echoing voices and music float throughout the space. I had the opportunity to tend the space during the exhibition and I encountered something I did not expect. Visitors sat with me around the radio and talked about their experiences with sound and radio, about their childhood memories or their imaginary worlds. I discovered that the radio also provides an environment that enables us to translate our own internal worlds into the one we share.

Reference


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Distorted RF Lullabies

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_Sound examples related to this article are available at_ <www.archive.org/details/cr05RottedOrange>.

All places have different sounds; a silent night in one place could be interpreted as a cacophony of sound in another. When I moved to the United States 5 years ago, I was shocked at the dead silence I found at night. I realized that in my homeland, Puerto Rico, to experience a “silent night” means to sleep tucked in bed by the orchestral lullabies of countless grasshoppers, pets and/or stray cats and dogs, distant or nearby traffic and *coquis* (tiny tree frogs whose singing is normal to the Puerto Rican ear; Hawaii, however, has recently found itself with so many—as a consequence of Puerto Rican immigration—that people are hired to exterminate them). So many elements create the soundscape of a Puerto Rican night. All have influenced me in my performance and selection of the sounds I extract from the transistor radios I hack. I tend to make a single unit explore a wide range of frequencies, from insect-like sounds to the roar of heavy machinery that creates (or destroys) a town.

The transistor radio I cherish the most, the one with the most expressive sounds, is my “compu-radio” (Fig. 8). When I made it, everyone around me was doing laptop-based work, but I was not able to buy a laptop at the time. So I went on a used-toy hunt and stumbled upon this transistor radio: very small, compact, analog and cheap, with a miniature personal computer shell. It was just begging for me to buy it and transform it into its own unique self. I placed photocells on it for a more natural sense of control of my variations of charge resistance in its circuit board and for more active engagement while playing it. Using photocells makes my interaction with the instrument more fun for the audience and me. It looks more as if I am playing a drum than just concentrating on a controller that no one can understand. For high-frequency chirps I added a nickel and connected it to a spot on the radio’s circuit board. When I touch the nickel, my body creates the resistance necessary for reaching insect-like high pitches. While

![Fig. 8. Compu-radio: Transistor radio turned into an oscillator unit/noisemaker; its homemade circuit-board extension uses a beta videotape case as a shell. (Photo © César Dávila-Irizarry)](http://direct.mit.edu/lmj/article-pdf/doi/10.1162/lmj.2007.17.32/1674730/lmj.2007.17.32.pdf)
I play with those high frequencies I have also added the option for sudden change in tone by adding a button that raises the pitch a little more and a knob that changes the timbre slightly; this last knob was not really necessary, but I got carried away with the hack. Add to those the tuner that allows me to use radio signals to modulate almost any of the instrument’s output or to add random sound bites, and the volume knob, which now also works as its own oscillation-distortion controller. As a result, I now have added to my collection of circuit-bent toys and hacked transistor radios an instrument with numerous charismatic noisy phrases.

The compu-radio appears on Rotted Orange’s debut recording [1].

Reference
1. See <www.archive.org/details/cr05RottedOrange>.

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THE BOSS GE-7 E.Q. AND FLEXIBLE SPEAKER ARRAY AS TONAL FILTERS

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Sound examples related to this article are available at <hhproduction.org/NRA.html>.

The most crucial element of what sounds I present is tone. Tonal filtration is the only sort of signal processing I am interested in, because it leaves no residue on the source signal and is also effective at revealing unexpected aspects of that signal. The source materials I use are pure cracked electronic squeal, with a harsh, immediate and unpredictable character that I do not want to smooth over. My use of a flexible (easily interchangeable) speaker array (a series of tonal filters), coupled with extreme use of a Boss GE-7 Equalizer (E.Q.) (Fig. 9), serves to expand the tonal characteristics and compositional relevance of my source material, so that I can use fewer source sounds. There is also an indeterminate aspect to the source material that is heightened by the indeterminate aspects of the tonal filters.

When I asked Gunter Muller what made his rig work, he pointed to his two GE-7 equalizer pedals and smiled, so I immediately stole the idea. He changed the character of a sound fundamentally and yet retain its essence. It was possible for him to use a very limited amount of source materials and yet present a full complement of sounds that were highly integrated with each other.

I form nonlinear patterns on the seven bands of the GE-7. I most often opt for spiking a band or two while allowing the rest to hover low. The goal is to allow parts of sounds to become more immediately visible, as in macro-photography. The bypass switch is essential—I favor distinct sounds and thus rarely adjust the unit while the circuit is active in the signal path.

My interest in building a flexible speaker array was inspired by an artwork by Jess Goddard that involved switching between several near-identical speakers that had been either filled with plaster, smeared with epoxy or treated in a similar extreme way. I enjoyed being surprised at the unpredictable and widely different tones of each speaker. These were singular tones; I could not imagine sounds with that degree of character and presence coming from a hi-fi.

When I built my speaker array to use in performance I bought a ready-made switch with five selector buttons that could activate any number of five pairs of speakers at a time. I added a master on-off switch (the most important single element of the entire instrument is silence at one switch). I wired only to the left channel of the stereo pairs. Thus, I send a mono signal to up to five outputs.

For the array itself I remove speaker drivers from their cabinetry and place them directly on the floor. I like the immediate visual presence of the drivers and feel more connected to the sounds they are making as I see them vibrate and pulse. I choose individual speakers for their idiosyncratic characteristics and aim to form an ensemble of complementary voices. Each speaker must realize the signal in a profoundly individualized manner from the standpoint of “natural” E.Q. The most valued ones are damaged in such a way as to add a further characteristic acoustic quality to the sound—a rattle or buzz that comes from fatigue or accumulated abuse. These direct tonal filters (the last in the signal line) provide extreme immediacy to the sounds they produce. There is no effect box or modeling device attempting to simulate something known and certainly no default “clean” setting.

I choose to be constantly blindsided by sounds that, were they available as samples or presets, I likely would not elect to use at a given moment. When I select speakers or blindly adjust the E.Q. I am almost always genuinely surprised by the results. By the time I know what the result of a given action will be, it is already present in the com-
Real-Time Prototyping in Live Electronic Music: A Modular Crackle Instrument

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During a visit to STEIM, the venerable institute of musical research in Amsterdam, I acquired several Crackle Boxes (Kraakdoos). This classic device, conceived by Michel Waisvisz with the assistance of Geert Hamelberg at STEIM in the mid-1970s, is a model of efficient and subversive design. A single op-amp, whose intended purpose is to amplify signals accurately, is configured in an unstable state, with its input, output and compensation pins brought out to six touch pads. The performer interacts with the instrument by bridging different points in the circuit with one’s hands, eliciting noises that are sensitive to pressure, sweat and the declining health of the 9-volt battery powering it. Although built with limited resources—the touch pads are simply traces on the printed circuit board and the speaker is glued on—the Crackle Box is housed in an elegant wooden enclosure and succeeds in providing a tactile experience where most electronic instruments fail.

Despite the unpredictability of the Crackle Box, the range of its behavior is limited, making it wonderful as entertainment for dinner guests but less useful as a “serious” instrument. After I peeked under the hood (always the first thing to do when encountering a piece of equipment), the simplicity of the circuit reminded me of textbook exercises in electrical engineering, which I studied in college. My first thought was to extend the circuit by bridging two units together. I stretched resistors, capacitors and diodes resting on the touch pads across the boxes, altering circuit values and feeding the two amplifiers back into each other. While the sensitivity to touch remained, the boxes now possessed an expanded repertoire and became even more temperamental. It was also possible to configure the components’ values to make noise without intervention by the hand, the sound shifting over time due either to instability of the circuit or the components being physically moved by the speakers’ vibrations.

I gave little more thought to the Crackle Boxes beyond those few afternoons of experimentation until I returned to STEIM for a residency in 2006. After deciding to scrap the project I had initially proposed due to its need for specialized parts, I remembered the ideas for a more configurable Crackle instrument (Fig. 10), which seemed appropriate to try out at STEIM. With the assistance of Jorgen Brinkman (who also assembled every one of the reused Crackle Boxes), the new module was laid out and wired in a few days.

The design goals of the new unit were to make it compact, battery powered and absolutely flexible in routing while retaining the tactile interface of the original. I wanted four Crackle circuits that could function independently as well as work in parallel and feed back into each other, with individual speaker-driving outputs as well as a summed line-level output to interface with the rest of my analog electronics. Perhaps having another flashback to engineering lab work, I decided to use a trimmed down breadboard to expose the circuit guts to real-time manipulation. The breadboard is connected to six points of each Crackle circuit, functioning much like the patch bay of a recording studio. The circuit can now be altered easily during performance: its routings can be changed and multiplied; it can even receive external signal and control voltage injection. In performance, acoustic filtering is provided by different speakers connected to each output—high-frequency compression drivers, mini paper cones, piezo discs, etc., chosen for their limited bandwidth and other imperfections. These can also be easily positioned at different parts of the performance space to take advantage of resonant corners and provide some primitive spatialization.

In my mind, while this instrument obviously owes much to the original Crackle Box and Waisvisz’s Crackle Synth, it is also a reduction of David Tudor-influenced electronics to the component level, manipulating frequency compensation cutoffs and gain values rather than gain blocks, phase shifters and filters. Although the outcome is laced with uncertainty, the visual simplicity and correspondence to what lies underneath (i.e. pad 1 is the output, pad 2 the non-
inverting input, etc.) gives the musician a visceral clarity that is so elusive on a laptop.

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THE PRIORITY OF THE COMPONENT, OR IN PRAISE OF CAPRICIOUS CIRCUITRY

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Further material, including sound examples, is available at <www.onoma.co.uk/jmbowers/victorian.html>.

Before the Ibanez Tube Screamer, there was the JRC4558 chip. Before the smooth sound of germanium fuzz, there had to be germanium, in particular in NKT-275 (“Newmarket”) transistors. And further: before there can be circuitry before our very eyes and ears. Mixtures of basic components create oscillation by Victorian means. Copy the construction and swap switches for buffer to avoid shocks . . . no seriously! Do it!). Try more than one knife (or fork or spoon) to sample from more than one spot. Thrust in a magnet or two to create lumps of arbitrary circuitry. Perhaps pour in a little hot wax and leave to set if you especially like what you have and want to keep it. This will probably instructively fail: Let capricious circuitry forever elude you and love it for that (moral).

Another lesson in all this: beyond and before the completed circuit lies the component in all its unruly potentiality as it awaits connection or gently decays away. And perhaps: the Good Device exists at the threshold of order/disorder where components reveal themselves once more in provisional constructions of requisite simplicity yet enigma.

References
2. Corbin [1].

Bibliography


John Bowers is a musician, social scientist and interaction designer. He has researched foundational issues in human-computer interaction for really quite a while now and is co-founder of the Onoma Research record label. Vanessa Yaremchuk is a photographer and computing scientist. She researches artificial neural networks and music cognition. Bowers and Yaremchuk do intermediary work under the collective name of Glorrph.

Let us describe some favorite hacks, ones that stay close to the components and exhibit them freely, unboxed.

First, The Mixing Bowl. Take a kitchen bowl. Pyrex for choice as it is more roadworthy than glass and squeaks nicely when rubbed. Just throw stuff in: cheap microphones, piezo elements, guitar pickups, electric motors, vibrators, maybe some fruit. Connect up, agitate, listen to the mix. The Victorian Synthesizer is an ongoing project to build a synthesizer using techniques that could have been employed by the Victorians if they hadn’t been occupied with other things. This is challenging. For example, one cannot create an oscillator with an amplifier feeding back to itself with near unity gain as this was post-Victorian—in 1921, by Heinrich Barkhausen, so a Weimar cultural affair in fact [1]. Instead, take a moving coil loudspeaker (Oliver Lodge, 1898, Victorian [2]), connect a battery directly to its terminals and enjoy the pops and thunks as the diaphragm moves in and out. Then, add in a tilt switch to make and break the circuit, placing the switch on the diaphragm for self-oscillation by Victorian means. Copy the construction and swap switches for cross-modulation. Vary freely.

Let us take these principles further. Let us investigate ad hoc assemblies where chance wiring and promiscuous mixtures of basic components create circuitry before our very eyes and ears. Ohm-My-God (Fig. 11) places a bunch of electrode plates into (again, say) a kitchen bowl with each plate connected to a low-voltage battery terminal. Pour in arbitrary components: resistors, capacitors, transistors, diodes, lengths of bare wire. Sample the current at selected spots of the mixture with a conductive knife (or fork or spoon). Stir the mixture (or maybe agitate it with a Victorian Synthesizer beneath). Run the circuit from knife blade to whatever you fancy: to serve as a control voltage for synthesis, to be amplified so that the electricity through the random circuit can be heard direct (electrically

Fig. 11. Components/Ohm-My-God/Components, 2007. (Ohm-My-God © John Bowers. Image triptych © Vanessa Yaremchuk.)
MAIZ: A CYBERTOTEMIC INSTRUMENT

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MAIZ (Fig. 12) is a kinetic sonic structure made from hybrid recycled industrial materials and found objects and controlled by computer. MAIZ is a syncretic cybersonic talisman, a hyper-folkloric object of reconnection.

Aesthetically, MAIZ wedds contradictory Western and Mesoamerican concepts, such as myth and science, faith and reason, and technology and animism. Conceptually, MAIZ explores the meaning of sound in relation to its generating source.

In an alternative approach to qualitative listening or the "reduced listening" proposed by French musique concrète composer Pierre Schaeffer, which suggests mentally removing the sound from its originating source, thereby stripping it from any meaning associated with it, the idea behind MAIZ focuses solely on the sound and the sound’s relationship with the object.

In a search for postcolonial and post-global hybrid art, MAIZ explores pre-Colombian ideas in language, art and religion. In Nahuatl (the language spoken by the Aztecs), the meaning of a word could not be separated from a constellation of concepts associated with it. In Mesoamerican languages, a word was linked both semantically and phonologically to a universe of concepts inseparable from the object described. In the case of names used for musical instruments, there was an inseparable connection between the phonetics of the word and a sound the instrument made. Furthermore, for the inhabitants of pre-Colombian Mesoamerica, a "sound object" was more of an entity in itself than an actual producer of musical sounds. The object itself contained the essence of the material with which it was built.

While most electronic analog or digital instruments and sonic objects generate sound through speakers, MAIZ is a computer-controlled sonic object that produces physical and mechanical sounds.

Every element used in the construction of MAIZ has a personal meaning for me. The process of construction became as important as the realization of the concept. MAIZ grew inside out from found recycled objects. Its construction flouts artist Joseph Beuys’s "enlarged conception of art," which included "every human action" in the process.

A heavy metal disk became the center and starting point of the construction. This rotating disk connects to a powerful servomotor. The disk was remodeled to fit the shaft because the two parts came from completely different machinery. The disk lies over a set of bearings, thus taking direct weight off of the shaft. MAIZ is built from a wine box, metal parts from a mechanical street cleaner (which became the tongues of a kalimba), a cigar box and my wife’s credit card, which plays three strings (tied to a guitar neck). MAIZ can alternately be triggered by light sensors, motion sensors, controllers or even the human voice.

The enlargeable sprockets and removable aluminum arms around the plate rotate and strike alternate series of metallic tongues, depending on the length of each sprocket, at different speeds. One of the arms excites a potentiometer, which sends data back to the computer. Each part of the instrument can be amplified independently. MAIZ can be used as an interactive independent instrument or as a live performance device.

My piece Post-Colonial Discontinuum, written for MAIZ and chamber ensemble, was commissioned by Earplay Ensemble and premiered at San Francisco Herbst Theater in May 2006.
Acknowledgments

Thanks to Raul Aguilar, Fernando Hernandez, Donald Swendingen (control) and Ricardo Rendon for technical advice.

Guillermo Galindo’s artistic work spans a wide spectrum of expression, from symphonic composition to the domains of musical and visual computer interaction, electroacoustic music, opera, film music, instrument building, three-dimensional installation, performance and sound design.

ARROWBOWS, CHIPS AND CHIRPS

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Sound examples related to this article are available at <www.janehenry.com>.

Since 1990, I have used both acoustic and electronic accessories in performance: a small but colorful assortment of “alternative bowing devices” and gloriously sabotaged simple consumer electronics such as hot-wired chips or VHS tapes played back on PAL machines. Almost everything I do is live, in real time. If I want more sound mass, I use pre-recorded material played back on Walkman cassettes, CDs or video players, which I control myself. I never use a computer, although I do play with computer musicians who process my sound. I never use the electric violin, and my violin is only amplified via a clip-on mic at the tailpiece when I am being processed, or sometimes when I play with other amplified musicians.

The “alternative bows” I use originate in my work with Jerry Hunt. He had an “array of bowing devices” for me to use on the “Chimanzzi” track of his CD Ground (OO discs): three bows that he had made himself—all crude, small, fetish-like, made of cheap wood and “haired” with nylon fishing line. Each produced a special, delicate yet bizarre sound. I was charmed and have been enthusiastically using alternative bows ever since. As a souvenir, he gave me the smallest bow, which I call the “tiny bow.” My very favorite, however, is the one he called the “grinder,” a stick approximately 14 in long, tightly wound with nylon fishing line.

My version of this is called the “arrowbow,” fashioned for me from an actual arrow by friend and composer Sarmad Brody, after my description of Jerry’s bow. Closer in size (29 in) and weight to an actual violin bow than was the grinder, it is easier for me to use freely. I use this one most extensively. Its sound can be compared to that of a guitarist drawing a threaded screw or nail across the strings, but its strength and pliability provide a great dynamic range and enable me to spin out entire pieces of music using only this bow. Wearing metal thimbles on my left-hand fingers to make a sharper and more brilliant sound with the bow, I produce zips and swishes and belches and plucks and plings normally associated with record-scratching and electronic sounds. Two of my pieces using the arrowbow alone can be heard on my web site: “Hands Off the Homeless” and “Haarlem Hat Dream (Double).” It can also be heard in my improv with Matt Rogalsky (“Kash: violin”) on his recent XI release Memory Like Water.

My favorite electronic accessory in my solo performance wardrobe is truly wearable. Dubbed the “Chipsaw” (Fig. 13) by its maker, Sukandar Kartadinata, during his internship with Nic Collins at STEIM, it is simply an amplified, hot-wired musical greeting card microchip with an anklet of articulating mercury-bead on-off switches and a pressure-pad voltage regulator that I squeeze between my toes.

It is amazing what a rich palette of sounds can come from that tiny black blob once it is open to distortion, released from its chain of monophonic Christmas tunes, ready for the joys of free improvisation! In performance, I balance on my left foot while squeezing and shaking the apparatus attached to my right foot and toe for 8 minutes or so, in addition to alternating between several kinds or bows, making me essentially a one-person band. In my violin part, I use pitch, squelch, chirps and rhythmic material dictated by the distorted microchip and mix in overdubs of alternate bows and microchip during performance to build a chaotic density, but the lone microchip gets the last word. This exercise in absurdity is my homage to Jerry Hunt, “The Chip Is Down (Jerry Goes to Glory).” Recordings of this piece are on my web site, my CD and the CD accompanying The Art of Hardware Hacking by Nic Collins.

Jane Henry is a violinist and composer/improvisor currently based in San Antonio, Texas, after 2 decades of residence in New York City and Holland. Classically trained, she is active as a violin teacher and freelance violinist with symphony and baroque orchestras. Her solo CD AutoViographie presents her work for violin and electronics. She has contributed to CDs by Michael Schumacher, Matt Rogalsky, Jerry Hunt and Rafael Toral. Her work is also cited in recent books on new music by Elizabeth Hinkle and Nic Collins.
FORMER GUITARS AND COCOLINAS

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Sound examples related to this article are available at <www.neilfeather.org>.

Since 1972 I have created an ensemble of instruments that fall roughly into six families, according to the principle they are designed to explore. These principles are mainly the following: inverse pitch relationships, rotary motion, magnetism, mechanical phase relationships, string physics and sonic transduction. The instruments are electroacoustic or electromagnetic and use strings and/or small motors for vibration. They are utilitarian, finely adjustable, ergonomic devices that respond to experimentation and technique with a rich spectrum of sound.

This statement focuses on the “former guitar” family and its newest member, the Cocolina (Fig. 14). The former guitar family was begun in 1980, when I successfully decontextualized a Silver-tone electric guitar. The first few former guitars were converted guitars. The subsequent former guitars were made from scratch using guitar parts, hardware, aluminum and high-density plastics.

Former guitars have two strings that share tension through a “head” that pivots under the control of a long whammy bar. This configuration causes one string to tighten as the other is loosened, creating a tonal center. The ratio of the strings’ diameter determines the interval at rest (equal length and tension).

Former guitars also have a movable “bridge” that acts as a big fret for hammer-on and other techniques specific to the instrument. Grooves have been filed into the bridge to facilitate a faux-bowing technique of rubbing the string across the bridge. Pickups are mounted on both sides of the bridge so that all of the string can sound. The movable bridge creates an adjustable ratio between the string length above the bridge and the string length below it. These two lengths change but always have the same sum. This tonal constant, along with the symmetry created by shared string tension, mechanically enforces a symmetry that rotates on two axes. This set up was designed to imitate the pitch dynamic of my earlier instrument the Nondo. The Nondo is a steel sheet that is strong lengthwise by two strings into a rocking curve. The string tension is created by the weight of the heavy flexible sheet. The Nondo is played by tilting so that round metal bars roll along the widely spaced strings. The Nondo’s pitch distribution is controlled by physical balance.

Former guitars are the most versatile of my instruments and are most often used in the context of free improvisation. The former guitar is also the instrument of choice of the dozen or so players who have seriously pursued playing my instruments and have been involved in my ensembles, which feature only unique instruments. They add to the sound palette originated by certain modern (table-top) guitar innovators, facilitating string stunts without the intention to create 12-tone music.

Former guitars have something in common with an obscure single-string-and-lever instrument that some early Foley artists used to make a boing sound. A direct influence is the Crychord, which is part of the Harry Partch orchestra, if not actually designed by Partch. Former guitars are excellent for producing boings, glissandos, caterwauling and other sounds spelled out in Don Martin cartoons.

My latest instrument is the Cocolina. It is the second former guitar design intended for multiple production. My tendency is to overbuild my instruments; instead, I designed the Cocolina to be light, simple, economical and open ended. Compared to the first former guitar production model, the Guitaint, it is half the weight (4 lbs) and requires half the cost and half the number of parts. Its design is rectilinear, as opposed to the curvaceousness of the other former guitars. It also features a mounting bar from an electric panel that allows prongs or tines or springs to be mounted near the pickups. These additions expand and enhance the musical possibilities.

The Cocolina is my new favorite ax. It has a full former guitar sound and produces bonus sounds as well, including one of my best boings yet. It is meant to be reproduced and played by others. I have long since built more instruments than I can practice on and would like these experiments to extend beyond my own imagination. The Cocolina can satisfy the serious former guitar player and intrigue collectors and users of unique instruments.

Fig. 14. Guitaint and two Cocolinas, 2007. (Photo © Neil Feather) Their lengths are 33, 33 and 25 inches, respectively.

Neil Feather has invented, built and performed on experimental musical instruments for 35 years. He is a member of the Baltimore, MD, Red Room Collective and the High Zero Foundation, which have presented improvised and experimental music for many years. His musical groups include THUS, Aerotrain and Mugwump.

THE G&L SC-1: OBSCURE OBJECT OF SONIC DESIRE


Sound examples related to this article are available at <robertposs.com>.

My discovery of the G&L SC-1 (Fig. 15) coincided with a fundamental shift in...
my musical thinking. Playing in Rhys Chatham’s guitar ensemble had solidified my interest in what might be called ecstatic guitar minimalism. I had developed an interest in electronic and experimental music in the 1970s under the tutelage of Susan Stenger and Nicolas Collins. In the mid-1980s I had begun to formulate a musical vision based on what I saw as the great moments of rock. These were bits of feedback heard in a certain song, a chord sustained in a certain manner, a certain brief juxtaposition of two clashing rhythm-guitar parts—moments that were for me a distillation of everything that I loved about guitar-based popular music. With the formation of my wall-of-electric-guitars group Band of Susans, I attempted to develop a musical vocabulary based solely on these moments, focusing on the textures and architectures of layered, distorted guitars rather than the conventions and clichés of riff- and melody-driven music.

On the lookout for a new, cheap, sturdy guitar to use with Chatham’s group and in my own work, I saw a guitar I had never seen before in a small music store on St. Mark’s Place. It was extraordinarily simple and very inexpensive, and when I played it, I decided to purchase it immediately. Even mass-produced guitars have their own idiosyncrasies of sound and feel. The wood, hardware, wire and plastic inevitably combine into something that is inscrutably more than the sum of the parts. I had bought and sold dozens of guitars, from pawnshop specials to blue-chip vintage models, but the SC-1 was in a class by itself. It balanced perfectly. Its intonation and stability were unsurpassed, and no one I knew had ever seen or played one before. This guitar had a faded baby blue (Viking Blue, as I believe it was called by the company) coloring, with a tincture of turquoise visible at the worn spots. Its blond maple neck provided an organic modernity of the unadorned spray-painted body. There was a perfection of tonal balance, compact physicality and understated physique. Rather than a display of overtly phallic horns, geometric protrusions or futurist planes, the SC-1’s gentle silhouette is almost Noguchi-like in its modesty. The guitar struck me as somewhat shy and diminutive and seemed to invite one to cradle it, to caress, to nurture; I felt that the instrument reciprocated. It had a perfect balance of bass and treble, neither strident nor dull, and its overtones sang. It felt right and sounded right and looked right to me. I was in love.

This guitar changed everything. I soon gave up my then guitar of choice, a Fender Jazzmaster, and elevated the SC-1 to the Number 1 spot. The placement and design of the single G&L Magnetic Field Design pickup was unlike anything I had ever experienced on a guitar. I found the SC-1’s ability to sustain controlled feedback inspiring and energizing. I developed a technique that enabled me to precisely control the overtones that fed back, giving me an almost magical power to shift my body a few degrees and have the pitches jump by an octave or perfect fifth. I could almost see the pitches in the air; the instrument became a theremin-like divining rod as I dowsed for the perfect overtone. I saw this as the ideal confluence of my interests in the worlds of experimental rock and the pure sonic architectures of Phill Niblock and Alvin Lucier. I found myself listening to the way the SC-1 responded to various arcane chains of distortion pedals. I found inspiration in the specific series and balance of the overtones I coaxed from it. All this found its way into Band of Susans’ core material.

Prior to discovering the SC-1, I had practiced serial guitar monogamy. My first oddball guitar was a 1950s National Town & Country; no else I knew used the model. I subsequently became obsessed with the Gibson Les Paul Deluxe—one of the least popular of the Les Pauls. I next was enchanted by the double-cutaway Gibson Les Paul Jr. and with vintage Gretsch hollow bodies. Whereas my relationships with other guitars had been temporary, my crush on the SC-1 blossomed into a romance and deepened into an obsession. It became a muse and a touchstone, an inspiration and a musical partner. Over the years, I have bought and sold dozens of electric guitars, but the SC-1 stands alone. For me, it is totemic; I consider it sacred.

As I acquired more SC-1s, its pickguard-less design began to strike me as just a bit too modern, too Spartan. One night it occurred to me that I could add a pickguard similar in design to one found on my Les Paul Jr. guitars; I thought of the SC-1 as a Fender variant of the single-pickup “student model” Les Paul Jr. An artistically inclined friend helped me sketch out a design, and I had a few pickguards professionally cut and affixed them to my SC-1s. The instrument suddenly looked “right” to me and it was finally my own: my trademark, my signature model. This modification was purely aesthetic, although I like to think of it as an enhancement to the vestment in a personal iconography.

The metonymic significance of my SC-1 reached its zenith when the guitar was used as the central design motif for Band of Susans’ Love Agenda, The Word and The Flesh and Peel Sessions CDs. Our record company sent a poster to G&L, and while on tour in California, we learned that we had been invited to the G&L factory to meet the legendary Leo Fender, co-founder of the company. For
I fell for the Casio SK1 (Fig. 16). I bought it with money saved up from my allowance and a birthday. It soon became clear that it had a lot more going for it with its limitations and weird quirks than was suggested by the presets. This thrilled me to no end and inspired hours of experimenting. The drum set was tinny, so I learned to sample my breath to make bane, snare and hi-hat loops like a Roland TR 808 or TR 909 (the drum machines that brought bottom-end bass to electronic music) with even a bit of distortion and tiny fills. I also became really interested in sampling the voices of AM radio newscasters in their weird polarity of speaking either really excitedly or in a morose deadpan worthy of funeral directors in old movies. I once accidentally sampled static as a station signal waivered. It was amazing. It somehow played back as a lush string sound! I learned with practice that the SK1 could capture static with a distortion at a certain tone and signal range that it translated sonically into something quite rich.

The SK1 recorded in two channels. If I played with the presets in record mode, it created a sort of odd semi-arpeggio, with a fluidity between short notes as opposed to the normal sustain. It was great for playing fast and working with scales. The batteries would die out quickly, however—the sound would begin from its pristine little presets and samples to slide into mutated distortion, spastic burps, electronic fuzz and a sort of sandpaper static undertone.

At first this was annoying and disappointing. After a while I realized that I could plug the keyboard in at full power and sample one of those odd mutants, providing a sound palette to manipulate. This was an exciting early taste of something like circuit bending. I learned to see sound in shapes, serrations, edges, color forms and their recombinations.

Television shows such as “Dynasty” and “Dallas” and infomercials provided arrays of sounds to utilize, from voices to layers and percussion. Monotone voices or voices with odd modulations (e.g. bad public-access cable hosts) could be used for bass on low keys, snares in the middle range and cymbals and quirky little accents on the high end. An ad for a truck-driving school aired one night at 3 AM yielded the most amazing drum and string sample I have ever heard. The samples could only be a few seconds long, so they had to pack a lot of elements or something really odd and rich. It surely must have sounded quite insane to my parents, when in the middle of the night they would hear the television play odd latenight detritus with massive 10-second spikes in volume at odd intervals.

I lost my SK1 years ago when it was taken apart by a handmate. He replaced it, but it somehow was not the same, and I began to experiment with other tools. I now create works such as a recent one composed of interacting architectures of sound fragments composed to the edits in an MRI brain scan [1]. I owe so much to that little keyboard with the yellow record button.

Reference


Jeremy Hight is a sound artist/electronic musician/new media artist. His sound work has appeared in several international festivals and museums.

LOVID’S KISS BLINK
SYNC VESSEL

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Sound examples related to this article are available at <www.lovid.org/kissblink/syncvessel>.

Our video recordings and performances are abstract audiovisual composi-
tions converting electricity into intense patterns of color and noise in which image and sound are created as one entity—the video is audible and the sound visible. As a result, our performances are experienced physically and viscerally as enveloping and engaging environments. Exploring this tactile relationship with media as well as our own bodies’ physical relationships with our instruments, we create sculptural analog hardware synthesizers. Our sculptural instruments elicit a cross-generational dialog with early experimentation in image processing by video artists/engineer pioneers as well as with current aesthetic pursuits within DIY and hacker culture among our contemporaries. We are interested in the evolution of media and the different goals and pursuits of these two eras.

*Kiss Blink Sync Vessel* developed from these interests and influences. It is a group of sculptural custom AV synthesizers. Peeking into a parallel world where media is tangible and emotional, the synthesizers materialize our fascination with the tension between wireless and wirefull, hi-tech and lo-fi, hand-made and machine produced [1].

We began this body of work during a residency at Eyebeam in 2005, with the support of the Experimental TV Center’s Finishing Funds.

*Sync Armonica* (Fig. 17) was designed as a modular instrument for us to use in performances, recordings and installations. The instrument has 28 multipurpose modules for sound and video, including VCAs, VCOs, VCFs, LFOs, envelope generators, sample-and-holds and a video-specific sync generator and encoder.

The modules are encased in clear acrylic tubes, which are placed inside holes in a custom-made 2-x-9-x-4-ft table. The top of each module is etched with a drawing based on video stills from recordings of the instrument’s output as well as graphic signs forming a legend for each of the inputs/outputs. The name *Sync Armonica* reflects an analogy between the flow of water and the flow of electricity, as it is inspired by Glass Harps or Glass Armonicas—glass cups of water that are rubbed with the fingertips to produce tones. Because of the modular nature of this instrument, each composition is created within a patch; a pattern of interconnections between the different modules made using ¼-in cables. The technical construction of the patch becomes a central element of the work. We use the mass of colorful cables as an aesthetic element in the physical presence of the instruments and develop visual scores for each piece. Other recent work from this series develops the patch composition into circuit-composition works, where the connections are done internally within an electronic circuit that is hard-wired to produce its particular output.

*Coat of Embrace* is a portable, wearable handmade AV synthesizer. Modules similar to those used in *Sync Armonica* were installed inside two 24-x-24-x-6-in boxes. In this version, many of the connections between the different modules are made using switches rather than exclusively through cables.

On the faces of the boxes are drawings of a monkey and a dragon, drawing inspiration from medieval coats of arms based on visual symbols and codes that retell family stories.

*Glome Mountain* is an installation in which our AV synthesizer expands into a room-sized object. The piece was created for Lumens Evolution Festival in Leeds, U.K. During a 2-day workshop, students participated in the soldering of the different components and boards, which were then mounted on a 7-x-7-x-6-ft cardboard structure.

The piece was designed as an inside-out video synthesizer inspired by four-dimensional mathematics and built to be played from the inside while projecting sound and image outside into the performance room. At the end of the workshop the students themselves performed from within the instrument.

**Note**

1. *Inverted H-Barn*, a new piece based on modules from *Kiss Blink Sync Vessel* was shown at the Neuberger Museum in Purchase, NY, 11 February–20 May 2007.

LoVid is the interdisciplinary artist duo of Tali Hinkis and Kyle Lapidus. LoVid’s work includes live video installations, sculptures, digital prints, patchworks, web projects, performances and video recordings. LoVid explores the translation, decay and preservation of natural, electrical and biological signals through time and memory.
COMPUTERS AS MUSICAL INSTRUMENTS? FROM COMPUTERMUSIC I <EXPLODED VIEW> TO BANDONEONBOOK

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A video example related to this article is available at <www.hans-w-koch.org/video/trailer.html>.

Now that so much of today's music is produced at every level with the assistance of computers, a title like the above seems rather old fashioned. However, when I started working with computers in 1996, I could not help asking myself whether the sound actually came from the computer hardware producing the music or rather resulted from the software running in it.

My first attempt at clarification resulted in my opening up that black box (actually mostly rather gray), attaching thin audio wires to the legs of the circuitry and diving into the world of hums, chirps, clicks and sudden bursts emanating from the motherboard. I called the result computermusic I <exploded view> (1996) and did not care that the process was lethal to the machine.

Later, when I started to appreciate working with software such as Max/MSP as well, my question was reshaped: Is it possible to find—besides clock speed, CPU power, bit depth, etc.—something specific to a certain machine that can pass as an instrumental quality for that model, similar to how, for example, even the cheapest plastic recorders are different from one another?

My research turned to hardware-specific aspects of Powerbooks, which can be of instrumental quality, and I began articulating these aspects with the help of patches and interfaces.

For example, when Apple introduced the Titanium Powerbook series in 2001, the heralded advance came with a very special design flaw: The built-in microphone that sat directly next to the left speaker began merrily feedbacking as soon as one tried to use both.

My piece bandoneonbook (2003) (Fig. 18) builds upon that feedback and makes it playable with the help of a Maxpatch. Two parallel filter lines, controlled by the keyboard, allow for an almost independent two-voice polyphonic texture while opening and closing the lid influences the dynamics and the timbral quality of the sound. The resulting instrument is perhaps not ideal for making people tango but has a rather intimate sound, suited for soft and ethereal moments. (In the later Aluminium series, Apple corrected the microphone placement, and while it is still possible to have that feedback, controlling the volume with the lid has become almost impossible.)

Another piece from this series, electroviola (2001), explores the viola-like qualities of an old Pismo by bowing on its lid, where the built-in microphone is sitting. The picked-up frictions control the bowing aspects of a viola's physical model. The title is a reference to the piece violectra by my teacher Johannes Fritsch, who played the "electrified viola" in Stockhausen's ensemble.

Of course this approach to computers as musical instruments has its disadvantages: Each piece requires its dedicated machine, and I can therefore sometimes find myself traveling with three different generations of Powerbooks. However, since it seems comparatively easy to tap into a recent Powerbook's sudden-motion sensor, keyboard-backlight sensor or fan-spinning speed control (as has been done successfully by others), there is still something left to explore, money permitting.

hans w. koch (mostly) lives in Cologne as a freelance composer and sound artist. In addition to creating open musical forms for various ensembles, often interdisciplinarily and incorporating live electronics, he develops (sound) installations, some in mixed media. Often the search for hidden aspects of everyday tools leads to sounds and musical structures. This also extends to the use of computers as musical instruments in a rather physical manner. In the spring 2007 semester he taught as visiting professor of composition and experimental sound practices at CalArts, near Los Angeles.

TRANSITION OF AN INSTRUMENT: THE AEO SOUND PERFORMANCE PROJECT

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Video examples related to this article are available. See the references section.

AEO is a sound performance project consisting of three members: Eye, Taeji Sawai and myself [1]. AEO has performed at several international festivals [2]. Each member takes one of three roles: in this project, performer (Eye), sound designer (Sawai) and instrument designer (me). During AEO performances, the performer holds the instrument...
in one hand and sways or shakes or swings it. These motions by the performer produce patterns of sound and light.

The instrument consists of two sets of hand-held plastic spheres, a converter and software. Each sphere contains a two-axis accelerometer, which converts the inclination and acceleration of each sphere into changes in analog voltage. Each sphere is connected to the converter with a cable. The converter provides the power for the accelerometers and converts the changes of voltage into signals. The software maps the signals onto sound parameters. The instrument has undergone a transition in function and form over four iterations (Fig. 19). I describe here the instrument’s enduring features and its transition over four iterations with respect to its switches, bulbs, color, converter and software.

In the first iteration, in accordance with the progress of the performance, the sound designer controlled the sound patterns. In the second iteration, a switch was added to one sphere, enabling the performer to control the sound patterns. The sound patterns were arranged in series, and the switch allowed the performer to choose the pattern with this switch. The performer also could use the switch to control the timing of changes in the sound patterns manually during the performance.

In the third iteration, two more switches were added for each sphere. The patterns of sound were independently arranged in series for each sphere, and the performer could adjust the sound patterns with these switches. In this iteration, the instrument transformed the performer’s motions not only into sound but also into light. A small bulb was added to each sphere; the brightness of the bulb did not correspond directly to the signal from the accelerometer but instead corresponded to the amplitude of the sound. To provide high-current Pulse Width Modulation (PWM) for control of the brightness of the bulb, the converter model was changed from I-Cube X to Makingthings Teleo.

In the fourth iteration, one switch was removed from each sphere. The sound patterns for each sphere were combined and arranged in series. The performer could adjust the sound patterns with these switches. The cap of the switch was embedded into the sphere to prevent its dropping out during performance. The sphere was made semitranslucent to show the color of the bulb. The caps of the switch and the connector of the cable were colorized to differentiate each sphere.

In each iteration, the software was also modified to correspond to the changes in the switches, bulbs and converters.

Through the four iterations, I tried to make the instrument act not only as a tool that the performer uses to play sound but also as an object that presents a combination of motion and sound to the audience. Although it is difficult to divide function and form, I aimed for a balance between the two. As a result, I added and removed switches, added bulbs and changed the color, converter model and software of the instrument.

It may be helpful to consider the design of physical objects in music and sound art not only at the point of initial creation but also continuously through various transitions [3].

References
1. Each member works on other artistic projects: Eye is a member of Boredoms <www.boredoms.co.uk>.

Fig. 19. (top left) 1st iteration; (top center) 2nd iteration; (top right) 3rd iteration; (bottom, left and right) 4th iteration. (Photos © Kazuhiro Jo)
disruption in the history and philosophy of musical interaction. This was an invention that made virtuosic performance available in some way to any household that could afford it, but at the expense of the flexibility and expressiveness that a live player could provide. The steel sculpture Player Piano symbolized a desire to sustain immediate contact with musical objects in the context of those emerging technologies that alienated the corporeal performer. It was influenced by hand-cranked barrel organs and elements of piano design: the fully symmetrical, balanced sitting posture, the frontal presentation of the paper roll, and the integration of organic linear patterns into an otherwise squarish, heavy shape. Handwritten text on a vintage piano roll of Franz Liszt’s Liebestraum discusses the physical demands of performance and the possibility of injury, as well as Heinrich Heine’s account of one of Liszt’s recitals. Liszt was known for having defined the modern concept of the virtuoso, through his physically and technically demanding music.

My work in the plastic arts strives for an interpretation not resting solely on verbal dialogue but also on kinesthetic and emotional responses in the viewer. Player Piano (Fig. 20) is a transfiguration of the piano and the activities associated with it: reading and simultaneous hand movement. Resembling a writing desk, it invites visitors in an exhibition setting to sit and read the text, using a slow and patient rotation of the hand crank. What follows is an excerpt from the writing:

The piano addresses the sense of immediate touch. Here I feel the physicality of silence, the layer of space beneath the hand that cannot be controlled or penetrated until the rest ends. This breathing space splits the unity of the two hands; they become equally entitled. . . . They create an argument for primacy.

This text is an interpretation of J.S. Bach’s keyboard works. Each voice is treated equally, and every note is given a separate impulse. This is essential to counterpoint, reflected in the composition and in the use of the hands.

The Romantic melancholy evoked by the sculpture, the industrial building material and the exaggerated prose reflect an extended period of time when the trajectory of technological advance and the effects of urbanization came into conflict with sociological concerns. Now, more than ever, there exists the question of whether the organic person will continue to function during such rapid development. This pattern of transformation, however, is dialogic: the instrument modifies the performer’s bearing, general body use, reflexes and mannerisms. Most Western instruments were no longer objects of substantial experimentation by the 19th century. Piano makers, however, made a significant structural advance with the introduction of the internal cast-iron frame in the 1820s. The instrument itself was then more capable, with an expanded keyboard, creating a higher demand on the performer.

Many recognize that expert performance relies largely on kinesthetic sensations, or muscle memory, and less on aurally perceived information. Yet what is lacking, not only in the general public, but in specialized musical practice as well, is a developed and analytical understanding of proprioception (internal feelings of muscular contraction or expansion, balance and weight distribution). The reciprocal, upward pressure from the piano key as the action returns to its resting position points to the mechanical behavior of the instrument as well as the opposite force supplied by the player.

Physically active interfaces create a
perceptual unity, a reciprocal transmission of movement and vibration in the auditory or extra-auditory range. Through this unity, a “vital touch” can be achieved. It is correct to approach music study by addressing the player’s physical apparatus, just as it is important to understand the behavior of the oral and nasal cavities while learning a new language. The body is a medium of music. In fact, almost all instruments are built to a human measure, centered on the human hearing range and bodily proportions.

New interfaces, acoustic or electronic, disrupt familiar notions of musical interaction; yet this provides a possibility for critical dialogue on the concept of sensorial unity. I would like to continue developing greater physiological literacy and aesthetic grounding for the advancement of musical practice, especially in the context of the potentially dissociative effects of emerging technologies. This new direction may even come from examples so burdened with history as the piano.

Laura Emeliantoff is a metal sculptor and classically trained pianist. She builds unique acoustic instruments and sonic electromechanical systems; currently she is designing resonant steel structures based on harmonic proportions.

**SIMULATED CHANCE AND STAGGERED GEAR RATIOS**

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One of my primary artistic activities has long been to create mechanical representations of chance, to try to capture the incredibly complex non-linearity of the world around us using only very linear, 19th-century, Newtonian technology—brass gears, motors, hand-built crankshafts.

My artwork has always been concerned with chance, and human perceptions of causality, but I had initially employed more symbolic depictions of these phenomena, such as small, mechanized dioramas, or dice as a symbol of chance. In the late 1990s, I discovered several sources that would expand my outlook on random and semi-random processes, among them James Gleick’s *Chaos* and Brian Eno’s *Year with Swollen Appendices*, in which he writes about Steve Reich’s early tape works and his own “Generative Music.” I thought that such processes—the overlapping of several simple elements to achieve complexity—would be an excellent way to actually incorporate chance, or at least perceived chance, into my own artwork, rather than just symbolizing it—and it was only a matter of combining simple mechanical systems rather than designing new, complex machines.

I began using these systems in two visually oriented pieces, *Mandala #2* (2000) and *Haiku Machine* (2002). In *Mandala #2*, 16 dice, arranged in a grid under a bell jar, all roll at different speeds, powered by one motor hidden under the base (see cover of this issue of LMJ). Due to my use of unusual gear ratios (say, 1:1.7, rather than 1:2) in the gears that connect the drive shafts to the dice’s axles, very few of the cycles line up again at once, and it becomes impossible to predict the patterns of all the tumbling dice, despite the fact that all actual randomness has been stripped from them. *Haiku Machine* works in a similar way, but uses three rows of motorized paper spools, each with six words printed around them, constantly rolling at different speeds. Six words per spool times nine spools produces 10,077,696 haiku.

For my first sound sculpture, I decided to use these same methods again. *Randomized Red Piano* (2005) (Fig. 21) is a tiny, worn toy piano, which I mounted atop a tall tower to fetishize it to a degree. It has 10 keys, all producing miserably tinny sounds. In the base, four motors turn 10 small crankshafts, each at a different speed, which then raise the long “pull-rods” that latch onto spring-powered levers at the top, which when released strike the keys.

The gear ratios for this piece were chosen to be truly randomizing. The drive shaft gears have either 21 or 23 teeth, while the crankshaft gears, with which they mesh, all have even numbers of teeth. This produces such ratios as 1:1.391, 1:1.417, 1:1.714 . . . Since the motors turn at a slow 1 rpm, it will take an incredibly long time for the cycles of all 10 gears to come back and line up the same again. The viewer/listener is extremely unlikely to hear the same sequence twice, and interesting moments do occur: randomized chords; arpeggios.

Although I am working on several new installations using digital randomizers, I do have two more mechanized pieces in the works. *Crawling Clavichord* is a slow-moving “cart” of 29 piano hammers from a salvaged piano, semi-randomly striking a row of 29 wires strung tightly across a gallery. The cart travels along on sprocket chains strung on either side of the wires, and the wires have guitar pickups and amplifiers on both ends. As the motorized cart slowly crosses the room, the tones and overtones on each side of the cart’s hammers change. The cart then reverses itself after bumping into either wall.

My other staggered gear piece is titled *Randomized Gregorian Piano* and is somewhat similar to the *Red Piano*. However, this machine is designed to be installed onto the keys of an already existing grand piano in the gallery space (a converted church), and instead of each gear playing an individual note, every *octave* on the keyboard has its own little machine that repeats snippets of melody, each at a slightly different speed. These snippets of melody are taken from old Gregorian chants. It will be a very pretty chaos as the repeating cycles of melody overlap unpredictably.

Marc Berghaus is a sculptor, photographer and sound artist living in Kansas, and has exhibited throughout the Midwest and western United States. Examples of his work can be seen and heard at <www.marcberghaus.com>.
The drum circle is a rich field for innovation and use of nontraditional materials and techniques to make music [1,2]. Over years of enthusiastic participation in river-camp drum circles, I have made quite a few instruments in order to create different tambours, to avoid the impulse to buy things and to simply show off entertaining stuff.

One of my favorite instruments is a collection of metal containers that I call the river gamelan (Fig. 22), originating from electric blowers used by river-rafting companies to blow up inflatable rafts before trips. After making one good blower out of two bad ones, I had housing left over. I kept the housing because it made interesting noises and put it in my kit of drums and percussion for the upcoming trip’s drum circles. One night at the fire, having gotten a beat going, I was passing out some percussion instruments. I held up one part of the blower housing and a little stick. One lady reached out for it; I gave it to her and went on. When the other half of the housing came out of the bag, she wanted that too. Pretty soon she had all my metal bits arranged on the bench beside her. Her groove sounded like Javanese gamelan music. I now keep the kit together and often play the river gamelan in small circles. If I step away, it does not take long until someone else sits down and gets a different sound from it than mine.

Some drum circle beginners are reluctant to hammer out their beats on a big drum. Many, however, will take a shaker and join in. As a substitute for expensive store-bought shakers, I use a plastic cosmetics container, cheaply available at certain big-box stores, and a tablespoon of BB ammunition. I screw the lid on and take one pass around the side and cap with transparent strapping tape.

I once had a tea can with some rivets in it that produced a nice buzzing sound. A friend took it, along with a stick, and customized it in a fit of drum-circle enthusiasm. It looked bad but, when stroked with a crenellated stick, made a rack-a-rack-a sound: a shaker and guiro in one. Also, if one taps on the bottom with the end of the stick and also brings the tea-can shaker down on the thigh, one can obtain a chick-a-tap-a sound.

For a totally different effect, when the circle grows quiet, a scratching sound is sometimes nice. Two small sanding disks with coarse grit sandpaper can be manipulated to yield many different qualities of scratch and whiz. At a camping store, I found a little bicycle bell that, when the cap was turned in either direction, made a very nice high-pitched ringing and could be easily manipulated to maintain some pretty complex patterns.

For the pure joy of showing off at a big drum circle, the gong rack is the big winner. I had restrung a friend’s gamelan nipple gongs to their original rack with some sturdy plastic-covered seven-strand fishing wire. This repair led me to the thought that it would be nice to have a sound like that in other drum circle venues. I obtained a set of five Thai nipple gongs by mail order and designed a rack to secure them to an upright drum I had in use for some years. The rack is just laminated plywood, with cutouts for each gong and holes for the seven-strand supporting wires.

When a spontaneous drum circle forms and conventional percussion resources are unavailable, do not panic. Whatever is at hand can often be brought to bear. I have joined in from time to time with nothing more that a Swiss Army knife and an empty beer bottle. With these one can find a variety of sounds depending on where the bottle is tapped and how it is held.

References and Note
