Low Brass: The Evolution of Trombone-Propelled Electronics

Nicolas Collins

ABSTRACT

The author describes the hybrid electroacoustic instruments that he designed and built and discusses compositions, recordings and improvised performances using them. The instruments incorporate electronic circuitry, microcomputers, elements of more or less traditional acoustic instruments, and arcane mechanical contrivances, all of the author's own design or modification.

I am a composer. I build instruments because I have to—because my interests, needs and desires seem forever out of sync with the market. In the backwash of the Cagean edict that 'any sound can be a musical sound', I find that I have no great instinct for originating sounds of my own, and much prefer to recycle existing ones. I love radio, bird songs, feedback, filmstrip soundtracks, fish croaks, scratched records, cheap electronic toys. I love not so much the sounds per se but the confusion and tension of sounds divorced from context: juxtaposed, superimposed, intercut, interrupted; one moment unrecognizably abstract, the next identifiable tags; one moment clearly a quote, the next seemingly the composer's own voice. I work at shifting the location of meaning in sounds back and forth between pure acoustical presence and messy cultural significance, from the tiny fragments that constitute sonority to the interconnections that belie phrase, form, structure, music.

Begin with playing a note or synthesizing a sound, and this tension is lost. But because initiating sound is fundamental to most other forms of music, I find myself poorly served by the manufacturers of musical instruments, both acoustic and electronic. (For every decent signal processor made today there seem to be a dozen synthesizers. As a synthesizer-control standard, Musical Instrument Digital Interface [MIDI] is optimized for articulating notes—only recently has it been implemented well enough in a handful of signal processors to allow truly musical real-time control.) In designing my instruments I have always been drawn to mixing technologies: computers and cheap electric guitars, homemade circuits and hot-wired rock boxes, cast-off brass instruments and feedback systems. This article is about one such instrument, which I call 'trombone-propelled electronics'.

Building and programming are time-consuming processes, but I have ended up with instruments that have a distinctly personal character, that I can afford, and that often are much more powerful—if specialized—than anything available commercially. Most importantly, buried in the mechanics of instrument design can be the seeds of music.

The early 1970s, when I studied composition with Alvin Lucier at Wesleyan University, marked the beginning of the trickle-down of electronic technology into the realm of the affordable and comprehensible. Synthesizers were making their way into university studios, but not yet directly into the hands of impoverished students. At the same time the first wave of cheap integrated circuits was providing essential electronic building blocks for those willing to learn how to use them. So while Alvin Lucier taught me composition and I studied synthesizers in the studio, I slowly acquired an understanding of circuitry through reading and blowing out chips in an unused corner of a physics lab. Later I learned microcomputer programming by slogging through a manual one long hot summer. Consequently, for almost as long as I have been composing I have been building specialized instruments for transforming 'found' sound material. The trombone-propelled electronics has its roots in two earlier such instruments: my 'backwards guitars' and a crude sampling system I assembled for a composition entitled *Devil's Music.*

Backwards Guitars

In 1981 I became interested in using the acoustical properties of strings to transform sounds. With an eye toward both economy and the natural theater of the electric guitar, I bought some of the cheapest, most garish electric guitars and basses I could find in New York pawn shops and modified them for my pieces. Using a high-voltage amplifier circuit, I was able to play sounds generated by radio, tapes, electronic toys and simple circuits *into* the existing guitar pickups to resonate the strings. Sensitive contact microphones in the bridge pick up the string vibrations for subsequent amplification. The interaction of the harmonic series of the source material with that of the strings produces a resonant wash of sound, not unlike shouting into a piano with the sustain pedal depressed.

The players select among various sound sources using small keypads on the instruments, which are linked to a computer-controlled audio multiplexer. They fret, re-tune, dampen and 'prepare' the strings to control the physical transformation of the original sounds. The 'left-hand technique' can be seen as an extension of modern guitar technique, while the right hand calls up different excitation sources instead of—or in addition to—whacking the strings directly [1].

The backwards guitar is my version of the Karplus-Strong 'plucked string algorithm'. It is crude and laden with pop iconography, but it sounds gorgeous, has an extraordinary

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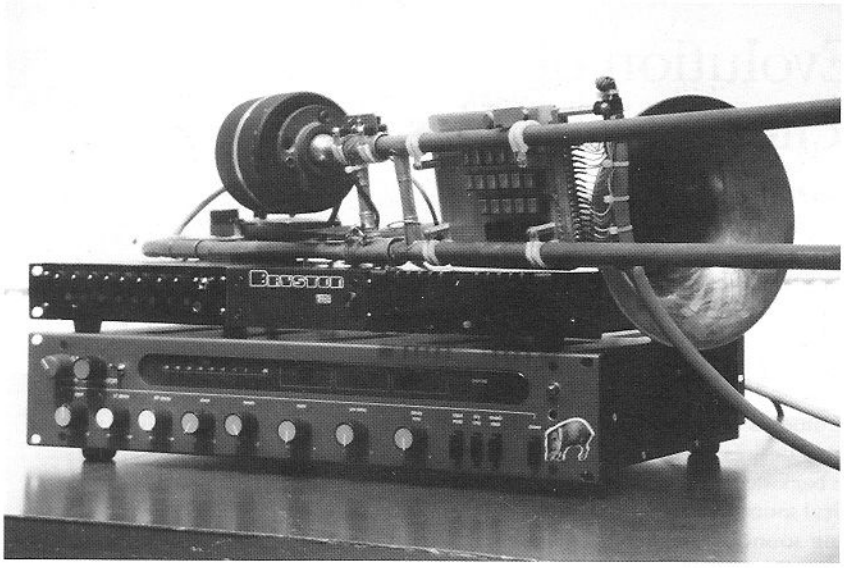

Fig. 1. Trombone controller, showing trombone, modified Ursa Major Stargate and modified Bryston amplifier (for trombone speaker), with custom computer-controlled mixer for Ursa input selection.

tactile quality and instant audience appeal, and produces the kind of irrational sound transformations that cannot be attained with even cutting-edge computer signal processing.

Devil's Music

For *Devil's Music* (1985) I modified inexpensive samplers by ElectroHarmonix (a '16-Second Delay' and two 'Super Replays') to incorporate simple 'stuttering circuits' that re-trigger or reverse the sample in response to the rhythm of the audio signal feeding the box. I wired the three together so samples could be shuffled back and forth among them. All of the sound material comes from radio transmissions picked up live during the performance. The performer sweeps the radio dial in search of source material, loads 1–2 sec of sound into one of the samplers, adjusts the 'stuttering sensitivity' as the different loops phase and collide with one another, and occasionally detunes them to set up beating patterns or produce radical pitch shifts. Load one sample of easy-listening music into all three boxes and we hear something like an anarchic remix of early Steve Reich or Phillip Glass; one loop of 'hip-hop' music plus one Chevy advertisement plus interstation static yields the ultimate dance floor break (I have been told that the vinyl version of *Devil's Music* is currently being played in Berlin Acid House dance clubs). The running stream of live radio is always present, providing a ghost-like structural underpinning. The equipment is very simple, as is my one modification, but that U.S. $1.00 stuttering circuit defines the whole rhythmic character of the piece.

Devil's Music is my quintessential 'found material' composition: the whole performance is put together from local radio stations in each town I visit. And in every performance there comes that lovely moment when the audience recognizes just what they are hearing, realizes that the music is as much theirs as mine: a local football game, an identifiable newscaster or a set of call letters triggers a shift in the listeners' perspective.

Trombone-Propelled Electronics

Unlike the use of the 'backwards guitars' with their obvious visual appeal, in performance *Devil's Music* has a cool, introspective presence. When I started on the next instrument after composing *Devil's Music,* I wanted both to increase the flexibility of my signal processing and to develop a controller that had a greater physical presence than did the switches and knobs of the ElectroHarmonix boxes. Trombone-propelled electronics was the result.

When I began the project in 1986, there was no commercially available device that fit my requirements. Real-time signal processing fell into a void between pricey instruments that sampled sounds for storage and retrieval from floppy disk, and simple digital delays for live looping. The prospect of building and/or programming a system from scratch was daunting and ran contrary to my natural scavenging instinct, so I sought equipment that could be modified to suit my needs.

For the circuitry I settled on an Ursa Major Stargate Digital Reverb (Fig. 1). Designed in 1983, the Stargate is a pre-MIDI device that offers several different reverberation and effect algorithms. The machine contains no microprocessors or digital signal processor (DSP) chips—all signal processing is accomplished with discrete digital hardware: a circuit board full of TTL counters, adders, multiplexers, logic gates and EPROMS. At first glance this seems to make the machine rather limited and incapable of customization, since the only controls are three 16-position rotary switches on the front panel for selecting the algorithm and adjusting two parameters within it (such as reverb time and pre-delay). In reality the opposite is true: the hardware design is elegant and logical and invites tinkering. With the addition of some simple interface circuitry I was able to hook up a cheap single-board microcomputer (Commodore 64) to automate the panel controls. By emulating the behavior of individual chips in the Stargate with parallel ports and software counters in the microcomputer, I implemented direct computer control of numerous parameters of the signal processing. If I imitate the 'correct' operation of the original chips I can run the Stargate as intended (as a straight reverberator, for example), but by resetting counters and redirecting logic I can produce a wide range of effects unanticipated by its designers. I can instantaneously catch a sample, make a loop and change its length, start point, pitch or loudness. By interfering with the reverb algorithms, I can perform a wide range of unusual timbral modifications on the sound coming through the system. Some are familiar multi-tap delay effects, but some are unique to this device.

For the controller I chose an old trombone I had bought years earlier for U.S. $12. I have never played trombone, but it reminded me of a giant slide pot, such as one might find on a huge sound mixer, and seemed an excellent candidate for an electronic control. On the crook of the instrument I mounted an optical shaft encoder that is coupled to the slide via a retractable dog leash (Fig. 2). A small keypad is attached to the slide; pressing one of its 21 keys while moving the slide signals the computer to change a corresponding

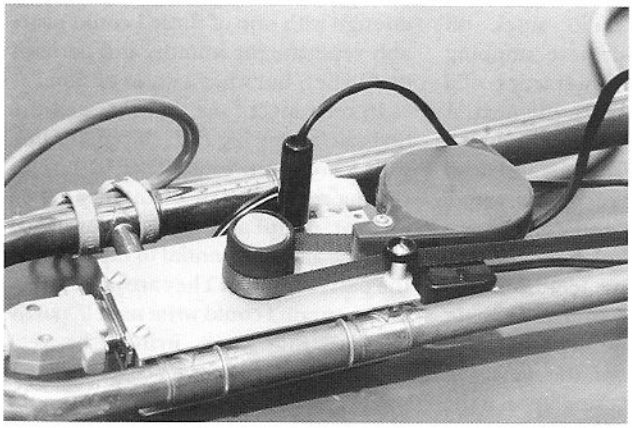

Fig. 2. Trombone controller, detail of retractable dog leash and optical shaft encoder.

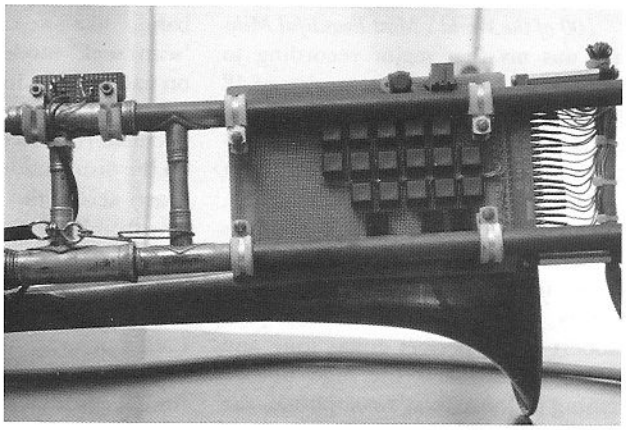

Fig. 3. Trombone controller, detail of keyboard.

aspect of the sound (Fig. 3). Pushing the slide out increases a value in direct proportion to distance (i.e. lowers the pitch), while pulling it in decreases this value (raises the pitch). Functioning somewhat like a 'mouse' input device of a computer, the slide is used to adjust any of the system's variables. Certain keys toggle functions directly, set limits to values, scale control curves or otherwise direct the behavior of the Commodore 64 or Stargate. The shaft encoder and keypad are read directly by the computer and their interpretation is software reconfigurable. Additional circuitry lets me select which of eight input signals to sample or process—these can be prepared tapes, compact disks, microphones picking up players' sounds, a radio whose tuning can also be controlled from the slide, etc.

A speaker-driver (from a sound reinforcement public-address system high-frequency horn) is attached to the trombone mouthpiece, transforming the instrument into a loudspeaker. Moving the slide changes the acoustical quality of this speaker by reinforcing different harmonics in different positions; ordinary trombone mutes can be used for further acoustic manipulation. A mono output from the Ursa Major is sent to this speaker, while a stereo output is sent to the main amplifiers and speakers; the performer can adjust the balance between these signals from the trombone-speaker. Since the instrument reproduces only frequencies above 800 Hz, the player can think of it as a 'tweeter', complementing the extended low-end of the stereo outputs. The trombone-speaker has a wonderfully tinny 'low-fidelity' sound—a bit like an old gramophone—and shifting the balance between the full-range stereo outputs and the trombone-speaker is an essential, and seductive, part of the instrument's character.

Mounted near the mouthpiece is a standard synthesizer 'breath controller', whose output is read by the computer: by blowing into it the performer can control the sample's loudness or tuning. The keypad and slide are used to assign the breath control to the desired parameters and adjust the range and direction of its effect.

The Commodore processor board and interface circuitry are built into the chassis of the Stargate. To modify my operating software (written in 6502 Assembler Language), I simply take off the top plate, hook up the disk drive, keyboard and monitor, and burn a new EPROM when I have finished. The trombone-speaker is powered by a modified Bryston power amplifier that sits on top of the Stargate; the chassis of the Bryston also contains the automated mixer used to select input signals for processing and an auxiliary power supply needed for the computer and interface circuitry. A multi-conductor cable links the trombone to the electronics. The entire system is quite compact and just light enough to lug from train to train when touring solo.

The acoustical presence of the trombone-speaker and the articulation of sounds by slide and breath give touch and presence to this Rube Goldberg-esque style hybrid of modern digital electronics and primordial brass technology. It is a *real* instrument. It has a certain charm that musicians with whom I have played and audience members seem to find captivating. It is also different, new, and a bit mysterious on first encounter. Although I designed the instrument around the assumption that the use of the slide as a highly visible controller would bring a degree of clarity and perceived causality to performance gestures—characteristics all too lacking in much electronic knob twiddling and computer keyboard thwacking—some people have difficulty with the idea of a 'soft controller', with which a single gesture can be used to affect different parameters of sound. Once the similarity to a computer mouse is pointed out, anybody who has worked with computers quickly comprehends the system, but to the uninitiated there is something baffling about a movement that changes pitch at one time and loudness the next, unlike the predictable outcome of the arc of a violin bow or, for that matter, the lunge of the slide of a 'real' trombone. Nonetheless, the apparently quixotic relationship between physical action and sonic response fascinates people, even those who do not understand it, and the instrument succeeds in ways I had never anticipated.

Music

Before working with the trombone-propelled electronics I never considered myself a 'player'. Each of the instruments I had built had been designed for a specific composition and was bound to it by virtue of its limitations. My trombone is different; it has an adaptability and degree of control that have carried it through a wide range of musical applications, from solo compositions to ensemble improvisation, from Guy Klucevsek's *Polka from the Fringe* to John Zorn's *Cobra*, from an album of Bobby Goldsboro songs recorded by When People Were Shorter And Lived By The Water, to my own compact disc (CD) of improvised duos, *100 of the World's Most Beautiful Melodies.*

100 of the World's Most Beautiful Melodies was my first major recording to feature the trombone. It consists of 42 brief, improvised duets with 15 musicians. For each duet I picked an emblem of the artist's personal style—not necessarily a 'signature' characteristic, but a quirk that linked our (sometimes disparate) musical inclinations: the rapid timbral juxtapositions of Ben Neill's triple-belled 'Mutantrumpet', Robert Poss's perfect guitar tone and sheets of feedback, the high heterodyning of John Zorn's saxophone, the simple ticks and pops of Christian Marclay's records, Peter Cusack's idiosyncratic 'Gate Crasher' circuitry for cutting up environmental tapes, George Lewis's uncanny affinity for plumbing, the pathetic wheezing of Anthony Coleman's aged electric organ, and so on. With the trombone I grabbed fragments of each musician's performance, drew them out, transformed them and played them back as my own voice in the duet. Occasionally I introduced snippets of shortwave radio or recordings of birds, fish, brass bands, noisy radiators, sex education dialogues or other inspirational sound bites.

All the duets were recorded live with no overdubs. Their extreme brevity—most are under 2 min—encourages attention to sonic detail and produces a formal clarity often lacking in longer structures. By using the trombone, an instrument that literally freezes moments of performance, I tried to limit the range of musical development within each duet and let it evolve instead across the entirety of the CD. Each duet represents a study in shared musical responsibility—which is, after all, what good improvisation strives for—while the sequence lies in the domain of composition. In the spirit of John Cage's and Lejaren Hiller's *HPSCHD* (the Nonesuch recording contained a computer-generated score for the 'playing' of stereo controls), listeners have the option of involving themselves in a further level of performance by using the random access capabilities of the CD player to rearrange the 42 cuts.

100 of the World's Most Beautiful Melodies could be thought of as classic tape collage adapted for the CD age. My compositions for live performance, on the other hand, are each a concise exploration of a single narrowly defined subject. In *Real Electronic Music* a hot-wired radio scans through the FM band, like a car radio stuck on 'scan/seek' mode, but here stopping on each station for only a fraction of a second before flying off to the next. A peculiar rhythm is established, based on the distribution of stations and dead space across the range of the radio. The trombone stretches these snippets into a rich sonic landscape of driving rhythms, shrieking feedback and wobbly reverberation. In *Tobabo Fonio,* I attempt a reconstruction of recorded brass-band music from the Peruvian Andes, essentially imposing upon it the kind of structural adaptations and cultural misunderstandings that accompanied its own diversionary course from European band music. The performance begins with the trombone spraying a resonant drone around the room, gradually giving way to bursts of trumpet riffs and drum rolls, briefly revealing its core of Cuzceña music before fading away. *Baby It's You* and *Roy* are love songs to pop songs—creative reconstitutions of, and homages to, two icons of popular music (The Shirelles and Roy Orbison, respectively). In *Pet Sounds* a 3-min tape composition drawn from sound effects recordings is processed three times: once through a backwards guitar, once through my trombone and once through the two in series. *Credenza* is a duet for Mutantrumpet (played by Ben Neill) and my trombone in which I process not only the trumpet sounds but also brass music played on a CD player that has been modified to allow the sounds of 'scratching'. *Son of Devil's Music* spins variations on fragments of local radio broadcasts.

Conclusion

In both the improvisational work and the composed pieces, the trombone has proven itself to be a very adaptable system for capturing, suspending and altering shards of sound—a sort of musical Cuisinart. Its odd acoustic character sets it apart from any other DSP system in the world (as far as I know). Even the electronics themselves have their own voice. There is something about the sound of the appropriated and mangled algorithms of the Stargate that I have been unable to find in any of the more recent, often more powerful, MIDI-signal processors. DSP cards are readily available for various computers, and I suppose if I worked hard enough with one of these I could probably replicate my sounds, and perhaps go further, but what a waste of time.

In retrospect I see that I treated the Stargate as one big DSP chip that came with a compact 'tool kit' of basic processing routines. These routines are so elegant, useful and musical as to have become almost essential to my music of the past four years. They are better than any program I could write myself, partly because they were written by real engineers, but mostly because of the way they fortuitously accept corruption. Computer music in general seems sadly deficient in 'benevolent catastrophe'. The analog circuitry of older electronic music usually sounded best and did the most interesting things when it was being 'misused' or was on the verge of breakdown—but computers typically go silent or drone listlessly when they get lost.

I subscribe to the 'good cop/bad cop' theory of instrument design: the dumb, plodding Commodore 64 buddied up with the fast-talking, high-strung Ursa Major misfit, an old trombone and a new-fangled dog leash. These make beautiful music together.

Acknowledgments

For technical advice on modifying the Ursa Major Stargate I am deeply indebted to Christopher Moore, Charles Anderson and Mark Bruckner of Ursa Major, Inc., Watertown, Massachusetts, U.S.A.

Note

1. Recorded examples of compositions that employ these instruments include *Killed in a Bar When He Was Only Three* (1981), *A Letter From My Uncle* (1984), *Say Uncle* (1986) and *Pet Sounds* (1987). The guitars have also been used in installation projects, such as *A Clearing of Deadness at One Hoarse Pool* (1983), with self-scanning radios and motor-driven 'whammy bars', or vibrato tailpieces.

Discography

Nicolas Collins, "Tobabo Fonio", *Aerial #3,* compilation, Nonsequitur Foundation, CD and cassette, 1991.

Nicolas Collins, producer, "Real Imaginary Music", *Imaginary Landscapes,* compilation, Nonesuch Records, CD and cassette, 1990.

Nicolas Collins, *100 of the World's Most Beautiful Melodies,* Trace Elements Records, CD, 1989.

Nicolas Collins and Robert Poss, "Pet Sounds" and "Say Uncle", *Inverse Guitar,* cassette, 1988.

Nicolas Collins, *Real Landscape,* Banned Cassettes, cassette, 1988. (Contains compilation of performances of *Devil's Music.*)

Nicolas Collins, *Devil's Music,* Trace Elements Records, 1986.

Nicolas Collins, "A Letter From My Uncle" and "A Clearing of Deadness at One Hoarse Pool", *Let the State Make the Selection,* Lovely Music, 1984.

Nicolas Collins and Ron Kuivala, "Is She/He Really Going Out with Him/Her/Them?", *Going Out with Slow Smoke,* Lovely Music, 1982.