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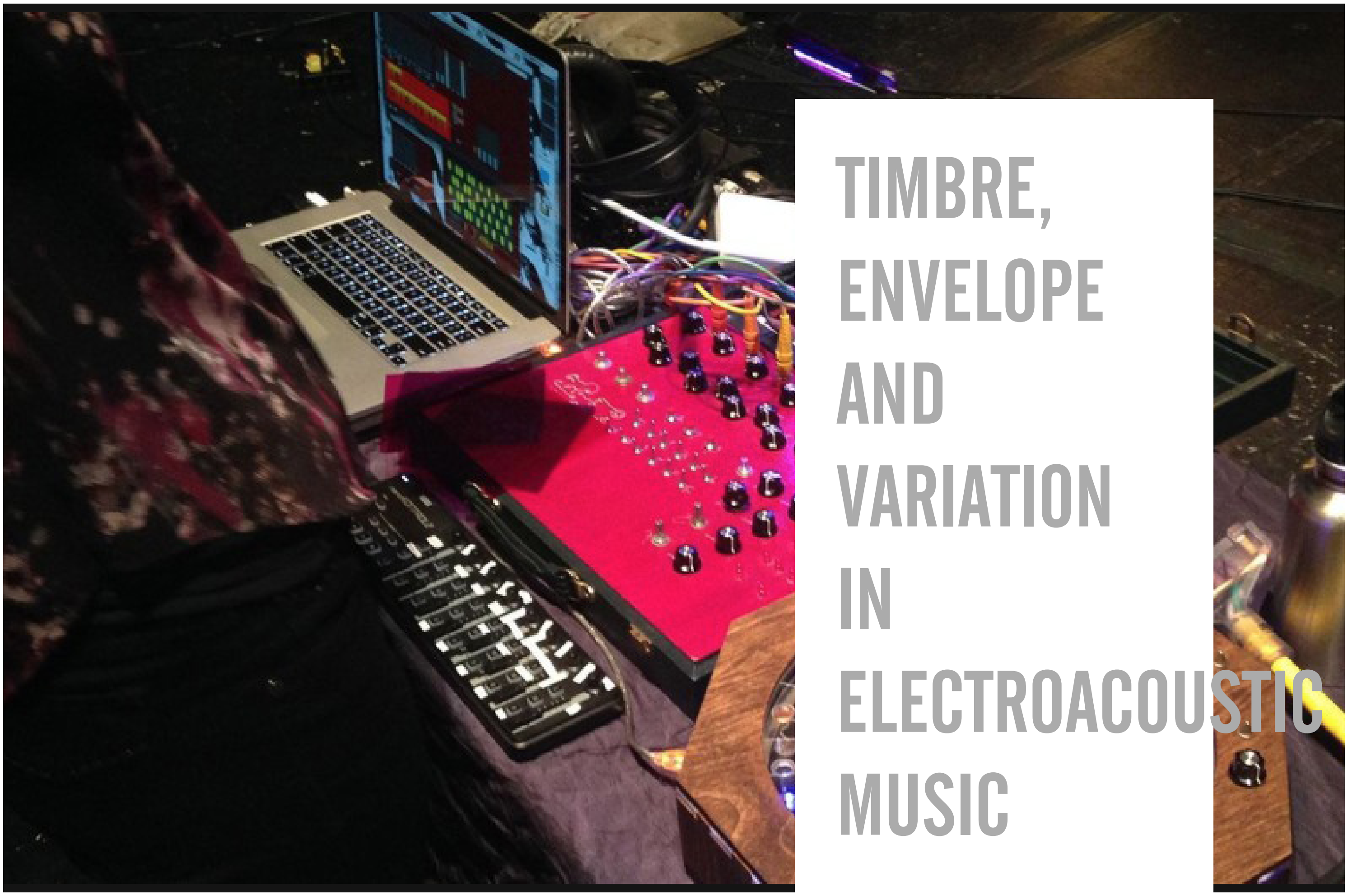

TIMBRE, ENVELOPE AND VARIATION IN ELECTROACOUSTIC MUSIC

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1. Timbre and Envelope

The timbre and envelope possibilites of electroacoustic music are rich and multifaceted. Timbre and envelope are intricately related and are major determinants of how effective a sound event in music will be.

Envelope

The term “envelope” when applied to music is the attack, sustain and decay of a sound. When performed by an acoustic musical instrument, depending on what the composer has notated in the score, the envelope of a particular note could begin with a *sforzando* attack, followed by a soft *piano* sustain, and an even softer *pianissimo* decay.

Timbre

The term “timbre” or tone quality or tone color is the quality that distinguishes different types of tone production, such as the difference between a flute and a trumpet playing the same note. The timbre of a sound depends on the number and relative strengths of that sound’s component frequencies, as determined by resonance. Acoustic musical instruments are typically based on an oscillator such as a column of air or a string which oscillates simultaneously at many frequencies. In acoustic instruments, these resonant frequencies are mostly limited to integer multiples (“harmonics”) of the lowest frequency, which largely determine what the human ear hears as the timbre of that particular instrument. At different dynamic levels, the relations of the resonant and other frequencies of an acoustic instrument typically shift or adjust to each other in a predictable manner.

In acoustic music composition, the composer has a wide spectrum to choose from in both envelope and timbre. In digital electroacoustic music, the composer has even wider options to choose from. The timbre and envelope possibilites of electroacoustic music are almost unlimited: the composer can invent her or his own timbre which is not limited to those that resonate in integer multiples of the lowest frequency.

To create such timbres, in pre-digital electroacoustic music one method was to submit a sound to changes which would occur a certain number of times per second, and see what happened. Any change more than 7 times per second was likely to be heard by the human ear as a change in timbre or even in pitch, whereas if imposed less than 7 times per second, the change might be heard as vibrato or tremolo. Many intriguing results could be obtained and used in a composition. But with digital electroacoustic technology, this kind of musical experimentation can be applied with much greater musical control, because smaller changes can be made at a time, which can be more likely to result in subtler, more musically useable results.

Using digital technology, a composer has access to a previously unimaginable level of control over both envelope and timbre. The digital options to vary timbre range from timbral modification of a single sample, to timbral modification of an attack or sustain or decay of a specific sound’s envelope, to timbral modification of a section of a work, or even timbral modification of an entire work. Likewise, in the imposition of envelope designs, the digital options range from imposing an envelope shape on a single sample of a sound (which will typically be heard as a timbral change) to the imposition of an envelope on a single note, to the imposition of an envelope shape on a whole section of a piece, or even to the imposition of an envelope shape on an entire pieece.

But at the present time, some composers have not yet taken advantage of these rich digital options for varying timbre and envelope. For example, as regards timbre, one can frequently hear pieces in which the composer uses a sine wave in low pitch register and attempts to massively boost the volume of this simple sound, which is essentially a funadmental without overtones. The composer has increased the dynamic of the fundamental pitch, presumably to make it sound more powerful, but such a simple sound lacks the overtones that if increased in volume could actually make the sound appear louder.

Such a low-pitched sine wave at high volume presents a health risk of noise-induced hearing loss by damaging the microscopic hair-like projections (stereocilia) in the inner ear. But in its musical effect, as long as that low-pitched sine wave at high volume continues, it obliterates all other musical activity, creating a loud, simple monophony, like the effect of an explosion, which when it's over leaves a sense of

A LOW-PITCHED SINE WAVE AT HIGH VOLUME PRESENTS A HEALTH RISK OF NOISE-

emptiness, a depleted musical energy.

INDUCED HEARING LOSS.

Part of the issue here may be the lack of awareness that there is a difference between the measured sound pressure level (SPL) and volume as perceived by the human ear. Over centuries, acoustic composers have developed techniques of orchestration as well as musical instuments that follow the perception of volume by the human ear. It's understanble that the emergence of pre-digital and digital electroacoustic technology makes it possible to simply turn up the dial, as it were, of a fundamental pitch, and some composers have made this weaker musical choice.

The desire for an increase in volume is easily satisfied by other means. The digital options for more effective musical results in timbre and orchestration are enormous, and one needn't settle for less powerful musical results. A basic tenet of the orchestration of instrumental music, when an increase in volume is desired, is not only for the composer to direct instrumentalists to play louder (which as mentioned above is likely to include increasing the resonance of the higher frequencies in their instrument's timbre) but also for the composer to bring in other instruments which play higher frequencies than the instruments which are playing the fundamental pitch. If there are other instruments available, acoustic orchestration does not have to simply increase the volume of the instrument playing the fundamental pitch in order to increase the perceived volume.

The same principle can be applied to the orchestration of electroacoustic music, adding higher frequencies as a way of increasing perceived volume. Not only can adding higher frequences be experienced by the human ear as a more powerful sound and a richer timbre, but since the energy is distributed over multiple frequencies and stereocilia in the inner ear and not concentrated on a single fundamental frequency, there is likely to be less risk of damage to hearing.

As with timbre, in many current electroacoustic works little attention is given to the shaping of a sound's envelope. The character of an envelope, its onset or attack, its duration or sustain, and its decay or ending, is determined by its gradual or abrupt (linear or exponential) nature. But in many current electroacoustic works, sounds are reduced in power and expressiveness by having unclear envelopes, with indistinct beginnings and endings and unclear shapes. This can be remedied in digital technology by simply drawing in the desired envelope shape to sculpt the volume of the sound, and listening critically to the results.

The timbre of a sound is greatly affected by its envelope. The physical characteristics of sound that determine the perception of timbre include both the frequency spectrum and envelope. The perception of timbre is closely related to the physical phenomena of the unfolding of the frequency spectrum over the duration of the envelope. This can be called the spectral envelope. The musical interest of a specific sound event of any duration can be greatly enhanced by introducing different frequencies in the onset, duration and ending of the event, especially by careful construction of the transient frequencies in the rise time of the attack.

The Development of Musical Material from Non-pitched Sound Events.

If the unfolding frequencies of a sound are in the harmonic spectrum (integer multiples of the fundamental pitch), the fundamental pitch may remain perceptible to the human ear, and the composer can therefore manipulate this sound event in any of the ways in which clearly perceptible pitch can be used in classical music.

But if such frequences are not in the harmonic spectrum of the fundamental pitch, then the composer will have to consider manipulating this sound event with non-harmonic spectral envelopes in ways that are not dependent upon the perception of pitch. There are a number of procedures she or he can use to generate musical material, in addition to the preeminent procedures based on pitch.

2. Variation Techniques

Variation Through 16th-Century Counterpoint Techniques

Since the sound events used in electroacoustic music often have little or no distinct pitch characteristics, contrapuntal sequencing devices which are based on pitch—inversion, retrograde and retrograde inversion—may well not generate identifiable or interesting variations. But in my experience, even sound events with non-harmonic spectral envelopes can sometimes generate unpredictably interesting musical results when submitted to the traditional manipulations of 16th-century counterpoint, and therefore should be run through inversion, retrograde and retrograde inversions to see what happens.

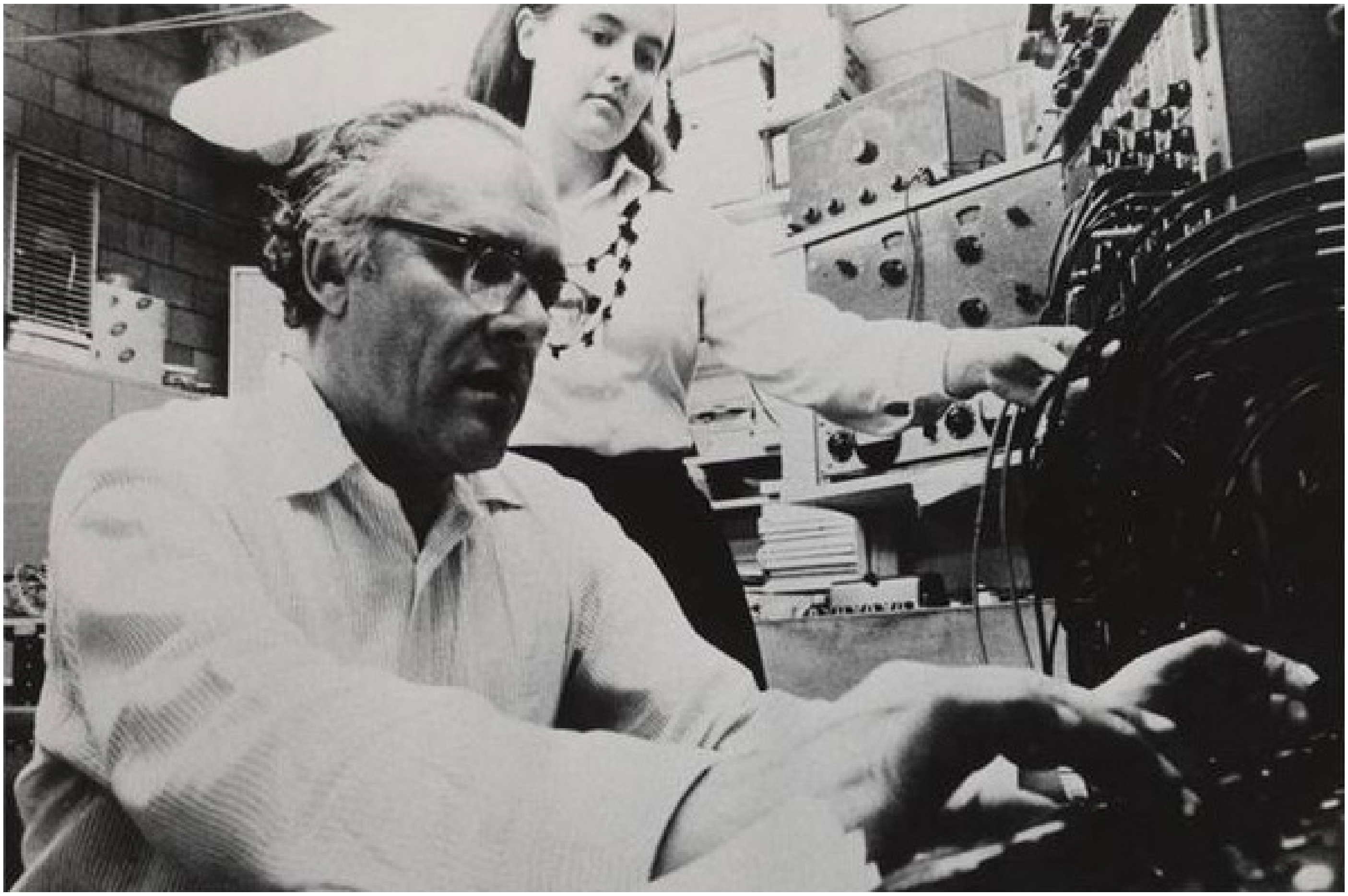
EVEN SOUND EVENTS WITH NON-HARMONIC SPECTRAL ENVELOPES CAN SOMETIMES GENERATE UNPREDICTABLY INTERESTING MUSICAL RESULTS WHEN SUBMITTED TO THE TRADITIONAL MANIPULATIONS OF 16TH-CENTURY COUNTERPOI

Variation Through Analog and Digital Technology

In earlier electroacoustic music there were a number of procedures used to create variants of unpitched musical material. At the Columbia-Princeton Electronic Music Center in the 1960s and 1970s, Vladimir Ussachevky and Bülent Arel taught younger composers like myself to create a limited number of sound events to use in a piece, and to experiment with each one to generate as many variations as possible. Usually these variations were created by running a unique sound event through various timbre, NT.

speed, and pitch modification devices, or by splicing them into sequences or rhythms, or by mixing them into larger events or even into new timbres.

Similar variations can now be made by digital means, if the composer can muster up enough imagination to replace the efficient analog sensorium of eye, hand, and ear. It's my impression that the use of digital technology may tend toward a reduction in an individual composer's sensitivity and bodily response to physical phenomena, including sound. If this is true, then I expect it may be at least in part a result of the physically ennervating, facile nature of using the computer. With touch keybords there is little pressure or contact between even the composer's fingers and the material world around him or her, and a minimum of awareness of the composer's own body or their physical surroundings.



I look on as Ussachevsky carefully adjusts pitch settings on an analog synthesizer. In the background are three sine-squarewave oscillators.

Variation Through Placement Techniques Modeled on Rhetorical Devices

Beyond the digital possibilites for timbre, speed, and pitch modification, or digital editing of sound events into sequences or rhythms or transformation into new timbres, there are a number of techniques, especially regarding placement in time, that are used in the practice of rhetoric.

WITH TOUCH KEYBORDS THERE IS LITTLE PRESSURE OR CONTACT BETWEEN EVEN THE

The study of rhetoric in language was traditionally divided into five parts. I summarize below some of placement and relational techniques used in the fifth division of rhetoric called "Style" (Elocutio). These variation techniques may be usefully applied to generate material from carefully sculpted pitched and non-pitched sounds.

I've adapted into muscial terminology selected definitions from Edward Corbett's and Robert Connor's *Classical Rhetoric for the Modern Student*. These are offered as little adaptations of rhetorical devices to the medium of sound, and focus on the placement and relationship of sounds. They are close to electroacoustic teaching exercises used in earlier analog electronic music studios, such as the Columbia-Princeton Center where I taught such things, and they can easily be performed digitally.

COMPOSER'S FINGERS AND THE MATERIAL WORLD AROUND HIM OR HER, AND A MINIMUM OF AWARENESS OF THE COMPOSER'S OWN BODY OR THEIR PHYSICAL SURROUNDINGS.

Rhetoric Exercises in Placement and Relation of Sound

Parallelism: Create a series of sound events with similar envelopes and timbres, with dissimilar pitches, octaves or locations (e.g on different loudspeakers).

(same envelope and timbre, BUT different pitches, octave, and locations)

Antithesis: Create and alternate two sound events which contrast in envelope and timbre.

(same pitch, pitch register and location BUT different envelope and timbre)

Anastrophe: Create five sound events that are heard three times in the same order. Then reverse the order.

ABCDE, ABCDE, ABCDE,

EDCBA , EDCBA , EDCBA

Parenthesis: Create five sound events that are heard three times in the same order. Then insert a new sound event in a position that interrupts the previously heard flow of events in that phrase.

ABCDE, ABCDE, ABCDE,

ABXCDE, ABXCDE, ABXCDE

Apposition: Create two separate sound events, then put them together so that the second modifies the first. For example, Sound Event #1 begins with a 2-second crescendo and ends with a 2-second diminuendo, but when immediately followed by Sound Event #2, Sound Event #1 ends with a 1-second crescendo.

Sound Event #1 (2 sec cresc. + 2 sec dim.),

Sound Event #2

Sound Event #1 (2 sec cresc. + 1 sec cresc.)+Sound Event #2

Ellipsis: Create five sound events that are heard three times in the same order. Then take one sound out.

ABCDE, ABCDE, ABCDE,

ABCE, ABCE, ABCE

Asyndeton: Create five sound events that are heard three times in the same order. Then separate all five by 3 seconds of silence.

ABCDE, ABCDE, ABCDE,

ABCDE, … ABCDE, … ABCDE

Alliteration: Create five adjacent sound events. Copy the envelope attack of the second event, and attach a copy to the beginning of each of the five sound events.

ABCDE

bAbBbCbDbE

Assonance: Create 3 pitched sounds and 6 non-pitched sounds. Place a non-pitched sound to preceed and follow each pitched sound.

ABC 123456

1A2 3B4 5C6

Anaphora: Create five similar sound events and one very different event. Repeat the five sound events three times. Insert the very different event at the beginning of each of the five repetitions.

ABCDE X

XABCDE XABCDE XABCDE

Epistrophe: Create five sound events and one very different event. Repeat the five sound events three times. Insert the very different event at the end of each of the five repetitions.

ABCDE X

ABCDEX ABCDEX ABCDEX

Epanalepsis: Create fifteen different sound events. At the end of every fifth sound insert a copy of the very first sound.

ABCDEFGHIJKLMOP

ABCDEA FGHIJA KLMOPA

Anadiplosis: Create fifteen different sound events. At the end of every fifth sound insert a copy of that sound at the beginning of the following phrase.

ABCDEFGHIJKLMOP

ABCDE EFGHIJ EKLMOP

Climax: Create five sound events that are heard three times. Make the second repetition medium loud, and the third repetition very loud.

ABCDE, ABCDE, ABCDE,

mf ABCDE, ABCDE, ABCDE,

ff ABCDE, ABCDE, ABCDE,

Antimetabole: Create five sound events. Repeat them three times, in reverse order.

ABCDE,

EDCBA, EDCBA, EDCBA

Chiasmus: Create five sound events. Repeat them three times, but in the second repetition, backwards.

ABCDE, ABCDE, ABCDE,

EDCBA, EDCBA, EDCBA,

ABCDE, ABCDE, ABCDE

Polyptoton: Create a sound event. Repeat it fifteen times.

XXXXXXXXXXXXXXX

Metaphor: Create two very different sound events and alternate them 8 times.

XyXyXyXyXyXyXyXy

Simile: Create two very different sound events and alternate them 8 times. Make the second sound event always be much louder than the first.

pXfY, pXfY, pXfY, pXfY, pXfY, pXfY, pXfY, pXfY

Synechdoche: A part stands for the whole: Create five sound events. Repeat them three times. Then add the total number of sounds.

12345 12345 12345

XXXXXXXXXXXXXXX

Anthimeria: Create two very different sound events, A and B. Insert a silence after A and B. Then add B and A, in that order.

AB

A_B

BA

Hyperbole: Create two very different sound events. On one impose an envelope of long slow attack and long slow decay. On the other impose an extremely abrupt attack and abrupt decay.

XY

X(long slow attack+long slow decay) Y(abrupt attack + abrupt decay)

Litotes: Create two very different sound events. Make them both as soft in volume as possible, at the border of hearing.

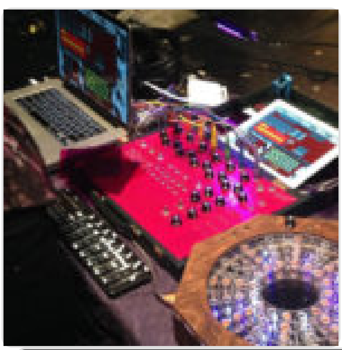
*ppp*X *ppp*Y

Onomatopoeia: Create a sound event and modify its timbre to make it resemble a sound from daily life.

A

A+eq

YOU MIGHT ALSO ENJOY



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