The Electronics of Music

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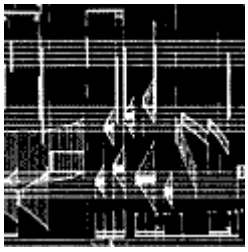

Today the word "music" is as outmoded as the word "shay" and has about as much connection with what is going on in America, Europe, and Japan as Euterpe has with choruses. Perhaps we should substitute Edgar Varèse's definition of music as "organized sound," provided we add two words from John Cage, making it "organized sound and silence."

The introduction of electronics has completely changed the face of present day "music" and more than anything else determines the direction of the future.

Now a composer has any sound he wants and has complete control over it (if he wishes it). Gone is the traditional musical instrument with its limited sound possibilities. It has been replaced by electronic sound-generating machines—such as the computer and RCA Synthesizer—which enable the composer to synthesize sound to his own specifications. Gone is the interpreter or performer. He has been replaced by the loudspeaker, a less temperamental and far more accurate reproducer of sound events.

Milton Babbit (top) and Vladimir Ussachevsky, co-chairmen of the Columbia-Princeton Electronic Music Center

"Suddenly we have instruments that have no limits," as Milton Babbitt, co-chairman of the Columbia-Princeton Electronic Music Center, recently said.

"When I work with the electronic medium, I am master from the beginning. I am responsible for every aspect of it. In one single step, I am preparing my materials, rehearsing the work, and coming out of the lab with the finished product.

"The new limits of music are the limits of human perception, human discrimination. We know so little about musical perception. All we really know so far is how little we know about how we hear music. Electronic instruments are far faster than the ear, and capable of differentiation which far exceeds the ear's discriminatory capacity. So that's where we are now."

> “With the electronic music instrument, any tone can be made available in any intensity and for any length of time. Note that the older symphony orchestra was, by comparison, a machine of separate instruments that gave the effect of organic unity. With the electronic instrument, one starts with organic unity as an immediate act of perfect synchronization. This makes the attempt to create the effect of organic unity quite pointless. Electronic music must seek other goals.”

> “Such is also the harsh logic of industrial automation. The range of choice in design, stress, and goal... is very much greater than it ever could have been under mechanization... Panic about automation as threat of uniformity on a world scale is the projection into the future of mehanical standardization and specialism, which are now past.”
>
> *Understanding Media*

Examine for a moment, where we have been. During the first half of the 20th century, an enormous number of problems confronted composers. Strauss had exhausted the size of the orchestra. Wagner and Mahler had squeezed humanity dry of tears and drama. Scriabin had built chords that used every harmonious note of the 88 keys of the piano keyboard. Schoenberg had written "Gurre-Lieder" which began ultrachromatically and ended with a wild sprecher and dissonant helter-skelter notes.

All the instrumental music written up to that time utilized instruments that were created for the needs of another age, an age whose historical roots lay still further back, three hundred years and more.

The composer, then, was faced with the very real problem of saying something new in the old framework. New wine; old bottles. No matter how diverse his compositional techniques may have been, he was still writing notes on paper for those same old strings, winds, and drums. He had neither built the instruments he wrote for, nor could he control the manner in which they were to be played.

More and more of the 20th century composers began to question their traditional language. Their new conceptions on the one hand and the traditional sound-producing mechanisms on the other became more and more irreconcilable. Moreover, harmony had been exhausted. Polyphony, with its further reaches of texture and organization, was beckoning.

Arnold Schoenberg and his pupil, Anton Webern, became vitally important at this same time of crossroads for the composer. One worked out, the other elevated to an art form, a system of composition that totally contradicted all traditional harmonic-melodic laws. Its purpose was to establish order, just as Bach's intention had been to make the clavier "well-tempered" by putting everything out of tune except the octaves.

People had accepted that without a murmur. However, there would be more than murmurings when Schoenberg put the "set" or "series" on the market of music. Formerly, all twelve tones of the chromatic scale had relations, pulls towards and pushes away from one note or the other. The system of inter-relationships was simple, definite, and compulsive. Schoenberg, however, made all the notes equal and independent. He arranged them in a sequence, or set or series, an arbitrary choice of succession and its eleven possible transpositions on the various degrees of the chromatic scale. Further, he inverted these, formed them in retrograde, or forward fashion.

Webern went further. He not only organized the melodic structure and determined its figures in "rows," but precisely serialized and formulated the rhythm, volume, timbre, density and the silences or pauses (rests) themselves.

What one now had was not the inspirational, temperamental, pouring out of undisciplined emotion in musical form, but a multi-dimensional, highly disciplined and controlled corporation of sound. Now music became infinitely more intricate and subtle. The performance was extremely difficult with the score totally organized and minutely registered for a specific sound at a specific time in a specific intensity of dynamics and duration.

In other words, the frontier of electronically tempered sound had been reached. Across it, the composer would be able to control to the nth degree every exact musical element.

An equally important development came from the opposite direction, a generation later when John Cage opened our ears to the fact that any sound, organized or accidental, can be put to work by the artist of the new waves. Thus he liberated the composer, giving him the freedom to utilize all sounds, including those newly available through electronics. And by promulgating his chance or aleatoric methods of composition, he further opened the door to many new marvelous music experiences where the composer strives to eliminate himself from his work and simply let the sounds happen.

But what can electronics do that ivory and ebony cannot? To begin at the beginning, look at a tone. It consists of eight elements: It must have pitch, length, loudness, reverberation, harmonics, vibrato, and attack (the beginning of a tone) and decay (the very ending or "dying" of a tone). Now, by means of electronic charges or signals, wave lengths, oscillators, etc., any tone (and a million more) can be reproduced. And each element in a tone can be manipulated.

When an engineer tampers with these elements determining a tone, a variety of effects can be created. A drum, for example, played four times its original speed is a pistol shot. The violin tone without the attack—the first touch of horsehair against catgut—sounds exactly like an oboe. A piano in the middle to low range, when reduced still further down the tonal scale, has a tremendous resonance and wow power that cannot be produced in any other way. For a home demonstration, switch your phonograph from 33-1/3 rpm to 78 rpm and a piano will sound like a harpsichord. Switch it from 45 to 33-1/3 rpm and a tenor will become a bass.

Of course, only a musical forger would spend all this electronic energy reproducing tones that way. The modern electronic composer is interested in creating new sounds by such ways as, say, removing reverberation and injecting the harmonics from one tone into another. There, in that area, the vast wealth of all sound possible at any time desired, becomes within the realm of today's musician—ranging from those inaudibly high sounds which make birds fly instantly from a wire to those depths where sound turns into vibration pure and the room shakes.

The history of this music is remarkably short in view of its lightning fast development, and now it may be added, popularity. The first successful attempt to synthesize all parts of a composition and put them directly on a recording medium was the "handwritten sound track." Optical modulation patterns were drawn by hand and

photographed onto film and then played back on a film phonograph. The first successful effort at this was made in Russia by Sholpo in 1930, according to an article in Radio-Electronics by James Seawright, the brilliant scientist, kinetic sculptor and electronic composer.

Of course, in a related vein, the Oklahoma-born architect, Bruce Goff, used to razor-cut holes in long rolls of wrapping paper to form a beautiful design and then play them on a player piano as music. And Len Lye, the kineticist, made "direct" films, where he sketched on the film itself and played it as sound and decoration.

During World War II, the tape recorder invented by the Germans, radically altered every aspect of our electronic civilization from phonograph records to space rocketry. Its existence came about somewhat perversely because of Hitler's need to broadcast to his people. Whenever he did, and often while doing so, the position was bombed. Finally, at rush priority, the tape recorder was produced whereby a lifelike simulacrum of his speech was broadcast one place while he operated in another.

Gone was the scratch of needle against rubber, the distortion of hard point against weak surface. Nothing but the wondrous electro-magnetic strips of plastic and capstan heads. Allied scientists were baffled, and they never came round to discovering the tape recorder for themselves. As soon as Germany was captured, a first specimen was flown to Washington, where, so rumor swears, a commercial firm secretly copied it and placed it on the market, before the military had begun exploitation of its advantages or could object, redfacedly.

Music, too, followed, and in 1948, two French radio pioneers, Pierre Schaeffer and Pierre Henry, began taping the sounds of life. At first they wanted to compose a "symphony of man," and a "symphony of noises," in which all the lifelike daily program of ear-entering sounds would be arranged into a pattern of near-music.

It was an accident on Schaeffer's part which started the celebrated movement, musique concrete. He wanted to record a church bell, but was late switching on his tape machine. What he got, without the identifying envelope of attack, was an oddity of pure sound. From then on, he pursued the process of distorting ordinary sound to make not only new sounds but to burst open the spectrum of emotion related to them. He also took these sounds and used them like notes in a musical scale and based compositions on them, somewhat as the serialist formalizes his musical code.

With a tape recorder, a composer can perform all sorts of legerdemain on a tone—he can put the end at the beginning, the beginning in the middle, and the middle at the end. He can speed it up, slow it down, and run it backwards. He can put a series of sounds into a loop of tape which will repeat itself indefinitely.

While musique concrete was astounding the French, another school of electronic music derived from electrical generators was being developed by the Germans in Cologne. Here Herbert Eimert and Werner Meyer-Eppler working in the electronic music studio of the West Deutscher Rundfunk (West German Radio) laid down the basic experimentation for much of today's electronic music. Karlheinz Stockhausen was to emerge as the most celebrated composer in this group.

As the Germans found out, it is possible to construct almost any

imaginable sound from two basic elements: sine tones and white noise. A sine tone is the pure tone devoid of any tremble or overtone to enrich and qualify it (the dead sound you associate with electronic music). White noise is a mathematical arrangement of all audible frequencies at the same level, loudness, and force (it sounds like a hiss). By (1) mixing sine tones together and (2) filtering out frequencies from white noise, the electronic composer has all sound at his disposal.

These electronically generated sounds are recorded on tape without using microphones (unlike musique concrète which uses microphones). Like musique concrète, they exist solely on tape and can be realized in sound only through an amplifier.

There are dozens of such studios today where the musicians of tomorrow are working—the Niemann Studios in Munich, the Southwest German Radio in Baden Baden, the Electro-Acoustic Institute at Gravesano, Switzerland, the Studio di Fonologia di Musicali in Milan. In America, the core of activity is at the ColumbiaPrinceton Electronic Music Center in New York. Here Babbitt and his group, including the great pioneer Otto Luening (one of the first to work with tape) and Vladimir Ussachevsky, genial cochairman of the center, have one of the most magnificent monsters in electronic music history—the RCA Sound Synthesizer. This massive 20-foot-long, 7-foot-high triple-deck music machine cost a quarter of a million dollars and took two and a half years to build.

Using what looks like two giant, old-fashioned typewriters, the composer punches holes in endlessly long rolls of paper (actually they are two 40-channel paper charts) to produce almost any sound he can conceive. He also manipulates a hundred knobs and switches, and 2,000 tubes, voltage-control oscillators, variable-gain amplifiers, etc. which modulate any steady-state tone to any specified degree. All this, while four or more channels are recording simultaneously.

Faced with this intricate machine, one realizes that the complexity of electronic music is not in understanding such scientific things as sine tones, square waves, triangular waves and sawtooth waves, but in its world of gadgetry. It takes a normal person, according to expert Seawright, two or three years working six hours a day to become proficient at the Synthesizer.

After the sounds are produced, then the mixing, editing, copying, channeling, and piecing together begin. Synchronization or matching one section of music with another in absolute and authentic simultaneity, can take even an experienced composer six or seven hours. If you watch a master craftsman, such as young Mario Davidovsky at work, you see that the process is akin to that of a mosaic worker, or a tailor's infinitely intricate stitchwork. One ten-minute piece of music, such as his masterwork, "Etude No. 2," took Davidovsky close to four months of patience and work. Anyone else, it is agreed by those who know, would have had to spend a year to end up with so flawless an exactitude, so radiantly perfect a composition.

The "Etude No. 2" opens with a long whistle, followed by the ticktock of a seeming clock. This anchors the ear witness' attention, and from there on, he is treated to a splashy, virtuoso display of height and depth, inner and outer electronic subtlety. Instead of sounding stultified or severe, the music seems to change constantly. So complicated has been the intention and execution,

the listener continually discerns new areas and dimensions. Since the music is essentially tonal, the experience is never too far out for a general listener's pleasure.

The medium of the future for the electronic composer, however, is not going to be the Synthesizer or tape studio—but the computer. A sine wave can be mathematically and numerically expressed—the distance a violin string moves, or the air pressure on the ear drum hearing it, or the movement of the electrical voltage in an electrical amplifier, are all computable, therefore digital. Thus the computer card becomes the music score.

Any sound can be transformed into a series of numbers. These are punched on IBM cards and recorded in the computer. Limitless sounds can then be generated, depending on the composer's instructions. The programming is accomplished by punching a second set of cards, feeding it into the computer which selects the designated sounds from its memory and records them on tape. Every note can be prescribed or latitude given to the computer for a certain range of selection. These magnetic impressions contain the music, so to speak, and the actual sounds are formed when the tape is run on a digital-to-sound transducer.

To the outsider, there seems almost too much control. You discover that it takes 20,000 calculations per second to get a note of good high fidelity sound in the upper 10,000 cycle frequency range. Such is the magnitude of detail, and that's why the electronic composer has to be a mathematician as well as an expert in the fields of acoustics, electro-acoustics and psycho-acoustics.

However, computer music, marvelous as it may be, is still fantastically expensive, and the proportion of time needed is phantasmagorically behemoth. It takes a trained artist 20 minutes of computer time to produce one minute of music. At the rate of $600 an hour, an etude is pure gold. Yet, the composer has had no "real time," that is, he has not heard what he has created. And once he has heard it, he may have to go back and recompose it all over again.

One theme runs steady as an undercurrent in this branch of electronic music—control. The electronic composer produces his score direct from his ear to the ear of the listener, sanitary, even sterile sometimes. The tide is away from the performer as it is away from the instrument.

For one thing, the music is now too complicated for a poor human performer to cope with. And as Babbitt recognizes, "there's scarcely a measure that I've written for electronic realization that could be performed on normal instruments."

However, there are exceptions, often with great effect. Stockhausen may have a performer play the organ with the back of his hands and whisper sex sounds (he was in love when he wrote this composition, "Momenta"). Or the magnificent electronic genius-composer Toshi Ichlyanagi may use the lonely wail of a Japanese flute.

In Babbitt's "Philomel," a soprano sings against a tape recording of herself. The song is based on a poem by John Hollander, describing Philomel, the lady of antiquity who sleeps with her brother-inlaw only to discover her husband is still alive, gets her tongue cut out, and wanders through the forest, eventually ending up learning to utter bird sounds and becoming the nightingale (although

ornithologically, only the cock nightingale sings).

The tape of the song has been altered and manipulated so that syllables are removed or doubled, and rhymes made where none exist as the score moves from grieving woman into the trills and cascades of bird song. An exceptionally complicated methodology guides the music's structure. It is unavailable to the ear, so arcane are its secrets of order.

Edgar Varese ended his "Poeme Electronique" with a high soprano vocal line distorted and speeded up so as to soar away into space beyond human reach. It creates an oddly disturbing emotion in the listener—not quite terror at the supernatural effect of a woman singing higher than high, and not quite sadness (it seems so irrevocable that drift of the voice beyond). The piece was written in 1958 for the Brussels World's Fair and Le Corbusier, who designed the building complex, gave him 400 loud speakers for the music to be swirled around, over and across the length and breadth of the vast architectural area. This piece was one of the landmarks of the new music—what Monteverdi's "Orfeo" is to opera, say.

While electronics has given complete control to one group of composers, it has given complete freedom to another. In the acclaimed and defamed "9 Evenings: Theatre and Engineering" last October, John Cage and David Tudor explored electronic sound with particular intrigue. One piece, which sounded like a cauldron of boiling water combined with a kettle of hissing steam, was produced between two workbenches equipped with photoelectric cells of light. When the two artists moved, they broke the light patterns, and these messages were fed into an incoder, then over to a decoder, and then programmed into 12 speakers scattered throughout the auditorium. The volume was controlled by a flashlight. The whole thing, as Leonard Robinson, one engineer of this feat, explained, came out of "one little box, a 40-watt amplifier." The "instruments" for this piece of "indeterminate music in its form and detail" were a Waring Blender, a fan, and other items of daily life.

The results were "different than anyone could have pre-imagined" which was the point of the whole thing: To have the composer strive to eliminate himself from his work and simply let the music happen.

There are many ways to let it "happen." Like Cage, he can let three tossed coins and the ancient I Ching (Book of Changes) tell him where to place the notes for music free from one's memory and imagination. Or he can let the imperfections on a sheet of paper (or even plywood) suggest the placement of each sound.

Like Feldman, he can use graph paper with no notes, just indications of high, low, middle, short, long, loud, soft. Or again like Cage, he can turn on a dozen or so radios at once.

McLuhan points out that the electronic network surrounding man and constituting his environment is an external nervous system as delicate and sensitive as the one within his body. Almost as if demonstrating this, Alex Hay at the same "9 Evenings" implanted himself with electrodes and wires so that his body sounds—breathing, stomach rumbles, heart beat, brain waves, etc. —were amplified by loud speakers. Thanks to the electronic system outside him, Hay was able to explore the internal sound potentials of the human being, and so was his audience.

Why a music based on chance bypassing the composer's own ego,

taste, self? As Morton Feldman once said, his desire was not to compose, "but to project sounds into time." And as Cage explains in his great book, "Silence": "One may give up the desire to control sound, clear his mind of music, and set about discovering means to let sounds be themselves rather than vehicles for man-made theories or expressions of human sentiments."

"We are simple enough to think that if we were saying something we would use words," he wrote, adding that this music "is an affirmation of life—not an attempt to bring order out of chaos, not to suggest improvements in creation, but simply a way of waking up to the very life we're living, which is so excellent once one gets one's mind and one's desires out of its way and lets it act of its own accord."

Christian Wolff, one of the brightest and most musical of the young composers now writing, has described his own music as like taking "a walk with a friend or friends, going by whatever ways you like, agreeing on the way, with a direction in mind or getting lost or going nowhere in particular, and you are absorbed by this."

Wolff also cites two adjunctive aspects of this music: "monotony and irritation." The best explanation of this comes from old Erik Satie, father of all new music. Way back at the turn of the century, he spoke of "provocation and boredom.... the listener is defenseless against boredom... it subdues him...boredom is mysterious and profound." And so he wrote (among a hundred other pieces) "Vexations," where eight measures for two pianos are repeated nearly two thousand times and the performance (recently done in New York) takes all night and a willow-run of a dozen relay, nightshift players.

The gentle, sweet, delicate master-miniaturist writer, Logan Pearsall Smith, almost as long ago as Satie also pursued the chimeric boredom. He thought it was akin to mystical experience and he dilated and expatiated as long on the subject as his fragmentary essay style would allow.

Actually, he hit upon a truth. Boredom of course is really a meditation and an enlightenment. One hundred Ave Marias, or sitting in the lotus position staring straight ahead, or repeating the thousand names of hard or god in Hinduism are designed to empty the mind (as the bowels) and produce an experience. It is the drone of the religious mind, symbolized in music perfectly by the Indian tambura instrument, the reedy sounding string instrument which goes on and on repeating the same bass notes, holding the piece of music together like a pedal point.

While Broadway and the commercial arts are straining their souls to keep from boring audiences, the avant-garde is exploring the esthetic core of this state.

At this juncture, someone usually ask "But is it music?" Within the past ten years, all of us has learned one lesson in the world of music. Any sound or noise can be put to work for the composer. Anyone who has ridden, say, between cars on a train and heard the rhythmic grating of the metal joiners scraping, screeching and squeaking together, doubtless has begun to "hear" music.

And emotion, you ask? Where is the human feeling, the response of the ear to two train sections jangling and jarring? Where then, is the answer, is the emotion in a bird song? The mindless bird sings in a most chance way, meaninglessly and for not altogether wholesome reasons sometimes, and yet, if it is a nightingale in an

appropriate place, man can be quite reduced to tears.

Major is happy, and minor is sad, someone declared; and all the musical world for centuries obeyed this senseless canon. Yet, Verdi begins Othello's agonizing death scene in G Major.

Or take from another area, Chinese opera. There the music remains the same whether the heroine (a man singing falsetto) sings of her happy, happy youth in the Summer Palace or when she sings of her grief at losing her lover and is about to commit suicide. Why does the Chinese cry in one place and smile at the other? Because, he will say if you ask him, "the words are different."

After all, emotion is not in the sounds. As Cage points out in "Silence": "Emotion takes place in the person who has it. And sounds when allowed to be themselves, do not require that those who hear them do so unfeelingly. The opposite is what is meant by response ability. New music, new listening."

Once an electronic piece is written, there is still the problem of where to perform it. Ussachevsky and Babbitt agree there is no place in the United States where electronic music can be performed adequately—not even the new art centers rising across the country have concert halls adequately equipped and acoustically designed for electronic music.

Despite this, one of the phenomena of our times is the quick and easy acceptance of electronic music. Babbitt tells a story of how "the medium is the novelty." He says "nobody yet listens to the music. People don't care whether it's electronic loops making white noise or an actual musical composition. It is accepted and rejected almost entirely on the basis of the medium."

Recently, at his own university, Princeton, the finest string quartet in the world playing four contemporary works by the best names in musical literature drew an audience of 50 people. When a student organization shortly afterwards announced a minor program of some simple electronic works of no special significance, 800 people showed up the first night and another 800 the second night.

This is partly explicable on the basis of the present. People, regardless of their age, willy-nilly, belong to today and electronic music is the now and here. Also, preparation for this widespread acceptance has been long in the making. Almost subliminally, people have been briefed for years. Remember all those mad scientist movies? The retort bubbles, the bunsen burners—the music, of course, was electronic. Outer space, too, has popularized electronic music. On television, in films, and whenever the eeriness of "out there" has required sound accompaniment, only electronic music served.

Electronics has taken over the pop music scene too—just listen to any rock and roll radio station. For example, the Beatles' hit tune, "Strawberry Fields." Here the accompaniment is electronically paced, a staggered beat behind the words, and at the end, the entire middle portion is played back, backwards, sounding like a garble or warp in the record.

When one contemplates the difficulties under which the contemporary composer labors with his music machines and the incredible intellection which goes into the production of a single new passage of heretofore unheard beauty, one loses sympathy a little for, say, Mozart who had to retune his piano himself every time he played a piece in another key. Electronic musical history is

being made today. Some very great music and some awfully beautiful sounds are reaching our ears from every direction and by all means of amplification and invention.

Original format: Ten page boklet, 8-1/2 inches square. A couple of illustrations are omitted here to reduce download time.

Previous Top Next