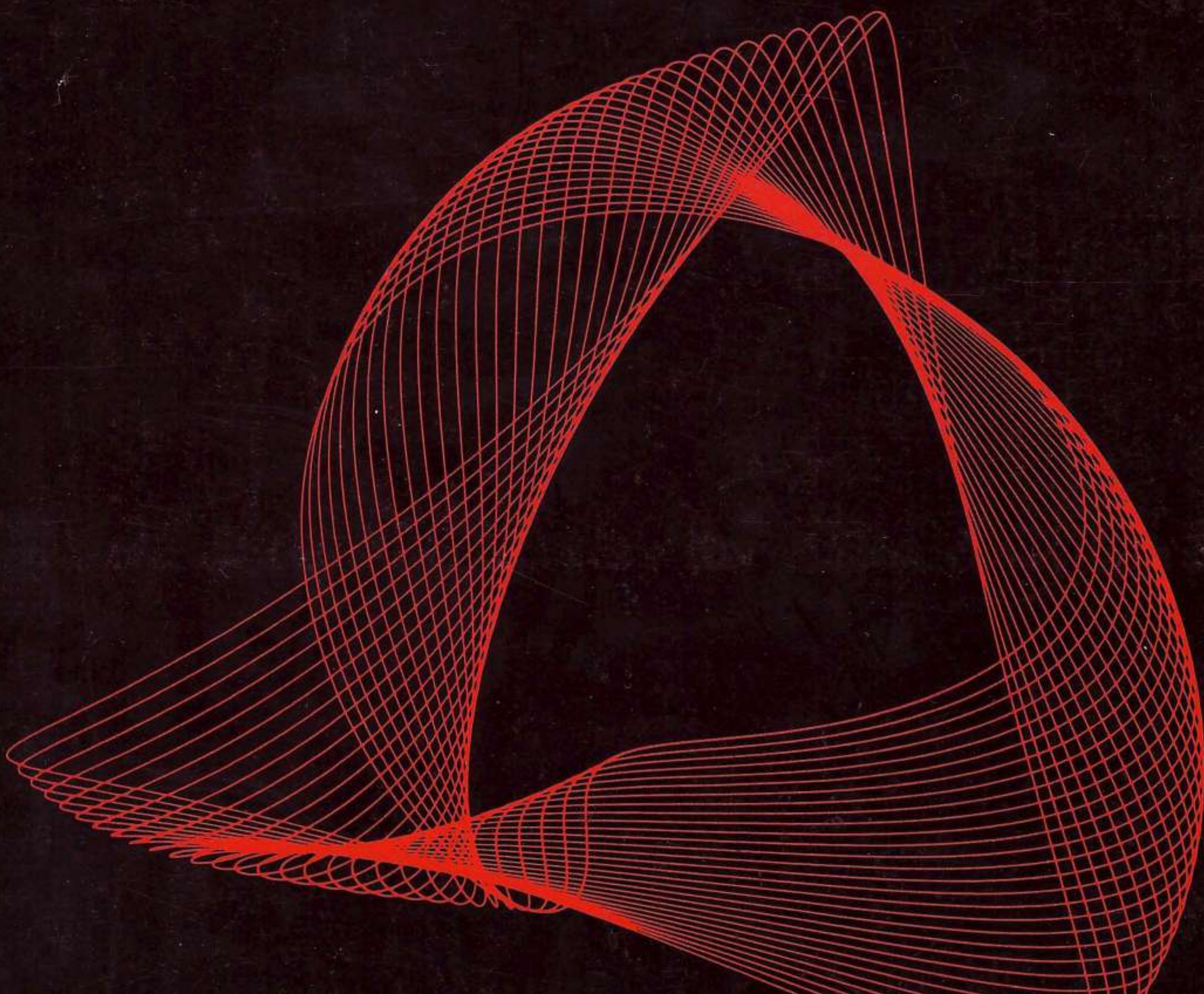
Electronic Music Review

No. 5 January 1968



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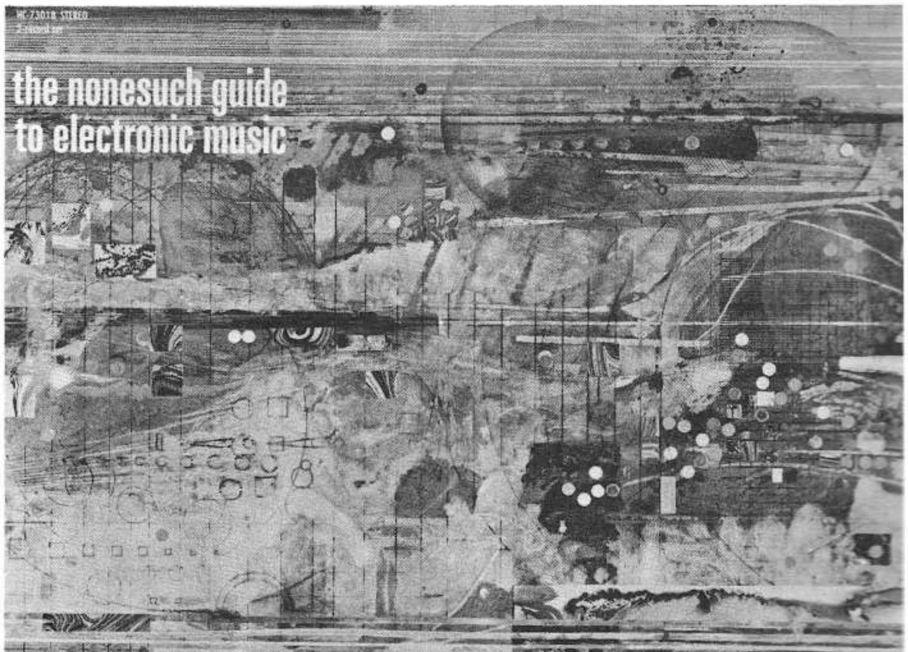

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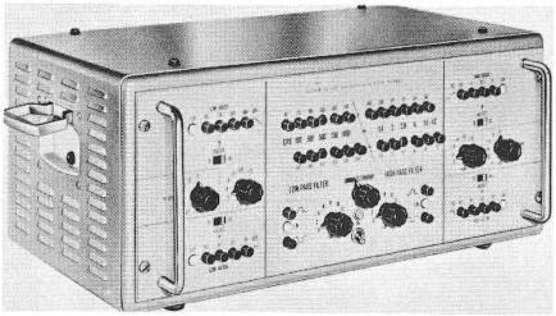

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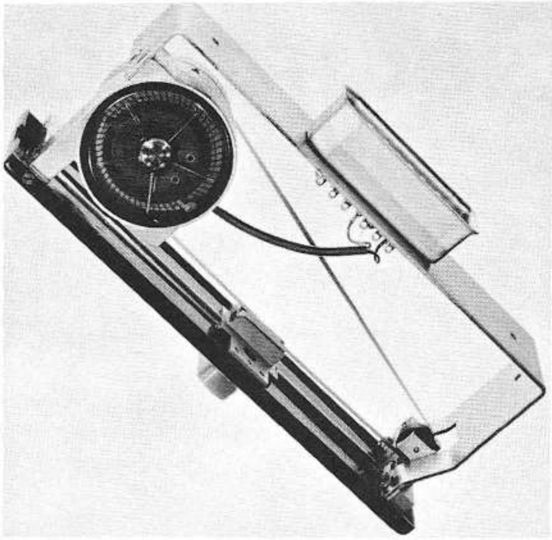

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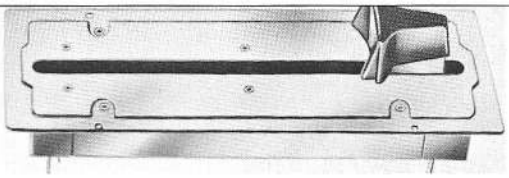

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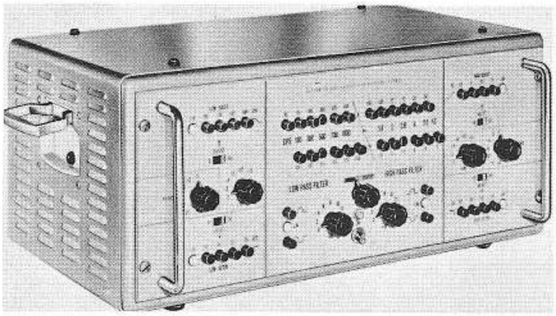

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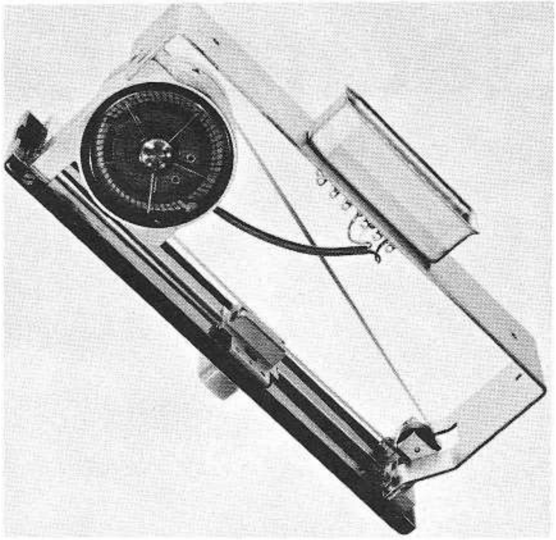

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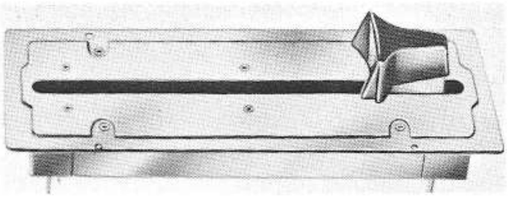

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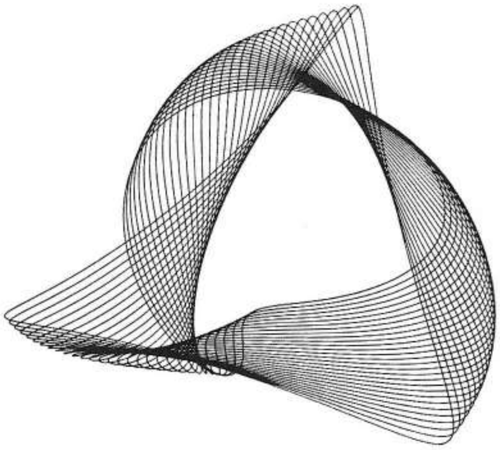

No. 5 January 1968

EMR is published quarterly by the Independent Electronic Music Center, Inc., Trumansburg, N.Y. 14886. Personal subscriptions are available through IEMC membership (annual dues \$6); institutional subscriptions, one year \$8, two years \$15. Outside North America, add 50¢ per year, payable in U.S. funds. Memberships and subscriptions by calendar year only. Application for second-class mailing privileges pending at the post office at Trumansburg, N.Y.

EMR is indexed in Music Article Guide and in International Repertory of Music Literature (RILM).

Contents

EMscope

We are pleased to announce the appointment of Hugh Davies as the European Editor of EMR. Mr. Davies is Director of the Electronic Music Workshop at the University of London Goldsmiths' College and is also Musical Director of the Arts Laboratory in London. He specializes in composing and performing live electronic music. Mr. Davies compiled *Répertoire International des Musiques Electroacoustiques / International Electronic Music Catalog*, published as EMR Nos. 2/3.

COMPETITIONS

Experiments in Art and Technology announces a competition for engineers and artists. Awards of $3000, $1000, and $1000 will be granted to the winning engineers for the most inventive use of new technology as it evolves through the collaboration of artist and engineer. Works submitted will also be considered for exhibition at the Museum of Modern Art, New York City. Deadline for submission of works is June 1. Further information is available from Experiments in Art and Technology, 9 East 16 Street, New York City 10003.

The Dartmouth Arts Council Prize of $500 for an outstanding composition of electronic music has been awarded to Olly W. Wilson, Assistant Professor of Music at Oberlin Conservatory, Oberlin, Ohio. Mr. Wilson's work, *Cetus*, was composed in 1967 at the Experimental Music Studio, University of Illinois at Urbana. The runners-up were:

Pril Smiley, for *Eclipse* (1967, Columbia-Princeton Electronic Music Center, New York City).
Jozef Malovec, for *Orthogenesis* (1966, Experimentálne Štúdio, Československý Rozhlas, Bratislava, Czechoslovakia).
Eugeniusz Rudnik, for *Dixi* (1966, Studio Eksperymentalne, Polskie Radio, Warszawa, Poland).
William Hellerman, for *Ariel* (1967, Columbia-Princeton Electronic Music Center, New York City).
Bohdan Mazurek, for *Bozzetti* (1967, Studio Eksperymentalne, Polskie Radio, Warszawa, Poland).

60 of the 109 entries were pre-selected by the contest administrator, Jon Appleton, Director of the Griffith Electronic Music Studio, Dartmouth College, Hanover, N.H. The judges were Milton Babbitt and Vladimir Ussachevsky (Columbia-Princeton Electronic Music Center, New York City), and George Balch Wilson (Electronic Music Studio, University of Michigan, Ann Arbor).

WORKSHOPS, SEMINARS, COURSES, EVENTS

An electronic music course has been established at the Royal Conservatory of Music. It is conducted by Samuel Dolin, and is open to anyone interested. Further information is available from Ann Southern, Electronic Music Department, Royal Conservatory of Music, 273 Bloor Street West, Toronto 5, Ont., Canada.

Electronic music courses have been established at the University of London Goldsmiths' College. The courses cover all aspects of compositional and technical areas, including live performance, and are being conducted by Hugh Davies. They are primarily intended for candidates

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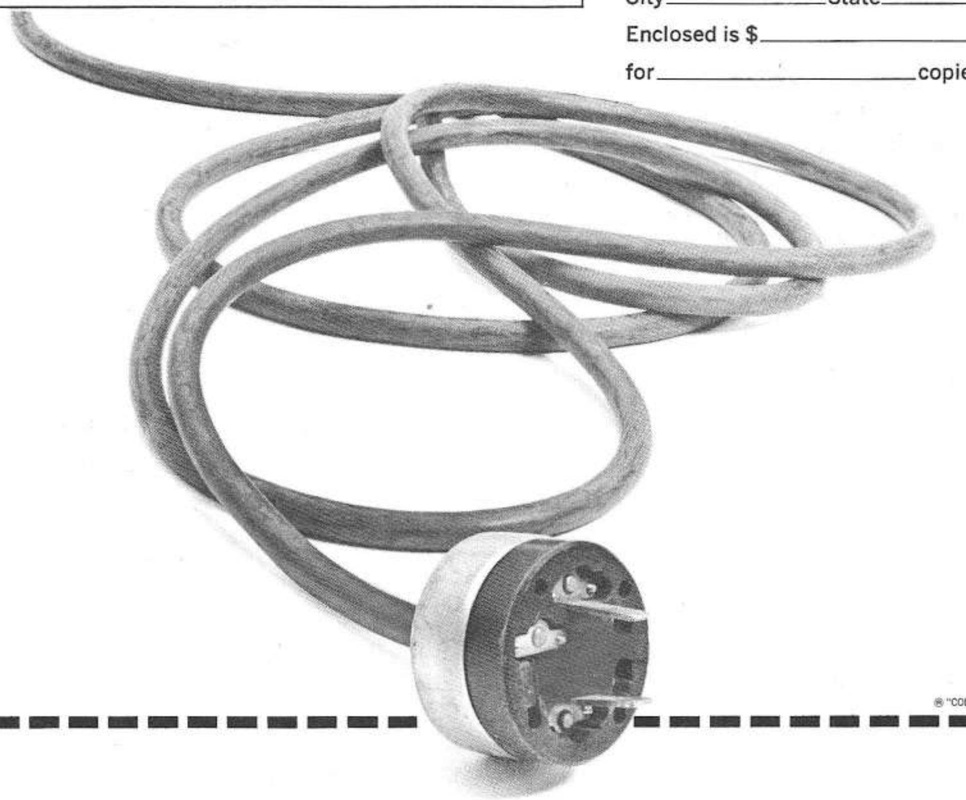


of the London University music degree, but are open to anyone interested. Fees are 17/6d ($2.10) per term. Further information is available from Hugh Davies, 26 Upper Park Road, London N.W.3, England.

Pauline Oliveros will conduct a graduate seminar in recording and the use of electronics for live performance at the University of California, San Diego, April-June. Three concerts of live electronic music and theater will be presented. Guest artists include Lowell Cross, Anthony Gnazzo, Alvin Lucier, and David Tudor. Composers are invited to send scores to Pauline Oliveros, Department of Music, University of California, San Diego, P.O. Box 109, La Jolla, Calif. 92037.

"Electronic Synthesis of Music", a workshop, will be conducted by Will Gay Bottje, Gordon Chadwick, and Hubert Howe at Southern Illinois University, June 10-22. It will be divided into areas of basic studio techniques and computer synthesis. Guest lecturers include Lejaren Hiller and Robert A. Moog. Further information is available from the Electronic Music Studio, Music Department, Southern Illinois University, Carbondale, Ill. 62901.

Various inter-arts workshops will be conducted at Group 212, June 15 - September 15. A number of student and teaching programs are available. Further information is available from Robert Liikala, Coordinator, Group 212, P.O. Box 96, Woodstock, N.Y. 12498.

"Electronic Music in the Classroom", an introductory workshop for elementary school music teachers, will be conducted by Jean Eichelberger Ivey at Peabody Conservatory, July 29 - August 2. The course will feature recordings and readings in electronic music, simple tape experiments, and suggestions for classroom applications and the planning of a school studio. Further information is available from Ray Robinson, Director, Summer Session, Peabody Conservatory, Baltimore, Md. 21202.

A "Congress for Electronic Music" will be conducted by Fritz Winckel at the Akademie der Künste and the Technische Universität Berlin, October 7-12. Papers and compositions for presentation are being solicited. Further information and application forms are available from Nele Hertling, Akademie der Künste, 1 Berlin 21 (West), Hanseatenweg 10, Germany.

RECENT PUBLICATIONS

Fylkingen International Bulletin (first issues). Nos. 1 and 2, 1967. Fylkingen, Prästgatan 28, Stockholm C, Sweden. Subscription, 4 issues, $4.00.

Kaegi, Werner. *Was ist elektronische Musik*. 1967. Orell Füssli Verlag, Zürich, Switzerland. Hardbound, DM 29.50 ($6.00).

Newsletter of the American Society of University Composers, Inc. (first issue). January 1968. A.S.U.C., Inc., c/o Department of Music, Columbia University, New York City 10027.

Sonda (first issue). October 1967. Juventudes Musicales, San Bernardo, 44, Madrid 8, Spain. Free.

Thesaurus of Coordinate Index Terms for Literature Related to Experimental Research in the Arts. January 1968. Information Storage and Retrieval Project, Center for Experimental Research in the Arts, Ohio

State University, 131 Lord Hall, 124 West 17 Avenue, Columbus, Ohio 43210. Softbound, free.

RECENT STEREO LP RECORDS

CRI S-219 - Otto Luening (*Synthesis for Orchestra and Electronic Sound*).

CRI S-227 - Otto Luening / Vladimir Ussachevsky (*Concerted Piece for Electronic Sounds and Orchestra*), Mel Powell (*Second Electronic Setting*), Ussachevsky (*Of Wood and Brass; Wireless Fantasy*).

MERCURY 90482 - Pierre Henry (*Le Voyage*).

MERCURY SR2-9123 - Luciano Berio (*Momenti; Omaggio a Joyce*), André Boucourechliev (*Texte I*), François Dufrène / Jean Baronnet (*U 47*), Herbert Eimert (*Sélection I*), Luc Ferrari (*Visage V*), Pierre Henry (*Investigations:Entité*), Mauricio Kagel (*Transition I*), György Ligeti (*Artikulation*), Bruno Maderna (*Continuo*), Henri Pousseur (*Scambi* [or, *Echanges*]), Iannis Xenakis (*Orient-Occident*); 2 discs.

NONESUCH HC-73018 - Paul Beaver / Bernard L. Krause (*The Nonesuch Guide to Electronic Music*); 2 discs + handbook.

CORRECTIONS

We regret that in the list of Advisory Council members in EMR No. 4, J.K. Randall (Composer, Princeton University, Princeton, N.J.) was inadvertently omitted.

The correct listing of *Technical Bases of Electronic Music* by Robert G. Meyers (Recent Publications, EMR No. 4) is as follows: In Spring 1964, Winter 1964, Winter 1966, and Winter 1967 issues (a list of errata will appear in a forthcoming issue) of *Journal of Music Theory*, Yale School of Music, New Haven, Conn. 06520.

PLEASE NOTE

Information for EMscope should reach EMR no later than one month before month of publication. In Europe, direct information to Hugh Davies, European Editor, Electronic Music Review, 26 Upper Park Road, London N.W.3, England.

The Magnetic Stencils of A. H. Frisch

Gordon Mumma

During the past two decades of creative work in electronic music many diverse ways of tape recording have been explored. One of the most unusual is the use of magnetized arrays for sound synthesis. This procedure has been developed in great dètail, not by a professional musician or an electronic engineer, but rather by a lawyer. The name of A.H. Frisch may well be added to that list of such pioneers as Fermat, Roget, or Borodin, who work in several occupations at the same time, yet become more widely recognized by their avocation than their profession.

A.H. Frisch has been experimenting with magnetized arrays since the late 1940's. He has bypassed the usual methods of recording on magnetic tape, which apply a magnetic signal to a moving tape by means of a recording amplifier and recording head. Instead, Mr. Frisch has developed a procedure using magnetic stencils. These stencils are placed directly against the magnetic tape itself, and a permanent magnet is passed over the stencil, thereby transferring the stencil pattern to the tape. This magnetically stenciled tape is then played back on an ordinary tape deck.

Mr. Frisch has developed virtually all aspects of this work by himself. He has fabricated his stencils from pieces of wire (cut from nails, paper clips, and the like) which he glues to long strips of metal. He has explored the efficiency of various procedures of magnetic transfer to the tape. After much trial and error in the fabricating of his stencils, Mr. Frisch developed an algebra in order to predict the acoustic result of many possible stencil patterns. In conjunction with building a library of stencils he has accumulated a large collection of multi-channel tapes made with these stencils. These tapes contain the results of his studies of timbre and pitch relations, as well as some remarkably detailed rhythm studies, all achieved by means of magnetic stencils.

Several applications of magnetic stencils deserve particular mention. First, magnetic stencils offer a graphic approach to sound synthesis. In this respect their educational potential for acoustics, mathematics, and music is enormous. Certainly the musical results of these magnetic stencils could be duplicated with computer synthesis. But the computer does not yet offer the student such immediately comprehensible access to the materials of sound. Second, the musician who is interested in experimenting with special intonation and tuning systems can achieve a degree of accuracy otherwise possible only with extremely sophisticated electronics. Third, magnetic stencils offer special advantages as a means of generating control or programming signals for use with accessory electronic music equipment.

The most common procedure of recording audio signals on magnetic tape is as follows:

A. Sound vibration patterns are converted to corresponding electrical variations with a microphone and amplifier.

B. These electrical variations are mixed with an ultrasonic "bias" frequency and converted to magnetic fluctuations by the recording head. (The ultrasonic bias removes distortion which would otherwise occur in the electrical-to-magnetic transfer.)

C. The magnetic fluctuations are stored as patterns on magnetic tape which moves past the recording head at a constant speed.

In order to play back this tape the process is reversed:

D. The tape is moved past a playback head at a constant speed so that the magnetic patterns of the tape induce corresponding voltage fluctuations in the head.

E. These voltage fluctuations are amplified by a playback amplifier.

F. The electrical variations are converted by a loudspeaker into patterns of sound vibrations.

In both the recording and playback procedures, many of the amplification functions are subjected to "equalization". That is, certain frequencies receive greater amplification than others, in order to overcome various types of distortion which occur in the electrical-to-magnetic transfer.

In the composition of some kinds of electronic music on tape, step A is eliminated entirely, and electronically generated signals are applied directly to step B. With the magnetic stencil procedures developed by A.H. Frisch, steps A and B are eliminated entirely, and step C is considerably modified. Mr. Frisch "composes" the magnetic pattern on a ferrous stencil, which he then transfers directly to the tape. The playback of this tape is accomplished in the usual way with steps D, E, and F.

The basic stencil developed by A.H. Frisch is shown in Fig. 1. A pattern of short, ferrous rods is attached to a long bar of metal. This stencil is the top part of a "sandwich". The bottom part, the "track-template", is shown in Fig. 2. Into each of the five slots which run the length of the track-template can be fitted an "under-strip" of ferrous metal. The middle part of the sandwich is the magnetic tape itself, which ordinarily is placed with its oxide facing upwards against the stencil (Fig. 3).

Recording, or transfer, of the magnetic stencil pattern onto the tape is done by moving a small, permanent bar magnet along the length of the stencil. (U.S. Patent No. 2,627,413, filed on Sept. 22, 1950 and granted on Feb. 3, 1953 to A.H. Frisch and Arthur Silverberg, describes in detail this basic magnetic stenciling procedure.)

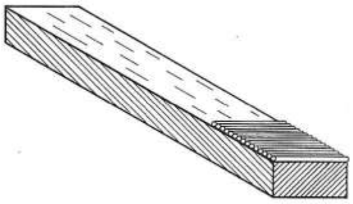


FIG. 1. STENCIL.

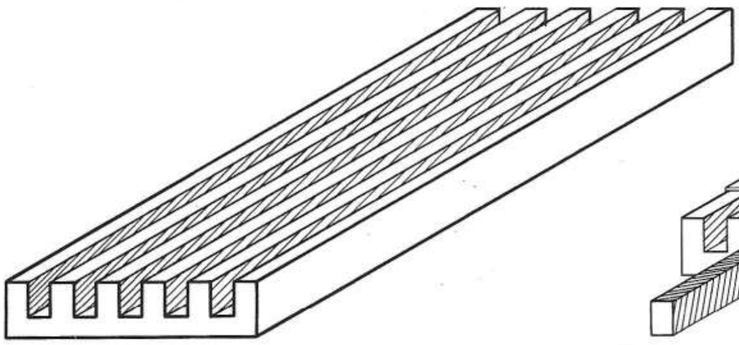


FIG. 2. TRACK-TEMPLATE.

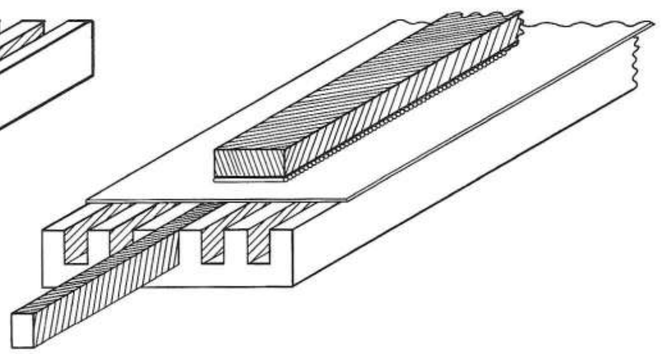


FIG. 3. SANDWICH FOR RECORDING.

With the track-template shown in Fig. 3, five separate tracks can be recorded on the tape. Mr. Frisch uses a five-track-template for recording on 35 mm sprocketed tape. By moving the stencil and the corresponding under-strip from one slot to another in the track-template, each channel can be recorded separately. Very exact synchronization of the channels is possible by placing pencil marks on the tape and matching the stencils to these marks. In playback, on a Magnasync facility, the signals of the five tracks are added together with a mixer and heard from a single loudspeaker.

A.H. Frisch has devised an algebra for designing stencils, and constructed a library of stencils in equal temperament, corresponding to the pitches of the piano. The pitch of each stencil is determined by the number of rods per inch along the length of the stencil. For each stencil of a different pitch, rods of different diameter are used.

If the tape will be played back at a speed of 15 inches per second, then the diameter of the rods for each stencil is determined, in ten-thousandths of an inch, by dividing the desired frequency in cycles per second (Hertz) into 150,000. For example, the stencil for the pitch "A-440" is constructed of rods which are approximately 341/10,000 of an inch in diameter (150,000 divided by 440 Hz equals 340.99). Thus, the pitch of the stencil is inversely proportional to the diameter of the rods.

Dimestore paper clips are ordinarily in A♭. If a stencil is made of rods cut from these paper clips, which, measured with a micrometer caliper, are 361/10,000 of an inch in diameter, the pitch is 415.5 Hz. (Transposing the above formula, 150,000 divided by 361 equals 415.5 Hz.) This is not exactly A♭, which in the equal-tempered scale would be 415.3 Hz, but is extremely close.

Within his algebra Mr. Frisch has designated a stencil made of rods of equal diameter placed side by side (without spaces between the rods, as in Fig. 1) as being part of a 1/1 series. The sound of recorded 1/1 series stencils, as perceived by the ear, and confirmed by observing the waveform on an oscilloscope, is essentially a sine wave.

A stencil in which every other rod is removed, leaving a space, is a "fractional" stencil of the 1/2 series. Each fractional stencil is considered to be made of "groups". A group is a pattern of rods and spaces (the width of each space equals the diameter of one rod). The numerator of the fraction indicates the number of rods per group, and the denominator is the number of rods and spaces per group.

The sound of a recorded 1/2 series fractional stencil is essentially that of a half-wave rectified sine wave. The pitch of a 1/2 series stencil made with rods of the same diameter as a 1/1 series stencil is an octave below (half the frequency) that of the 1/1 series stencil. The 1/3 series fractional stencil consists of one rod and two spaces per group. The waveform is a narrower pulse than that of the 1/2 series. The pitch is a third that of a 1/1 series stencil made of rods of the same diameter.

If the fractional stencils for a given rod diameter are extended in a similar manner (e.g., 1/1, 1/2, 1/3, 1/4, 1/5...) the waveform becomes a progressively narrower pulse. The pitch fundamental of each pulse waveform follows the pattern of an inverted harmonic series, such as that obtained with certain electronic frequency dividers. As the pulse width becomes narrower the harmonic content of the waveform changes. Thus, by building a fractional stencil series for every pitch in his stencil library, Mr. Frisch has developed a vocabulary of timbres as well as pitches.

An even larger timbre spectrum is available with extensions of the fractional series. The 2/3, 2/4, 2/5, etc. fractional series produces a type of "camelback" waveform, consisting of a double, rounded pulse followed by a space. The 2/3 series fractional stencil is made of groups of two rods and one space, the 2/4 series is made of two rods and two spaces, etc.

The 3/4, 3/5, 3/6, etc. series fractional stencil produces a very unique triple pulse group (a mutated camel with three humps!), consisting of three rods and the designated space. Thus, the fractional stencils can be developed for many diverse timbres for any given pitch. Mr. Frisch has also constructed stencils with hexagonal rods, instead of cylindrical rods. The use of different shapes of rod offers another direction in the control of timbre.

Finally, special stencils have been developed for imparting a vibrato to the resultant sound. These vibrato stencils use rods of two different diameters, chosen for each stencil according to the desired width and rate of vibrato. The result is a true frequency-modulation vibrato.

Amplitude and envelope control is achieved in four basic ways:

A. By the use of magnets of different strengths.
B. By the direction and speed at which the magnet is drawn along the top of the stencil.
C. By the use of different metal under-strips inserted into the track-template slots.
D. By the use of "amplitude-templates" of variable thickness, which are inserted between the moving permanent magnet and the stencil.

The amplitude-templates are particularly interesting because they enable very accurate control of the distance between the moving permanent magnet and the stencil. The flat, lower surface of the amplitude-template is placed against the stencil. The permanent magnet is drawn along the varying upper surface of the amplitude-template. The greater the distance from the upper surface to the lower, the less magnetic force will be imparted to the stencil from the moving permanent magnet. The amplitude of the stenciled signal decreases as the distance of the moving permanent magnet from the stencil increases, following the thickness of the amplitude-template.

Because the amplitude-template must be a non-magnetic material, it can be constructed from strips of various types of plastic which are easily molded or carved. By this means, very complex amplitude envelopes can be easily obtained and applied with great flexibility of combination to any stencil and track of the magnetic tape.

The working procedures employed by A.H. Frisch for his magnetic stencils are similar to those of motion-picture editing. The track-template runs the length of the work table, and is flanked on each end by hand-cranked reel holders. The supply reel for the magnetic tape is at one end of the track-template, the takeup reel on the other. Affixed to the side of the track-template is a long ruler. Space is also allowed on the work table to accommodate various under-strips, amplitude-templates, permanent magnets, marking pencils, stencils, and accessories. A music stand is useful for the composer who works from a prearranged score.

With magnetic stencils it is convenient to compose on extremely long lengths of magnetic tape without recourse to splicing, since coordination of separate channels can be done with pencil cues directly on the tape itself. Tape-loops are very easily accomplished with standard splicing procedures.

When A.H. Frisch established his studio for experimentation with magnetic stencils, he chose the most applicable tape playback equipment available at that time. This included the Magnasync

35 mm sprocketed tape system (which actually operates at 18 ips) and the now historically famous (and still widely used) Magnacorder PT6. The 35 mm width facilitated the development of a five-channel system. Today, two-, three-, and four-track magnetic heads are available for playback with standard quarter-inch width tape (it might even be feasible to develop a system based on the increasingly popular half-inch width tape), and the lower tape speed of 7.5 ips has become standard.

Metal rods are available in the form of ferrous wire of precise diameters, and can be cut into whatever length is required for the desired stencil width. Numerous bonding methods are useful to attach the rods to their metal stencil bar, including the various epoxies and silicone rubber compounds.

Thus, the materials are easily obtainable for the individual composer or experimenter to construct a magnetic stenciling facility tailored to his own specific interests. Further, the widespread use of standardized teaching facilities and procedures from one school to another indicates a great potential for the development of mass-produced stencil facilities, including modular kits which could be put together by students themselves for specific pedagogical use.

One area for further technical experimentation in magnetic stencils is that of playback equalization. In order to obtain a relatively flat frequency response and optimum signal-to-noise ratio in standard magnetic recording procedure, equalization is applied in both the recording and playback functions. With the magnetic stencil procedures of A.H. Frisch, the entire standard recording function, including equalization, is bypassed. In order to optimize the signal-to-noise ratio and approach flat frequency response in playback of magnetically stenciled tapes, a special equalization curve is needed. It may be that attention should be given to the use of a special oxide formulation for the tape itself, since frequency and noise characteristics are also determined by this means. Many specialized types of oxide formulation are now available for audio recording (not to mention the realm of video and instrumentation recording), and this is a direction which could easily be accommodated by the industry.

Because magnetic stencil procedures are visually graphic, uncomplicated, and relatively inexpensive, they can bring the electronic music medium directly to the hands of very young students. Their graphic nature is immediately comprehensible in illustrating fundamental mathematical properties of sound, and musical applications of mathematics. For both the young student and the sophisticated musician, work with systems of tuning other than equal temperament, both historical and innovational, is immediately accessible with magnetic stencils.

For the composer, musical performer, and experimenter, the use of magnetic stencils in conjunction with electronic modification procedures, such as those already available in many electronic music studios, offers new means of artistic creativity. Perhaps the most interesting of these is the use of magnetic stencils to create "control" tapes for use with voltage-controlled electronic music equipment. Precise electronic control for the various musical parameters is presently achieved only at considerable cost, and with great difficulty if the rhythmic articulation of these parameters is at all complicated. By the use of magnetic stencils, control tapes can be composed to the requirements of the most fanciful imagination. In conjunction with the appropriate electronic music equipment, control functions can be interchanged among parameters, and parameter inter-relationships can be established with great ease and accuracy. For the creative artist working with electronic procedures in visual, literary, theatrical, and inter-media, magnetic stencils as control and program means can be effectively applied to these arts.

Inside-Out: Electronic Rock

Tod Dockstader

> "Listening to rock bands has convinced me — and I'm old enough to have teen-aged children of my own — that we are in the process of evolving a new kind of electronic music."
>
> — Ralph Gleason (in notes for the Jefferson Airplane's first LP).

> "I feel as if I was <u>inside</u> a song, if you take my meaning."
>
> — Sam Gamgee, Hobbit.

When Karlheinz Stockhausen's long piece, <u>Kontakte</u>, came out years ago on LP, I played it for someone used only to popular music and got the comment it would have been a groovy thing if all the "wandering around" could be cut out.

"Wandering around" has long been identified with electronic music. In <u>Conversations with Igor Stravinsky</u>, the composer commented: "The shortest pieces of electronic music seem endless, and within those pieces we feel no time control." And this time-sense has, along with strange sounds, kept electronic music from a large audience in the past. In the past, popular music — rock — has been the opposite of both "wandering" and strange; it's always been three minutes of rigid metrics, and unvarying dynamics and instrumentation: loud electric guitars. Yet now, just in the past year, rock groups are beginning to not only wander around, they're making strange soft sounds as well, and along with these new, and previously unpopular, sounds, has come a time change: in most cases, the strangest sounding cuts on the new rock records are also the longest. At times, even the inviolate Beat is abandoned in a timeless stream of sound.

> "My friends have lost their way.
> We'll be over soon, they said —
> Now they've lost themselves instead."
>
> — Beatles lyric.

It took jazz years to lose the beat and slowly disassemble into introspection. The musicians gradually stopped swinging and went inside themselves; solos became longer, and both the melody and the beat ceased to matter much — and when the pulse stopped, the patient died. (You may not agree jazz is dead, that it's still alive and living in Poland. But for me, it died when it stopped swinging , and most of its young audience left it at that time for rock — including a great many people who took it seriously, and now take rock seriously.) Rock, with its strong beat and direct melody, took over the large young audience left stranded by the musicians' departure for Infinity. Now something like this is starting to happen to rock — very fast. It still holds its vast audience, but Infinity is beckoning again, this time in the form of "electronic" sound and time. Yet, if anything does succeed in killing rock — and many futile attempts have been made on its life in the past — I think it will turn out to have been an overdose, not of tape echo, but of drugs.

> "One pill makes you larger,

And one pill makes you small,
And the ones that mother gives you
Don't do anything at all."
— Jefferson Airplane lyric.

Five years ago, long before any of this happened, I was asked at the end of a radio interview if I thought there was a similarity between the effect on the listener of a piece of mine (Quatermass, Owl Records, ORLP 8) and LSD. At the time, I thought the question silly; now, I'm not so sure. If I thought about "the listener" at all, it was to assume he'd gradually come around somehow to electronic music, though it would probably take him years to do it; I never thought he would try and catapult himself into it, because I realized some profound changes in aural orientation were involved. But the catapult is at hand:

"If you take the trip tonight,
Focus in on the flashing light.
Take a step right through the door —
When it's done, you'll ask for more.
You're on the one-and-only home-made time machine."
— H.P. Lovecraft lyric.

One of the few guaranteed effects of the most widely used and least exotic hallucinogen, marijuana, is an expansion of time perception — or the loss of it. Time, under the effects of pot, seems to go on and on, and one ceases to be concerned with the lengths of things. A three-minute song can go on indefinitely, and the form of the piece is lost in a slow procession of fascinating detail. This detail becomes enlarged; sounds that were before almost inaudible can emerge abruptly from the background and become startlingly clear and present — and their identity (as instruments), no longer automatic, now seems irrelevant. Also, these now unfamiliar sounds can appear to come from outside the room and behind your head, as well as from the speakers — a kind of super-stereo that is not always pleasant to be in. (In short, an experience not unlike that to be had at a concert of "serious" electronic music. It should be noted now that what I say about these drugs is not an endorsement of them; if you play with your head in this way, you stand a real chance of losing it.) I suspect it is this composite experience, and not the influence of electronic music per se, that has led to the suddenly accelerated change in rock — and it's an experience shared in part by both the musicians and their audience:

"Why don't we sing this song all together —
Open our heads and let the pictures come."
— Rolling Stones lyric.

This new music began life as something called "acid rock". Acid rock didn't sound very hallucinated, but the lyrics began to establish the new experience:

"Remember what the Dodo said —
Feed your head, feed your head."

— was the final advice in the Airplane's White Rabbit. (Alice in Wonderland and J.R.R. Tolkien's Hobbit books have become popular sources of imagery for rock lyricists: the Beatles' I Am the Walrus and a new group called The Hobbits.) Some of these song titles depended on a knowledge of inside matters (Acapulco Gold; A Small Package of Great Value Will Come to You Shortly) and the names of some of the groups themselves came out of drug literature — The Doors

(— of Perception; a pioneering book on hallucinogens by Aldous Huxley), Clear Light (also mentioned in Huxley's book) — and drug culture (Big Brother and The Holding Company, a reference to the ever-present problem of a "stash").

The progression from acid rock to what is now being called "electronic rock" is particularly evident in the three LP's so far released by the Jefferson Airplane. Their first LP was regular high-school rock — Why-Don't-You-Love-Me-Anymore-Baby lyrics, but with more inventive instrumental playing and varied beat. The second LP contained the White Rabbit, which became a hit single. The third, and latest, album is hallucinated in lyric and sound, and time. The new time-sense sounds, in many cases, "electronic"; the whole LP contains only five cuts, while their earlier records had at least five on a side, and it is not always clear where one song ends and another begins. Time goes on, unspiraled, and sometimes unmeasured by any beat at all. One "song" (A Small Package...) is entirely vocal mumbling and giggling in tape echo, moving to and fro between the speakers. (The use of tape echo exemplifies the change in rock: faint tape reverb was common in the first days of rock recording and then abandoned; now it's reappeared in a more dramatic use, repeating vocal figures into infinity and pushing instrumental sounds into a totally white-noise distortion.) In Two Heads (in this case, a "head" is a regular user of hallucinogens) Grace Slick's voice splits in two and goes wandering in and out of the echo chambers and back and forth between channels; throughout the piece, everything is in constant motion, including the drummer.

The first electronic rock record I came across was a little-known release by a group called The West Coast Pop Art Experimental Band. Most of the cuts on this record were nice acid rock, with love-lyrics, but two cuts contained the first (to my knowledge) examples of dis-organized sound in rock music. (I do not include the Mothers of Invention here because their sound is disorganized for purely anarchic reasons — intended as a kind of philosophical insult. In fact, the very existence of this group is an insult, as their live appearances make clear.) In Leiyla and Help, I'm a Rock the guitars were scraped and slammed, amplifier feedback was built up into sustained howls, and vocal growls, barks, and shrieks completed the din. "Fuzz boxes" were used to heavily distort the guitar sound into something like a square wave. (The fuzz box is a kind of clipping amplifier, introduced into rock several years ago but not used until recently to achieve total distortion.) This was "performable" electronic rock in that everything could be done live on a stage. Besides the familiar fuzz box, other devices came to be used to change the sound of live performance: a pedal volume-control was used to eliminate the naturally sharp attack of the guitar (the fuzz box also does this) and turn it into an organ-like sound. The BluesProject had a long piece called Flute Thing in which the "electric" flute (a contact microphone was taped to it) worked through an amplifier and a tape-loop device. The flutist controlled the amount of tape echo mix with his feet (there were two pedals, one for volume and one for tape speed) playing a kind of duet with himself and sometimes building the tape echo up into great burbling cascades of sound. (This piece can be heard without electronics on Projections [Verve/Forecast 3008]; without electronics, the piece is half as long and a good deal less rambling.) Pushing guitar amplifier levels up so high that acoustic feedback loops resulted became a favorite addition to the already deafening sound. ("Deafening" = a steady 120 Db, measured in the hall.) The tremolo circuit (a blocking amplifier) of the guitar amplifier is used in the Rolling Stones' new LP to shake the singer's voice throughout the song In Another Land. (This particular use is a striking example of the sudden search for new sounds on the part of rock musicians. The tremolo circuit has been available for years as standard equipment on guitar amplifiers, yet not until this has it been used to affect anything but a guitar.)

"It's a wild time —

I'm doing things that haven't got a name yet."
— Jefferson Airplane lyric.

Most of <u>these</u> new effects are less impressive on records than they are in live performance. (The popular idea that rock groups can't play a note outside of a recording studio — that they exist only on records — falls apart when you hear them in concert. In most cases, their recordings are a faint carbon of the hair-raising power they can achieve on stage. Rock, if you want to listen to it at all, must be heard clean and <u>loud</u>, and this is hard to achieve outside of a concert. You can, if you've never been to one of these concerts, get some idea of the sound by listening to the Clear Light's <u>Mr. Blue</u> through stereo headphones and a pair of clean 30-watt amplifiers with the volume all the way open; at the same time, try to visualize six rather rancid-looking young men on a distant stage, producing this sound with an apparent minimum of effort. My warning about playing with your head might also apply to this experience; keep your hand on the knob.) As these groups move farther into electronic-tape sound, however, the problem of repeating a recorded performance — of living up to it — on stage will get serious. They may have to include an engineer in the group to play tape-tracks and circuitry. More likely, they will begin to abandon live performance altogether, as the Beatles have done, and then they <u>will</u> exist only on records. I think if this happens, their audience will begin to drift away toward other groups that still can perform their material live. Most reputations are still based on concerts — even in rock — and this is particularly true for new groups getting started; these new groups may be discouraged from developing electronic rock for this reason. To a "Groupie" (a rock fan) the 3-D photograph of Mick Jagger which adorns the cover of the new Stones album just can't generate the same hysteria as being <u>there</u> — with Him! in the same <u>place</u>! — even if the same place is Shea Stadium. And it's the Groupies, not the intellectuals (who, though they take rock seriously, prefer not to have to look at Mick Jagger if they can possibly avoid it) who have been keeping rock alive through all the attacks it has sustained.

The Beatles have reached the stage where they <u>can</u> exist only on records (and in films and TV) and have to, because their influential ideas are now so complex they are largely unperformable. <u>Sgt. Pepper</u>, their first "acid" LP, has been called a Complete Trip — yet I find in it little use of what could be called truly hallucinated sound, certainly not the kind of sound in either the Airplane's or the Stones' LP's which followed and were largely influenced by it. <u>A Day in the Life</u> ends the LP with the line "I'd love to turn you on" but the turning-on is done with straight, though unprecedentedly complex, orchestration and tracking (building a piece like a layer cake on eight or sixteen track tape). This song has a Wozzeckian full-orchestra effect in it which sounds electronic, but isn't. What this LP did do was to present the work of a rock group — work usually divided up into singles — as a total experience. It's a vast (and expensive) show, a concert for loudspeakers.

The Beatles' newest LP, <u>Magical Mystery Tour</u>, has cuts in it that do use tape-sound. In <u>Flying</u> and <u>Blue Jay Way</u> backwards vocal and instrumental tape passages are used, and in <u>Blue Jay Way</u> everything is in constant phase-shift. In <u>I Am the Walrus</u> a complicated superheterodyne-radio-tuning cacaphony ends the piece, full of inaudible voice fragments and other unidentified sounds. This ending din is exactly the sort of thing that can become unaccountably interesting under pot; without that, it remains another example of creeping infinity.

An attempt to play infinity-rock, while keeping the beat, is <u>Third Stone from the Sun</u>, a long and rambling instrumental on Jimi Hendrix's LP that uses backwards-tape rhythm and half-speed voices growling a cosmic-air-to-ground communications "lyric". This LP has the most terrifying fuzz I've ever heard; the guitar sound is completely destroyed by it. This kind of fuzz is also responsible for a powerful percussion sound in the Clear Light's Mr. Blue — it sounds like a five-foot coiled steel spring being hit with an axe, instead of the single guitar note it is. The Beach Boys' new LP incorporates a Theremin and tape speed acceleration, yet the overall sound of this album (despite its Middle-Earth cover) is, to my mind, more Disneyland than Hobbit-land. Yet this LP represents a schoolgirl's-world shaking change in sound for the Beach Boys. Similarly, the Pearls Before Swine LP has a properly hallucinated cover (by Hieronymus Bosch) but the sound inside is straight (though varied, in the acid style. One nice effect is the lead singer's speech impediment). A sine-wave oscillator does appear in one cut, but only to dit-dah out a four-letter synonym for passionate cohabitation in Morse code. The Doors' new LP has one cut, Horse Latitudes, that has no beat and no melody, being entirely a mad babble of voices that flutter rapidly back and forth between speakers; the declaimed lyric is an example of what heads would call a "bummer". (Another bad-trip lyric is in the Airplane's Rejoyce which refers, I assume, to a famous acid incident with: "I've got his arm. I've got his arm. I've had it for weeks." This sort of thing may indicate that the romance with drugs is about over.)

Finally, the Stones' new LP: probably the most extreme example to date of Infinity-Through-Electronics (a correlation to the heads' Better Living Through Chemistry). This LP was influenced inside and out by Sgt. Pepper. The eye-wrenching cover has the costumed group seated in an out-of-focus 3-D landscape, with Beatles' faces hidden in the Hobbit-trees. The record, like Sgt. Pepper, is a never-to-be-performed concert, involving complex orchestration and tracking. Voices mumble an introduction to one song; a prepared piano (coat-hangers on the strings), running both forwards and backwards, introduces 2000 Light Years from Home, and during the vocal of this song, phrases are run backwards and an oscillator burbles up and down in variable-speed tape echo; one long cut is a kind of add-a-part chaos (Sing This All Together — See What Happens); and the last cut on the first side is entirely electronic in both sound and organization: waves of white noise washing up on the label.

Most of the electronic rock I've heard so far recalls the musique concrète of the fifties. (The all-electronic cut on the Stones' LP, for instance, is a slowed-down Christmas carol.) There is, as yet, little evidence of sophisticated generation or control of sound. There are a few efforts being made outside of rock to totally synthesize the rock sound, but none of these has so far surfaced in LP's, and the few I've heard, on tape, couldn't be said to swing. The curiously lumpy, mechanical beat recalls the strained effort of the RCA Synthesizer to play Blue Skies. (It conjures up a picture of a metal man you put a quarter into and his eyes light up, and after much clanking a little metal disc comes out with your name stamped on it.) A partial attempt at synthesis has appeared on LP, produced by a non-rock duo named Perrey-Kingsley, but they depend on a straight (and uninspired) rhythm section of bass and drums for an inflexible beat, and the music, despite the funny sounds, is as rigid as the earliest three-minute rock. The whole effect sounds as forced as the titles (Jungle Blues from Jupiter; Computer in Love) and as square. Somehow, it seems to me, totally electronic rock will have to swing on its own new terms, and not as an imitative thing, as this is.

So far as I know, no one from the "serious" electronic discipline has ever worked with these groups. (I hear that some work is going on at Columbia-Princeton Downtown [The Electric Circus] involving Morton Subotnick, and some of this work surfaced in the Circus's Electric Christmas celebration at Carnegie Hall last year. But since the electronic work was accompanied by an eye-splitting Walpurgis light show of multiple strobes, it was hard to know at the time what the music was doing on its own. I have the feeling, from what I heard at this concert, and from Subotnick's LP, that he may be the first to really pull it off.) The unassisted rock groups seem to be in the process of finding it out all over again for themselves, with the inevitable awkwardnesses. But they're moving fast, and they are unhampered by the lack of money for time and equipment that has plagued electronic composers in the past. (A single cut on the Beach Boys' LP cost, in studio bookings alone, the equivalent of a fully-equipped electronic music studio for a school.) These groups now book recording studios for months at a time — in effect, they are "playing" the studio, and they're bound to come upon all the devices they need to get the sound they want. Whether or not this ultimate sound will be all electronic, or whether they'll begin to find their huge audience falling behind them and retreat to the original Beat, abandoning everything they've picked up on in the past year — or trip on into Infinity to join the jazz musicians of the past — seems to depend on how turned-on they, and their audience, can remain as both the government and old age move in on them. They have not yet developed a self-sustaining form, as serious electronic music is; right now they're running on an extra-musical fuel, a common experience that faces extinction by law.

Drugs began this new trip for rock, and enriched it by forcing open a lot of plugged young ears, resulting in new ideas; and electronics furnished the new sounds to express these new ideas. I don't know if this new rock can survive the inevitable withdrawal; I do know it can't survive the withdrawal of its audience (unlike serious electronic music, which has survived two decades with very little audience at all). These groups are playing for the heads — not, as in the past, the feet — of their audience, and it may be I'm underestimating all those heads. I hope so. I've liked rock for a long time, and I think the introduction of electronics into it could, by itself, power a great new popular music. I don't think anybody's truly heard this new music yet, because nobody's succeeded yet in making a sustained original electronic rock that swings on its own terms, and not on those of either the infinity-gropers or the electronic-pop paste-up people who are doing it now. That it has to swing, I have no doubt. Wandering around inside a piece of music is what I listen to (and make) electronic music for, and getting lost inside is part of the joy of it, because there's enough time in the form to find my way out again. But rock is short pieces of time, and a clear road ahead, and I like it for that. If electronics can build a yellow rock road (I wonder why no one has used the Oz books for rock lyrics and group names, like "Toto and the Munchkins") that's even better — but no detours; Stockhausen Builds Better Detours.

STEREO LP DISCOGRAPHY

The Beach Boys: Smiley Smile Capitol T-2891
The Beatles: Magical Mystery Tour Capitol MAL-2835
Sgt. Pepper's Lonely Hearts Club Band Capitol MAS-2653
The BluesProject: Live at Town Hall Verve/Forecast 3025
Clear Light Elektra EKS-74011
The Doors: Strange Days Elektra EKS-74014
Jimi Hendrix: The Jimi Hendrix Experience Reprise 6261
Jefferson Airplane: After Bathing at Baxter's RCA Victor LSO-1511
Surrealistic Pillow RCA Victor LSP-3766
H.P. Lovecraft Phillips PHS-600252
Pearls Before Swine ESP 1054
Perrey-Kingsley: The In Sound from Way Out Vanguard VSD-79222
The Rolling Stones: Their Satanic Majesties Request London NPS-2
The United States of America Columbia CS-9614 (This LP — the first so far to be promoted as electronic rock — was released after this article was written. It will be reviewed in a forthcoming issue of EMR.)
The West Coast Pop Art Experimental Band — Part One Reprise 6247

Calculation and Imagination in Electronic Music

delivered at the State University of New York at Buffalo, on February 28, 1967, by

Henri Pousseur

Serial electronic music in Europe began as a result of two seemingly contradictory intentions. One of the most pressing reasons we had fifteen years ago for searching after new acoustical means was the need to enrich the resources of sounds at our disposal — and not in general but precisely in the direction of those complex sound qualities that for a long time were contemptuously grouped under the category of "noise". We had already heard some examples of these sounds in the music of the early part of this century, for example in the Rite of Spring and in Schoenberg's Five Pieces for Orchestra, in some pieces of Webern — like the Bagatelles for String Quartet and in a very different way the later Variations for Orchestra, and in much music of Edgard Varèse. However, there were also other strong influences contributing to this new special sensibility: the kind of sound the contemporary world makes (traffic, factories, and so on), and also the kind of general experience it creates without looking principally to its sounding aspects; this experience is basically one of movement, of speed, of complexity. And finally, there was the growing asymmetry in other artistic fields, and even in other levels of musical composition, which were awakening in us the desire for a new, fresh, and aggressive sound material.

However, at the same time we were possessed by an implacable desire for strict organization, for rigorous and clear control of what we were doing. This was the time of so-called "total organization" in its first, very rigid version; we had undertaken to apply, on all possible levels and in every perceptible dimension, methods of guiding and combining the musical elements which we had deduced from the Schoenbergian and above all from the Webernian serial system, stressing almost exclusively the rational, quantitative, and metrical aspects.

The two intentions, which probably developed themselves on different levels of our consciousness, the one more imaginative and the other more rational, were not, however, completely independent of each other. For example, experience with so-called "musique concrète" (an experiment that Boulez was making as I first met him in 1951) had taught us almost ad absurdum that such complex materials as those recorded sounds and noises needed a particular care in manipulation and in putting together, a very strong and, above all, well adapted structure to become musically significant. So we thought it would be better to take the question from its most simple side, to study at first the elementary properties of sound material, to reduce it to essentials, and to try to rebuild from that point all the other things, all the complex phenomena we knew to be lacking. That was the beginning of electronic music in its narrow sense, and of its at first extremely pointed opposition to such practices as "musique concrète".

Karlheinz Stockhausen was the first to have the chance to try to realize this idea, and I think this was appropriate, since he had the strongest, the most radical, and probably the clearest conception of what there was to do. When he was invited to work at the Cologne radio studio in the summer of 1953, he decided to use only pure sine tones. Such waves have the simplest, the most continuous form imaginable. They are completely free from secondary asperities which give rise to overtones. There is an acoustical theorem based on fundamental mathematical laws, that every sequence of vibration (including those which are perceived as sound), no matter how complex, can be reduced to an assemblage of sine waves, each of which has its own frequency and amplitude, so that these two parameters have to be measured and the whole phenomenon can be described in a two-dimensional system of coordinates. If the sound to be analyzed is regular, that is, if it is periodic, it can be described by a set of harmonics, also known as a Fourier series. If not, that is, if it is a complex and non-periodic noise, one has to use the integral function developed by the same mathematician.

Stockhausen felt that what could be done in one direction could also be done in the other. If the analytic way is correct, the synthetic way must also be possible. If one could consider a complex sound, a complex wave, as the sum of a number of simple components, then one could also produce such a complex sound, with absolute precision of control, by putting together, by mixing these different components. And so, using only sine waves, and through their assemblage, one would be able to rebuild, or to build originally, any imaginable sound event.

In this way Stockhausen composed Studie I. Studie II was made by a similar method but already with certain liberties. I had the opportunity to follow his work very closely and, in 1954, to make a little composition of my own at the Cologne studio, called Seismogrammes. In these first attempts, we were still very far from the desired goal. Instead of a situation in which the sine tones came together to form more complex sounds, they remained basically discrete and identifiable; we had a situation in which the sine wave material was used like an easily recognizable instrument. Sometimes (with a decrease in volume) like a very sweet, attackless vibraharp, sometimes (with more sustained sounds) like the softest tones of a pipe organ.

Departing from an analytic hypothesis, the result remained very analytic, and each component could be heard by itself. Of course, there was a possibility, in later works of the same kind, of reaching a higher level of fusion and integration of the elements (for example, already somewhat in Stockhausen's Studie II). This higher level of fusion could be obtained if one used a great number of components for each resulting sound, or if the components had a very special relation of frequency, either a harmonic one, so that most components were absorbed by a few that served as fundamentals, or a more noise-like, quantitatively complicated one, in which the different partials destroyed each other's identity by being out of phase and fusing together in a new, rough opacity, no longer separable by the ear. But these processes showed various handicaps. A great number of generating operations were required to produce a single sound, so the noise level went way up. That diminished the quality of the results, which remained far from what had been planned. Furthermore, it was not really possible to control all the detailed aspects of the juxtaposition of components, since Fourier's analyses of harmonic series do not exhaustively show the internal structure of a complex wave. For example, the relation of phases between the components is of capital importance in the degree and type of their interaction. It was impossible to control this because the instruments we used did not allow precise phase control. In fact, this method, which was believed to supply an airtight description and control of the microstructure of sound, was afflicted by a fundamental contradiction: something that must basically be considered an autonomous, irreducible unity — for instance, a note of the trumpet or the sound of a struck piece of metal — was transformed into a group of discrete, abstract components.

This lesson could be heard in a very concrete way. Working with electronic means, one can verify that there were much faster ways than using sine waves to realize the intended sounds.

There are other types of waveforms, upon which one may use such means of transformation as filters and modulators to get results which take an exceedingly long time to be produced, <u>in a less satisfying way</u>, by the assemblage of sine tones. But, to be able to use these other sources, it was necessary to renounce, to a certain extent, the primary postulate of reducibility of all sound events to a unique, homogeneous, and isometric basic material. It was necessary to accept, at least provisionally, a certain plurality of origin, even of the electronic waveforms.

That was the next step. In his first great electronic work (which is, I believe, the first great electronic work by anyone), <u>Gesang der Jünglinge</u>, Stockhausen used different sources. Among them, of course, were sine waves, but no longer exclusively. There were also square waves, impulses, and variously filtered white noise. And there was finally, as the most unexpected element for those who knew Stockhausen's radicalism at that time, the voice of a little boy singing the text of the "song of the three Hebrew youths in the fiery furnace", from the Book of Daniel. Stockhausen tried to control the mixing of this much stretched sound palette by finding all possible points of contact between the different elements, by producing a great number and variety of intermediary types. He succeeded indeed in composing an admirably unified and, however, much more diversified piece than those previous. But this resulted probably just from the fact that he sacrificed a purely hypothetical postulate and accepted a certain degree of indeterminacy in controlling the material. He accepted this indeterminacy not only in the lowest level of sound events; where the vibration is no longer perceptible in all its details but becomes integrated by the ear in a purely qualitative manner; but also by generalizing this change of mind and giving up the control of some perceptible, macroscopical facts of structure, except in a total statistically integrated way.

From that point, a new branch of evolution began to develop, above all, I think, in the newly established studio of Milan (under the direction of Luciano Berio), a branch in which the <u>intuitive</u> apprehension of the available materials was chiefly stressed, and where the aleatoric factors grew very quickly. That was the time when a certain degree of indeterminacy and of chance was also included in instrumental music; it was the first search for so-called "open" or "variable" forms. Here I must certainly mention the influence of John Cage, whose use of chance elements in musical composition had an unquestionable importance in giving the impulse to this new possibility. However, except for the very important difference of attitude between him and the European composers of my generation regarding the questions of form, use of randomness, control of the results, and so on, I believe that the European experimental music of this time contained the germs of this new evolution and would (even if more slowly and with more difficulty) almost certainly have found this way for itself. The experience with electronic means, as I just showed, should have had — and indeed did have — an important part in this growing consciousness. And it was also to have an important part in further proceedings.

In 1957, I had the occasion to work two months at the studio in Milan and there composed my second electronic work. I was searching, on one hand, for the most asymmetric sound material possible, which would show on its own low level (of small wave unities) the same properties of unpredictability as my colleagues and I had put on the higher level of our former compositions (the level of perceptible structures); and on the other hand, I was looking for the application of the new, movable patterns of form in the field of electronic music. It was rather probable that I would have to connect those two researches (which on different levels showed a certain similarity) in using rather aleatoric methods of <u>producing</u> and <u>guiding</u> both the sound material and its combining structures. So I started with only one source, white noise, and through different methods of selecting various stratifications out of this basic "magma" (methods which were too long to describe here in detail, but of which I can principally say that they always contained a certain degree of unpredictability), I produced a material which had the noisy, irregular character I had wished, but which I could also control in an effective way. It was a total way of control, not of each single element, but of whole groups of elements. I could totally determine the motion of pitch and the variation of statistical speed of the impulse-like, short elements that I had extracted from the white noise. I could also control the transformation of these short, pointillistic elements and groups of elements into continuous, gray, and moving surfaces, and their more or less precise interruption of silences of varying lengths and of varying numbers. I did not compose a finished piece. Under the title Scambi (Exchanges), I made a certain number of separate sequences, which could be combined in succession and also in superposition after certain well-defined rules of connection. I personally made two different versions, and some other musicians, like Berio, used it as a speed exercise and realized their own versions.

Scambi was for me an extreme point in the direction of irregularity, of asymmetry and non-periodicity; it was a point from which I could well verify that one needed to proceed not so much antithetically (that is, in a purely opposite direction to the traditional periodicity), as synthetically, trying to combine all possible appearing things, from the most traditional to the most unknown. At first it was necessary, on the level of sound, to make available as a unified area the largest possible range of materials, from the extremely periodic sounds of traditional instruments, to the most irregular noises one can hear (for instance, in heavy industry). As Stockhausen's Gesang der Jünglinge had shown, it was now possible, without falling back on the stigmatized superficiality of "musique concrète", to use non-electronic sounds as well, either recorded and more or less transformed, or in a dialogue between loudspeakers and live performance. In practice, a recorded sound becomes one electronic impulse among others, even when provided with particular structural characteristics which make it recognizable. From that first degree of transformation (recording the sound), one can go further and further until the result can no longer be distinguished from a purely electronically generated sound. And, furthermore, to become audible, an electronic signal has to be transformed into acoustic vibrations through a loudspeaker, which in this case plays the part of the body of an instrument and is not principally different from other instruments.

In 1958 I began the composition of a work for loudspeakers and a small orchestra (35 musicians), the three parts of which I worked on until the fall of 1959. The tape was one of the first realizations we were able to make at the new studio in Brussels, established in early 1958. In the year after finishing this piece, Rimes, I had the opportunity to make another experiment using recorded sounds. In the meantime, Berio had composed his Omaggio a Joyce, in which all the sounds, even the most "electronic" sounding ones, were derived from the single recorded voice of Cathy Berberian, speaking the beginning of the eleventh chapter of Ulysses. What I made was not dissimilar to this piece; but the pursued goal and the result were very different. I was asked to compose the music for a TV ballet, which was to deal with the tragedy of Electra and to use large portions of the drama of Sophocles. I used only speaking voices (in a little scene in the second part, also singing voices) and many instrumental elements. I moved between an extremely faithful playback of these recorded elements and a very high degree of transformation; these transformations were so great as to give the illusion that the sounds were electronic. I used the different types obtained either to illustrate all the emotional "gestures" of the violent drama or to articulate the scenic divisions of the overall form.

In all these works a rather large concession seems to have been made to a purely intuitive point of view, where the rational principles of control seem to have been widely surrendered. But our basic intention remained, in fact, to overcome the dualistic opposition between intuitive and intellectual meaning, to reach a point where calculation and imagination would no longer be separate. Stockhausen, once more, was the first to look at the work again from a systematic point of view. When I met him in 1958, he told me of the beginning of a new electronic composition, and he told me about the particular technique he was trying to generalize for this work. Already during all our earlier work in the studio, we had been able to verify that multiplying the speed of sound events on tape had very special and interesting properties. On one hand, the transients, or attacks (obtained, for example, by cutting the tape), grew with this process in their sharpness and brilliance; and on the other hand, if one had a sequence of short discontinuous elements, these had, when speeded up, a tendency to fuse with each other and eventually result in the impression of a continuous sound material. Already in Perspectives (1957), Berio had used this technique for one of the sound families of which the work was made. It consisted of tape-loops. These contained sequences of short sine tones that were periodic on two levels, namely: not only did all the elements have the same durations, but the pattern of pitch variation necessarily repeated over and over again. This material was used at different speeds, but not at the highest possible speed, at which some of the tones would have passed beyond 15,000 cycles and, therefore, become inaudible, but at which also the rhythm of the tones, the frequency of their succession, would have passed 15 cycles per second and, therefore, become heard as an independent, very low sound. This last possibility was, until this moment, considered to be an undesirable, parasitic phenomenon. But that was just what Stockhausen now intended to use and to systemize. He took recorded single electronic impulses with durations as short as possible and perhaps with various amplitudes, and he spliced them to one another according to a certain rhythm, so that he got patterns of periodic oscillation which he could repeat by using tape-loops. When he accelerated them until the time intervals between different tones of a sequence passed the lower limit of audibility, he obtained very beautiful complex noises which periodically modulated in amplitude and timbre; when he accelerated them more so that the time period of a whole sequence became the wave length of an audible frequency (at least 15 cycles per second), he got fundamental tones which he could transpose in all possible registers by accelerating them more or less, and which had a very rich "spectrum" or range of overtones. The time intervals he had established by putting isolated impulses together had now become the shortest parts of the vibration, measuring thousandths of a second, and so he was really controlling the whole internal process of the wave, the physical support and determining pattern of the audible sound and of its concrete qualities. That was, of course, a stroke of genius, which made possible once more the consideration of exhaustive control which had been the primary driving idea of electronic music in Cologne. But, instead of analyzing a sound event as the theoretical, often inaudible superposition of frequency components, he would now analyze it in its authentic chronological components, in the different successive details of the real waveform. Stockhausen took this possibility as a basic method for the production of the sound material for his new piece, Kontakte, which was finished in 1960; however, he did not apply such a rigorous technique for all the sounds he produced and accepted many more pragmatic methods for this operation. Since, of course, he didn't always wish to have the very brilliant color that the unchanged use of the sharpest impulses gives, he sometimes put the material into filters and kept only certain ranges of the spectrum — in other words, attenuating the sharpness of the waveform so that it came closer to a sine wave. Of course, the control of this operation was no longer so absolutely strict, and once more into the process of composing the internal structure of these sounds there came a certain degree of approximation, of indeterminacy, and of unmeasurability. In a theoretical text he wrote after finishing Kontakte, called "The Concept of Unity in Electronic Music" (published in Perspectives of New Music, Fall 1962), Stockhausen tried to vanquish this last difficulty, and that was a decisive, even if paradoxical step.

After having shown that either the pitch or the timbre, being functions of frequency, can be reduced to microrhythmic structure, he asserts that there remains an uncontrolled residue. In fact, as we said before, in criticizing the early synthetic theory, the tone color or its physical support cannot be exhaustively predicted by the analysis of the frequency of components. The form of the wave directly corresponds to the perception of sound quality; and since it can have very different curves, it cannot be simply reduced to a purely microrhythmic structure. It has at least a two-dimensional pattern; it must be shown as a continuous variation of amplitude in relation to time. However, Stockhausen tried to reduce even this obstacle. When we have, he said, sequences of impulses that are so fast that the longest interval of time which appears between two successive impulses remains over the upper border of audibility and will then not be perceived as an individual frequency, we have the means to describe, through varying only the speed of this ultrasonic phenomenon, all different waveforms, and we have reached the point where all the aspects of sound, in all its perceptible qualities, can be reduced to a one-dimensional chronological description and through it to an exhaustive quantification. This is, in fact, a well-known radio technique called "frequency modulation". And, for the technical questions of producing and synthesizing sound, it can be of unquestionable interest. But when one tries to apply it, as was certainly the intention of Stockhausen, to a purely musical theory, that is, to a phenomenological level of perception, then it appears as a false extrapolation, from which, however, some decisive lessons can be drawn. Indeed, such ultrasonic sequences are not only presently incapable of being reproduced by loudspeakers, but if they were, our ears could never receive them. If they could, they would receive elements of frequency, and that would be contradictory to the explicit initial definition. For the ear — and, therefore, also previously for the loudspeaker — the only thing that counts is the audible modulation of the ultrasonic impulses and their lower waveforms, and so we have returned to our point of departure. The proof that the impulses themselves are here irrelevant to the ear is that their range can be arbitrarily changed without changing their modulation, that is, without changing the perceived sound.

This is, I believe, a very important finding that could also be of interest for disciplines outside of music, for such disciplines that try to reduce the concrete world to a purely rational net of description, to render it completely transparent to the mind. Reality, however, cannot be completely juggled away by our measures and calculations. Fortunately, it will always offer an irreducible resistance to our penetrating will, and not because it would be basically irrational. For instance, I think that the efficacy of modern technique (even if it looks sometimes like the work of "apprentice wizards"), is sufficient proof of the narrow relation, of the unquestionable communication, between the structures of our operating mind and those of the so-called "external" world (to which the instruments of this mind, the body and its organs of perception, obviously belong). But this world is too complex and its rationality too rich ever to be exhausted by the interrogative operations of our intellect. It cannot be encompassed by our intellect because it includes it. For instance, if we have appeared to describe a certain level exhaustively, we will quickly discover that there is a lower level on which the first one depends, and that this process goes on indefinitely. So, for instance, when radio engineers use frequency modulation, they don't forget that either the particles of the electric current or the molecules of the atmosphere are moving inside the waves they are using, and that they are to a certain extent ignorant of these subordinated facts, that their description, indeed, is only a statistical, and from a certain point of view, a macroscopic one. But that is not all, and that is not the most important! The microscopic phenomena, which are not perceptible in themselves, support larger phenomena, which become evident to our senses. These larger phenomena become evident because they exhibit a certain independence, because they constitute higher forms, effective entities, on their own level. So, for instance, frequencies are audible, as pitch or as timbre, because of the existence, on this level, of unities of wave which must be sufficiently definite and probably sufficiently recurrent. What is important, here, is the existence of specific unities, which we have to grasp in their specific irreducible nature. The perception of these unities is synthetic and in the highest sense of the word, intuitive; it is the perception of qualitative individuality. But, once more, that does not mean that it is irrational and would not need formalization to realize and improve itself. To grasp clearly such a unity, we have to make operations of comparison; either we refer it (even unconsciously) to a background or to a larger context, which can at last be our own being, and which certainly has also to be seized in an immediate, intuitive manner, but which functions now as a measuring instrument, as the other term of a metaphor; or we compare the given unity to another unity of the same level, which shows at the same time identical and different aspects (even only the situation in space or time); or finally, we try to find from which perceptible parts our unity is really built, we ask which higher form these subordinated unities (which we must also at first apprehend) are building, defining the proper shape of this quality in which we are interested. Indeed the concept of shape is here, I think, of greatest importance, because it permits us to supersede once and for all the opposition between rationality and intuition, between calculation and imagination. Calculation, rational formalization, is here the more active side of our relation to reality; it is the operation with, the manipulation of, the intended objects; it is, we could say, the hand of our consciousness. The imagination, the intuition, the qualitative grasp of things is not so much the passive as the receptive aspect, the deepest looking eye of our mind. I think it is obvious how much they need one another, in the same manner as for a worker: hand and eye are absolutely complementary and indispensable and indissoluably bounded faculties. Separate from one another, they would be like a blind man and a paralytic. Between them exists, at least, a relation of the most immediate feedback. We must speak of "the eye of the hand" and "the hand of the eye".

This finding brings us to conclusions which cannot be forgotten. If the synthetic, intuitive apprehension of things is the primary condition of all further operations, among others the rational ones (and indeed we can say that, being operations, formations, they are all rational, to one or another extent), then it is not only possible but absolutely necessary to work with qualitative criteria on all levels of consideration. Then, not only single impulses, not only single pitches and even instrumentally related single timbres, not only figural units in the traditional sense, like melodies, chords, modes, etc., but also complexes of sounds and noises that have a picturesque association, and whole blocs of pre-existing, "historic" music can be used as elementary, no longer divided units of a higher composition. An interesting proof of the validity of this assertion can be given from Stockhausen's Kontakte, proving also that Stockhausen himself had undergone and understood this experience, and that he had practically accepted its consequences, even when in a purely theoretical way he still tried, for a while (not very long, in fact) to persevere in a unilateral way. After having studied and produced a great number of sounds of the type I have described or of its derivatives, and before beginning the actual composition with them, he stopped and changed his orientation rather radically. Instead of going on to organize his structure after purely quantitative points of view, he asked himself to which well-known instrumental sources he could compare his different electronic products; he asked with which kind of vibrating material they would be associated: wood, metal, or skin. He arranged all the collected types according to their greater or lesser resemblance to these basic types and then composed his piece according to this qualitatively preorganized palette. However, bear in mind that his knowledge of the internal structures had certainly contributed to this organization. To render this reference as functional as possible, he added for concert performances of Kontakte, two percussionists playing on different instruments of woods, metals, and skins, including a piano. Whoever has heard this piece remembers that its greatest beauty comes just from the fact that, out of these points of musical anchorage, the tape develops sounds which grow further and further and build large natural or "urban" landscapes, in which all the strange forces we meet in modern life seem to have undergone a first degree of harmonization and humanization.

In his more recent works, which belong more or less to the field of electronic music, Stockhausen has made further steps in this new direction of dialectical exchange between an undeniable will of strong and clear organization and the relaxed acceptance of what nature (even technical nature) can put at our disposal. In these works (Mikrophonie I and II, Mixtur), the sounds of voices or instruments (often used with a rather great degree of indeterminacy regarding the results of performed actions) are picked up by microphones, transformed by different electronic instruments, filters, modulators, tape recorders, etc., and at the same moment, or at least during the same performance, are played back in the hall through loudspeakers, mixing with the sounds directly produced by the performers.

From that point, one could, without being in contradiction with the defined principles, go as far as possible in the way of using preformed reality; one could, for example, pick up street noises, transmit them to a hall where they would be mixed with the sounds made by living (and possibly answering) musicians (perhaps using original sorts of instruments), and one could add, as a third part, the unpredictable program of a broadcast station, trying, through particular types of formalization, based on reaction and on adaptation, to work out a sensible result. Indeed, we know that John Cage, and other similarly oriented composers, created experiences very close to this possibility. However, the way I imagine such a possibility, and the way I believe other composers like Stockhausen could imagine it, is rather different from the practices of chance, which continue to play so great a part in the music of Cage. Instead of having confidence in all that can happen, I believe that we should try to intervene as profoundly as possible to assure, to the limit of our abilities, that a significant form results. The more complex and highly preorganized the material, the more it seems necessary to consider its specific possibilities, to try to find out what are the real parts of which it would be composed, and the genuine functions that all its components would assume in the whole. In other words, we would need to analyze it, but no longer in a purely quantitative way: rather by a method which would consider its own structure or shape as a qualitative one and develop itself according to this structure. So the acceptance of high unities of form and of meaning, far from excusing us from the lack of a rational and deepest possible knowledge, render this knowledge indispensable. Being convinced that organization and expression do not exclude one another, but on the contrary depend one upon the other, and that expression is bound to a certain degree of formal organization, well adapted to our organs of perception, and also that organization needs expression to be effective, we therefore believe that only by putting our whole effort into this best organization, can we develop the rich means of expression we need to master the tasks defined by the present situation. For instance, if we hope to be able to use means of automation and of computing to accelerate and to enlarge the field of electronic music, in such a way that our mastery of the material, or at least our communication with it, really grows, we must go on developing the microstructural methods initiated by Stockhausen in his Kontakte.

> [Here I must mention the considerable work that has already been done in this field, especially in the United States. After having given this lecture, I had the opportunity to visit the main centers of this research: Urbana, Princeton, etc. I was impressed and pleased to see that what we had been dreaming of as the solution to the most burning technical questions of electronic music in the narrow sense had already begun to happen with the use of digital to analog converters. The main criticism I would make of all the present results of this work is that they are still too particular and too fragmentary (though I understand very well that beginning endeavors must always be elementary and partial). Instead of programming the computer as a sort of enlarged instrumentation, I think that one should try to define the most truly general criteria of forming and varying

waves, units and sequences (modulations). But this implies effort in an area of music theory (that might be called "generalized periodicity"), which has not yet been done, perhaps just initiated, to which the first experiences with computers will probably give considerable help.]

I think and hope that the near future will be oriented more and more towards the coordination of all existing possibilities. That does not mean a mixture which rubs out all characteristic properties. On the contrary, each possibility must be developed according to its own way and power. But one must also constantly undertake to compare the different results, to relate and to clarify one by means of the other. If possible, instruments must be electrified and electronic equipment must become like instruments. Microstructural work must be done to clarify as much as possible the nature of macroscopic images, and highest unities must be treated so that their smallest parts become imbued with necessity. Research must be made in all thinkable directions of specialization, and links must be established between them as often, as closely, and as compactly as possible. Then we can perhaps hope that today's music will help to find the language that today's world needs and which will help it to be itself, to be the <u>best it can be</u>.

The Making of
North American Time Capsule 1967

Alvin Lucier

Introduction by Robert A. Moog

A vocoder (contraction of "voice coder") is a device which analyzes, or breaks down, an audio signal into a number of slowly varying voltages which constitute a coded description of the audio input material, then synthesizes, or reconstructs, the original audio from the analyzer output. Vocoders are used primarily to encode and decode voice signals for efficient transmission over long distances. The vocoder concept itself in general, and existing vocoders in particular, are intended for and suited primarily to the processing of voice and voice-like sounds, an application where intelligibility is the only performance criterion.

In the simplest form of vocoder, the analyzer consists of a bank of bandpass filters, each of which passes a portion of the frequency spectrum. Voltages proportional to the amplitude of each of the filter outputs are derived. These voltages are the encoding of the spectral distribution of the audio input. A frequency discriminator circuit, which produces a voltage proportional to the fundamental frequency of the audio material, and a voiced/unvoiced decision-making circuit, complete the analyzer portion of this type of vocoder. The analyzer outputs (which, because of the nature of the voice, are all slowly varying compared with the voice signal itself) may be transmitted by any of a variety of multichannel transmission techniques. The synthesizer portion reverses the process by first producing an excitation function consisting of the fundamental frequency plus all of the natural harmonics of the original audio input, and then feeding the excitation function through a bank of filters. The gain of each filter section is determined by the magnitude of the output of the corresponding filter in the analyzer portion.

The Sylvania vocoder used by Mr. Lucier does not employ bandpass filters to encode or decode the audio material. Rather, special circuitry continuously computes the autocorrelation function of the audio input for a set of delay times. That is, the instantaneous value of the input is compared with an earlier-occurring value and the correlation, or extent to which they agree, is the value of the autocorrelation function for that time difference. While the complete autocorrelation function contains the same information about the audio input as the output of the bandpass-filter analyzer described above, the information is in a different form (code), and the results of altering the transmitted parameters (scrambling the code) between analyzer and synthesizer are different. Since the altering or rerouting of the encoded information is of prime importance in using a vocoder for music processing, Mr. Lucier's remarks on the manipulation of control signals (the encoded information) may not completely apply to other vocoders.

I was happy to accept an invitation by Sylvania Electronic Systems to compose a work using an experimental model of their vocoder, currently in the last stages of development. Vocoders in general are designed for purposes of making secure voice communications by encoding speech sounds into digital information bits for transmission over narrow bandwidths via telephone lines or radio channels, and then decoding the information for reception at the other end.

The original speech sound source is fed into the vocoder via a telephone receiver. In this particular vocoder system (Figs. 1 and 2), a Spectrum Analyzer takes the autocorrelation function of the speech signal and expands it in terms of a set of mathematical functions, the coefficients of which are represented by the slowly varying transmitted parameters. At the same time, a Pitch Detector develops a voltage proportional to the fundamental derived from the waveform of the original speech.

The Voiced/Unvoiced Detector is comprised of a bandpass filter set at a range of 200-700 Hz and a highpass filter set at 4000 Hz. Voiced sounds are those which have more energy in the 200-700 Hz range; unvoiced sounds have more energy above 4000 Hz. A comparator processes the

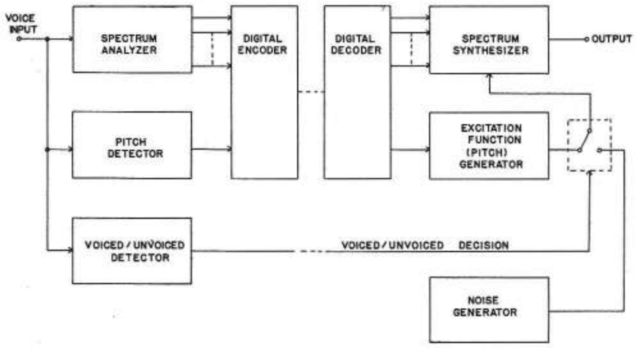


FIG. 1.
BASIC VOCODER BLOCK DIAGRAM.

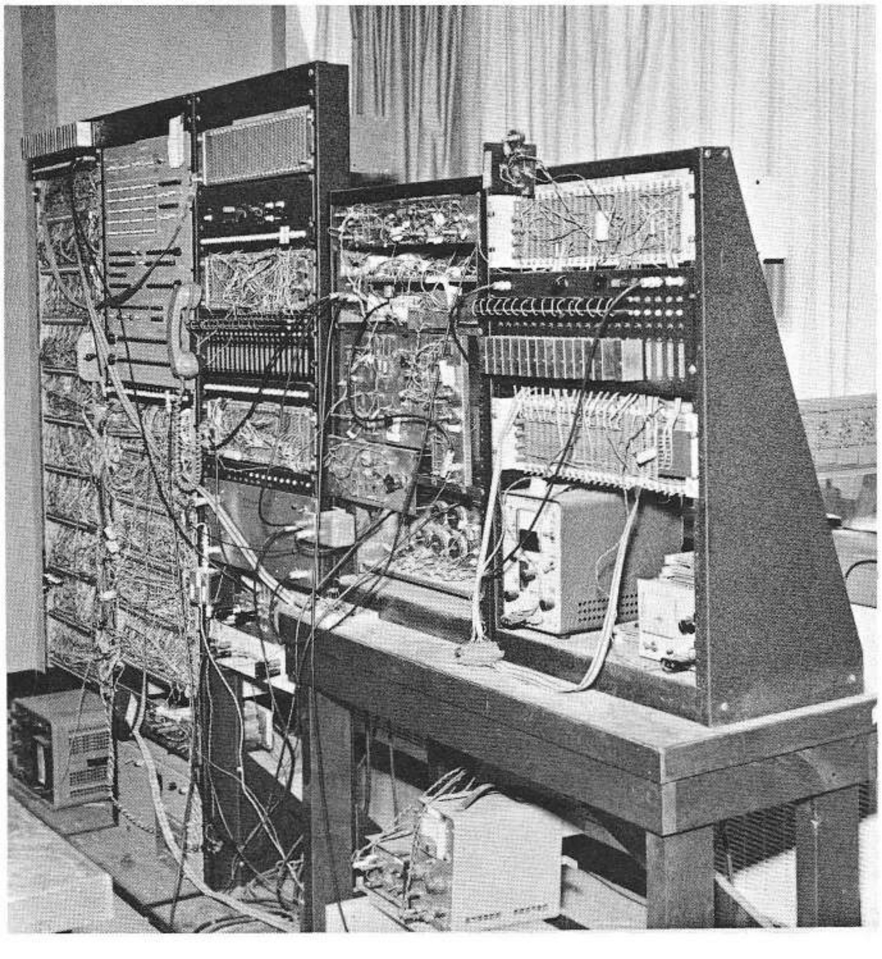


FIG. 2.
ENTIRE VOCODER PROCESSING DEVICE. TWO LARGE RACKS AT LEFT ARE DIGITIZER WHICH CONVERTS ANALYZED SOUNDS INTO DIGITAL INFORMATION FOR TRANSMITTING AND BACK TO ANALOG DATA FOR RECEIVING.

outputs of the two bands and decides whether the sound is voiced or unvoiced. The output is digital and is transmitted directly.

In the Digital Encoder, each of the spectral parameters is sampled every 22 ms and is quantized into three bits (seven levels of amplitude). The pitch signal is quantized into seven bits (63 levels of frequency). The Digitizer (Fig. 3) assigns the proper digital code to each level and clocks these signals out to the Decoder.

The Digital Decoder performs the opposite operation, taking the digital pulses, remaking the quantized signals which are then filtered to produce the original analog parameters.

The Spectrum Synthesizer is an autocorrelation synthesizer which accepts the transmitted spectral parameters plus the excitation function and combines them in such a way as to produce intelligible speech. The Voiced/Unvoiced Decision determines whether pitch or noise will excite the Synthesizer to produce either voiced or unvoiced sounds.

In making the piece, two types of activity were used to modify the sound sources: live performers were employed as inputs to the Spectrum Analyzer and the Pitch and Voiced/Unvoiced Detectors; and, alteration of various components of the vocoder itself were made in real time by the composer and Sylvania engineer Calvin Howard.

The pitch of the human input to the Pitch Detector determined the pitch of the synthesized sound source. For example, if a low male voice were at the input to the Spectrum Analyzer and a high female voice were at the Pitch Detector input, all the parameters would be that of the male

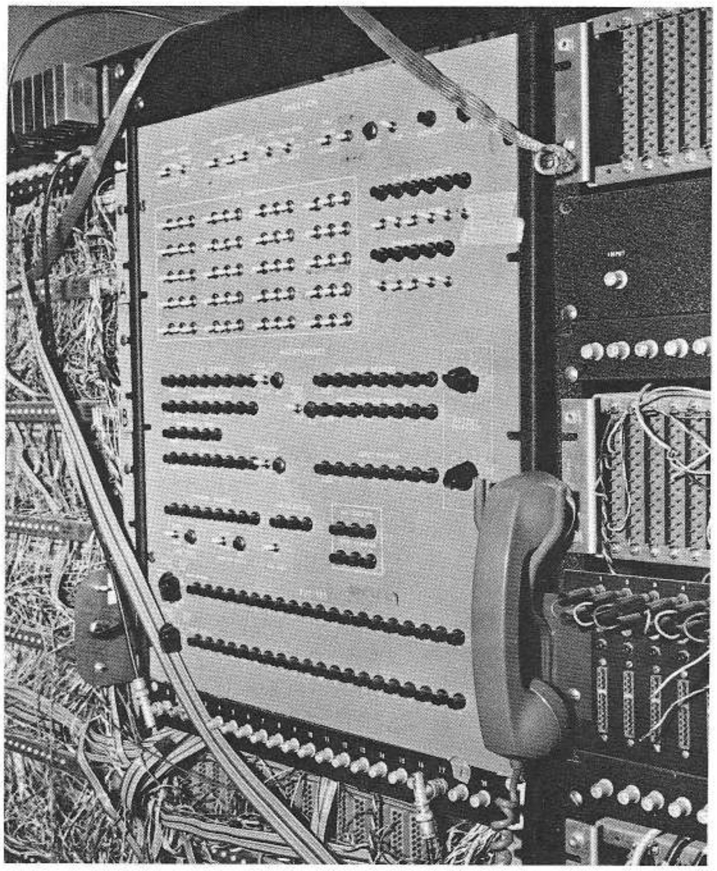


FIG 3.
DIGITIZER CONTROL PANEL. CONTROL BIT RATE, SAMPLING RATE, AND DIGITAL PROCESSING ARE REGULATED HERE AS THE SIGNAL PASSES FROM TRANSMITTING TO RECEIVING LINKS.

voice except pitch, which would be that of the female voice. We had simply substituted a different fundamental frequency for that developed by the performer controlling the other speech parameters.

A third person was put at the input of the Voiced/Unvoiced Detector to further control the voicing decisions for the original source. The original sound input was voiced only when this third performer made voiced sounds. If he refrained from making sounds altogether, an unvoiced decision would occur, causing the original sound input to become whispered.

Two types of spectrum control were obtained. By adding and deleting three bands of arbitrarily divided speech spectra, we allowed only selected portions of the speech spectra to come through. These spectra were divided by bandpass filters into sections of 200-600 Hz, 600-1400 Hz, and 1400-3500 Hz. In addition, by manipulating a set of sixteen filters in the Spectrum Analyzer, we could add and delete various control signals which would vary the spectral resolution of the speech signal. This spectrum analysis is made in terms of the autocorrelation function of the speech signal. Removing any one of these filters reduced the resolution, or the ability to discriminate fine differences in frequency.

Pitch frequency control was achieved by manipulating a Pitch Doubler in the Decoder, which controlled the gain on the pitch amplifier, which in turn controlled the frequency (to the tune of a one-octave jump) of the synthesized pitches.

The Digital Hold was used for getting long sustained sounds. Located in the Encoder, the Hold stops the clock which samples the incoming speech parameters, holding the last set of values. The Synthesizer continues to reproduce that sound.

In the Pitch Detector, the Pitch Hold (a DC voltage) establishes a reference pitch for the Synthesizer pitch generator. This reference pitch is set at the median expected pitch of male speakers (ca. 120 Hz). During the recording (or performance) it was detuned as high as 400 Hz and as low as 50 Hz, so that it took a discernible time for the Synthesizer to track and lock on to the correct pitch.

The pitch quality was controlled manually in the Spectrum Synthesizer by varying the spectrum of the pitch excitation, which in turn varied the amount of high frequency energy of the vocal sounds, causing changes in synthesized sound from boomy to strident.

Intonation control, which could be varied from nearly continuous speech intonation to a great degree of quantization or stepwise control, was achieved by altering the quantization switches. This allowed us to obtain a pitch resolution variable from two to 63 discrete frequencies.

North American Time Capsule 1967 is an electronic work which uses human voices both as sound sources and as control signals. I conceived of the work as a live performance situation which would be possible by having several portable vocoders available in the performance area.

I made, however, a stereo tape version for a disc recording (Odyssey 32160156) of new choral music performed by the Brandeis University Chamber Chorus. This version, a reduction of eight channels of material, was recorded at the Sylvania Applied Research Laboratories in Waltham, Massachusetts on two days in May 1967 by members of the Brandeis Chamber Chorus, students from my course in Fundamentals of Music, miscellaneous Brandeis students, Mr. Howard, and myself. The eight tracks of material were made in sequence since only one vocoder was available.

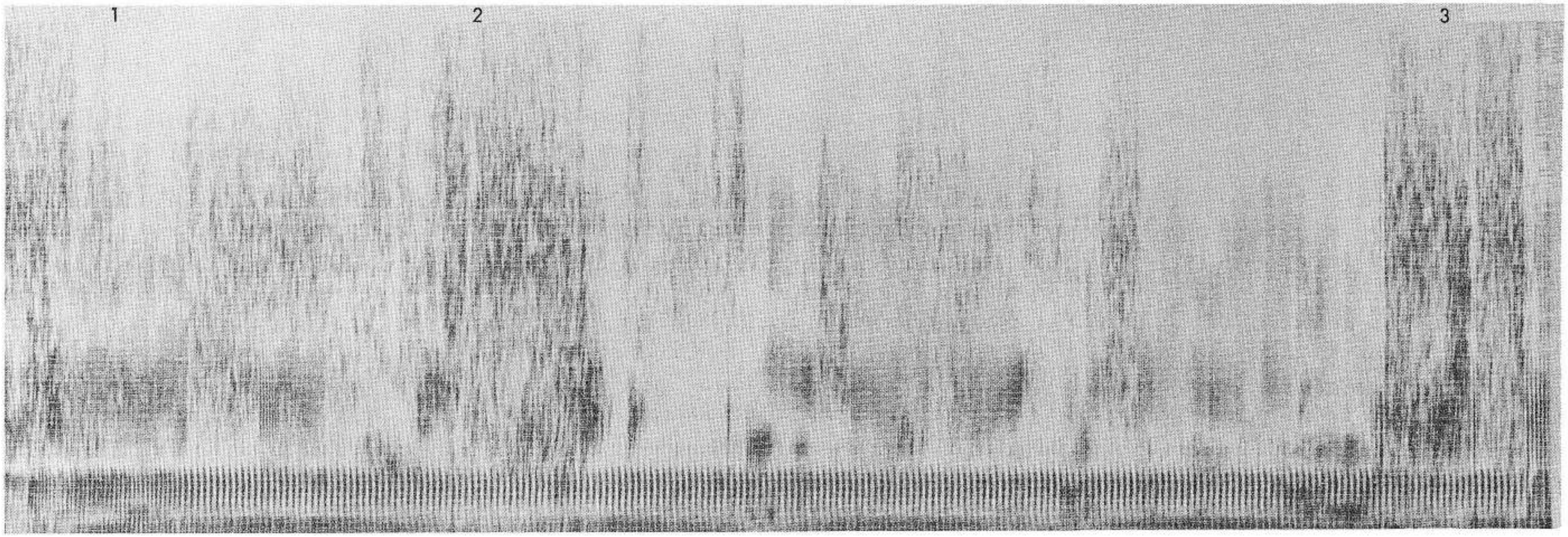


FIG. 4. SPECTROGRAM:

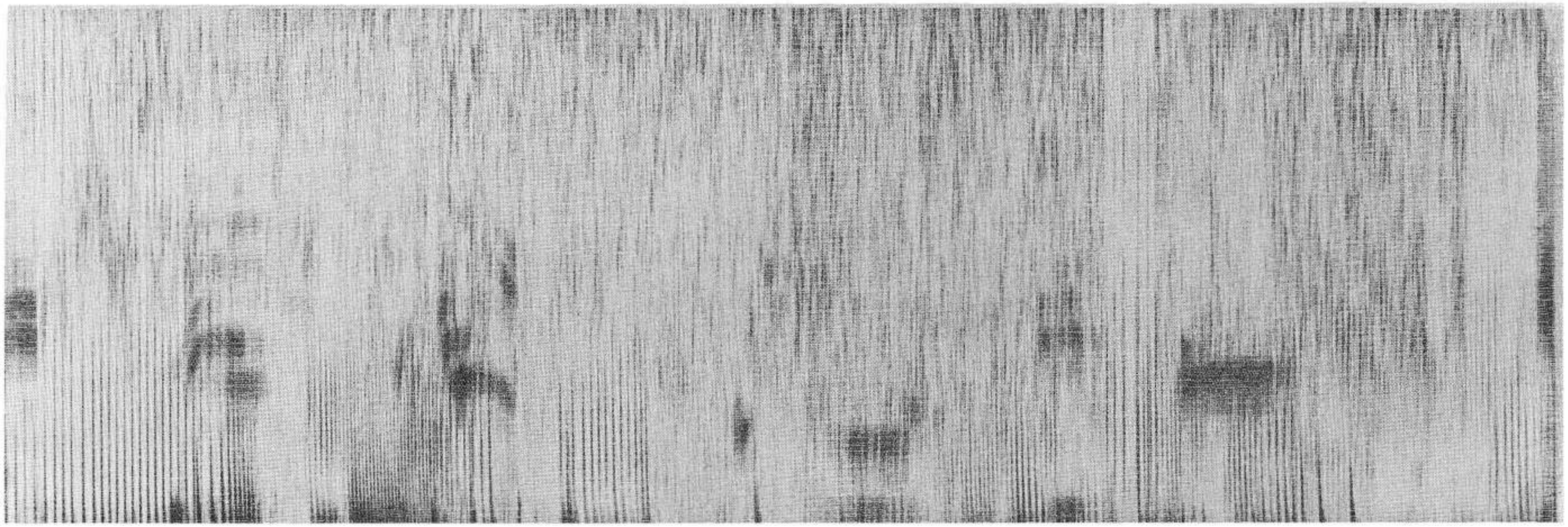
- FREQUENCY RANGE 85-12000 HZ
- ANALYZING FILTER 300 HZ
- TIME SPAN 2.4"
- STARTS 1' 4" AFTER BEGINNING OF PIECE

VERTICAL LINES RELATIVELY FAR APART ACROSS BOTTOM INDICATE ENERGY CONCENTRATED IN TWO RELATIVELY NARROW FREQUENCY BANDS. CONTINUOUS SOUNDS ARE PRODUCED BY DIGITAL HOLD. IN THE UPPER PART OF REGION 1, MEDIUM RANGE PITCH GOES TO LOWER PITCH. IN THE MIDDLE PARTS OF REGIONS 2 AND 3, SECTIONS OF UNVOICED SPEECH MAKE AREAS OF WIDE-BAND NOISE OUTPUT.

FIG 5. SPECTROGRAM:

- FREQUENCY RANGE 85-6000 HZ
- ANALYZING FILTER 300 HZ
- TIME SPAN 2.4"
- STARTS 5' 25" AFTER BEGINNING OF PIECE

DARK REGIONS ARE FORMANT OR RESONANCE BANDS SPECIFYING THE POSITION AND ENERGY (THE DARKER THE STRONGER) OF INDIVIDUAL SPEECH SOUNDS. SINCE THEY APPEAR TO BE CHOPPED, BECAUSE THERE ARE NO NATURAL TRANSITIONS, THEY MUST HAVE BEEN SEGMENTED BY THE VOICING TRANSITIONS OF ANOTHER SPEAKER. THIS IS A GOOD EXAMPLE OF THE MULTIPLE-VOICE CHARACTER OF THE WORK.



I made no written score for this work. However, spectrograms of excerpts may be seen in Figs. 4 and 5. I suggested to the performers that they prepare a plan of activity using speech, singing, musical instruments, or any other sound producing means that might describe — to beings very far from the earth's environment either in space or in time — the physical, social, spiritual, or any other situation in which we find ourselves at the present time. Using sound, the performers might choose to convey, for example, the ideas of life and death, young and old, up and down, male and female. Sonic aspects of our technological environment, such as household appliances, trains, aircraft, and automobile horns, might be used. Anything was allowable that employed sound, that had meaning for the performers, and that would show the human situation to a being with no previous connection with us.

Languages such as Ugaritic, Tagalog, Ancient and Modern Greek, British and American English were used, along with such musical instruments as the electric guitar, clarinet, and harmonica, plus such appliances as electric shavers and toothbrushes.

For each of the eight channels (actually performances), I continually changed the configurations of performers. For example, I might have from one to eight persons at the Synthesizer input while from time to time I would change those at the other two inputs. Throughout each take, Mr. Howard and I would freely manipulate the vocoder as explained above. After working this material for a while, I felt that ten minutes would be time enough for the material to develop itself.

I discovered that by letting the performers be as free as possible, I could produce a rich and complex sound situation that I could not have achieved otherwise. I found very beautiful the unexpected voicing decisions made by the natural flow of the speaker at the Voicing Detector, the chopped transitions of one voice made by the voicing transitions of another, and the sustained damped sine waves produced by the sound-catching ability of the Digital Hold. I was struck by the rhythmic strength of human language which, along with the expressive content of speech, can cut through almost any amount of electronic modification. I look forward to composing more works with human speech, our most interesting and beautiful sound source.

Additive vs. Subtractive Synthesis

Jon Appleton

When I was a student at the Columbia-Princeton Electronic Music Center, Vladimir Ussachevsky discussed at length the distinction between additive and subtractive synthesis in the composition of electronic music. (Although "subtractive synthesis" is a contradictory term, it stems from our notion that synthesis is both a process and a final product. Anthropologist Leonard Kasdan has suggested to me that the distinction is not unlike that between cultural evolution and devolution.) Although for many works, including some of my own, this is a rather arbitrary distinction, an awareness of diverse compositional approaches can only give the composer a greater command of the medium.

The often random and sometimes confusing assortment of equipment in a "classical" studio often prejudices a composer against one or the other method of composition, but assuming all things to be equal, I contend that the decision to use additive or subtractive synthesis is a pre-compositional decision often determined by the composer's non-electronic (and more likely pre-electronic) predilections. The choice may be understandable and it has resulted in a kind of stylistic consistency within a single composer's opera. The works of such diverse figures as Babbitt and Badings tend to support this view.

One young composer of my acquaintance, who must remain nameless, earned a reputation as an outstanding creator of instrumental music before he had an opportunity to work in a studio. His music was, for the most part, serial in orientation but suffered none of the monotony common to the works of composers who undertake this method of organization with little understanding or perspective. His first year in a studio produced no compositional results for a variety of reasons: he wanted to master "classical" studio technique, his time was limited, and exposure to new works changed his attitude toward his first electronic "sketches". But the major reason he failed to compose a piece was because he encountered conflict between his taste in materials and his methods of composition. To be more specific, the composer in question had finally decided to use, as raw material, some rich instrumental sounds. He subjected them to various modifications: filtering out certain harmonics, rearranging the remaining frequencies, and adding various amounts of reverberation. The results were striking because the transformation had not entirely obscured the original instrumental characteristics. Some of this was due to the preservation of the original attack and decay patterns. It would have been a tedious job to additively synthesize the resultant sonorities, and if for no other reason, this is one of the advantages of subtractive synthesis.

Once in possession of these various sonorities, my friend faced the more significant problem of how to structure the material into a meaningful work. (I realize that the last adjective used may limit the number of people who finish this article.) The composer had already decided that serial technique should be central to his first electronic work because it had been most satisfactorily employed in his previous music. He had decided to construct a series of twelve distinct sonorities from his modified sources. Having done this, pre-compositional planning was relatively easy. Sections of tape were cut to appropriate lengths and then mixed in accordance with the plan. It took only a few hours of studio time to create the first minute of music. The results were, however, unsatisfactory as the piece lacked spontaneity and sounded rather "square".

An adjustment was carried out without reference to the plan and by using the ear in the studio to rearrange and shorten certain fragments. This improved the piece but confronted the composer with his ultimate dilemma: the serial structure which was to be used to give the whole piece a certain unity was impossible to employ if the potential of the original material was to be exploited.

Is it fair to conclude, then, that serial technique is not compatible with subtractive synthesis? I think not, for had the composer subtracted from sonorities that had fewer timbral implications and were heard uni-syntactically, then serial organization would have succeeded. (See my article "Tone Relation, Time Displacement and Timbre: An Approach to Twentieth Century Music", The Music Review, XXVII, 1, Feb. 1966, 54.) If I seem to be suggesting the old dichotomy between concrète and electronic sources, it is only because we have too often accepted without question the arrogant philosophy expounded by the spokesmen of each self-proclaimed school, philosophies which too many composers entering the "third stage" of electronic music still espouse.

In their understandable eagerness to remain au courant with technological advancements in the field, many composers have turned to methods of composition which do not truly reflect their esthetic and artistic attitudes. Programmed control, depending to some extent on its mode, is more suitable to serial organization than is "classical" studio technique. The rush to the computer by composers of every persuasion, at a time when available programs are awkward and musically primitive, reflects both a desire to stay in the forefront of musical "progress" and a singular neglect of the wide possibilities inherent in the medium. I have heard it said that the use of serial techniques in electronic music supplies a much needed link between the musics of the twentieth century. There is a great deal of truth to this statement, but composers should remember that it is for future musicologists to discover those traits which are shared by the various media and that stylistic consistency, if it is indeed a virtue, is achieved without special effort by any composer who is consistently self-critical.

One should not forget that electronic music has its own tradition and this includes its own syntax or primary method of organization. Simply because composers have been slow to articulate the syntax does not mean that it is not known to any composer familiar with the literature.

One of the elements of this syntax is not the distinction between additive and subtractive synthesis, for these are basically studio procedures which have, in the past, occasionally reflected the more fundamental kinds of structure which may be employed by the composer. What is important to realize at this juncture is that a variety of approaches, all successful in their own right, still exist and should not be passed over by the young composer who has enjoyed the opportunity of working in a studio.

The New Age Is Coming

Harold C. Schonberg

A couple of weeks ago I dropped into Carnegie Hall to goggle at the combination of New York Pro Musica and Electric Circus: an unlikely combination, but then again many things about the evening were unlikely. Several things struck me. One was the fact that Carnegie Hall was sold out. Another was that the audience was overwhelmingly young. Still another was that I had the nagging notion that here was the music, the art form, the Gesamtkunstwerk of the future.

The event was a synthesis of certain aspects of the avant-garde. The New York Pro Musica sang their Renaissance music against the filmed projection of a monstrous fish (Northern pike? muskie?) on a screen: jaws balefully working, eyes without pity, a machine for marine murder. Lights were projected on the side walls: angels, doves of peace. On stage were not the usual Renaissance accoutrements. No organ portatif was seen, no little group playing tabors and cymbals. Instead was a huge array of electronic equipment, as baleful in its way as Esox lucius, ready to play Morton Subotnick's electronic score.

It was the kind of evening where the interest was not in how well a particular piece was done. In this kind of phenomenon, there are very few guidelines. Everything is too new, and most of it is frankly experimental. But what kind of emotional impact did the new techniques make? Did they succeed on their own terms? Those are the key questions; and to this bemused onlooker, the answer was yes, the techniques did succeed. In a way the evening was a breakthrough, for it was the first time Carnegie Hall, one of the two major concert halls in New York, played host to this kind of event. There will be many more. The new age is coming upon us with a rush, and a lot of notions are going to have to be revised.

The point is that the avant-garde is no longer avant-garde. Things are beginning to consolidate. and the younger generation is in the process of using the work of the last ten years as a matter of course. Everything doctrinaire is going out of the window, and that is a healthy sign. The younger composers are no longer strict serialists (thank goodness), or strict Dadaists, or Third Streamers, or whatnot. All techniques are being synthesized. The Beatles had something to do with it, and John Cage, and the Columbia-Princeton Electronic Music Center, and the jazz boys, and some of the movie composers, and some television commercials, and Vietnam, and the psychedelics. Young composers today enthusiastically use everything within reach.

A new art form is being developed. It is not music as the term has been used for the last few hundred years, though music does play a part. It is not cinema, not opera, not fully electronic, though here again all those elements play a part. The electronic component is of special importance. For the first time, electronic music is breaking away from the professors and pedants. The kids are beginning to use it in a loose manner, far from the carefully serialized blips and boops and appalling sterility that have been only too prevalent up to recently. They are expanding the vocabulary of the electronic medium, making fuller use of its remarkable potential, joining it with other media. As one who from the beginning has been entranced with electronic music, and also as one who has been despairing of the unimaginative direction it has been taking, I can only cheer.

The other thing is jazz, or what might better be described as a jazz offshoot. Up to now jazz has never seriously entered the thinking of serious musicians. In the 1930's the jazz boys would gleefully point to such a score as Milhaud's Création du monde or Stravinsky's Ragtime and tell the world that jazz was now part of the language. Only it wasn't, and such scores as Création or Ragtime remained sports, freaks, highly exceptional. But today the younger composers, even some in Russia, take jazz as a matter of course, and all over the world jazz elements are being incorporated into "serious" scores. It usually is not improvised jazz, and it may be indebted to pop and rock, but it nevertheless is recognizably jazz and all that goes with it.

Which makes Henry Pleasants something of a prophet. Many years ago, in his The Agony of Modern Music, he claimed that the art of serious music had reached a dead end and that the only salvation was jazz. Most musicians laughed at him at the time (I know I did) but recent developments suggest that he may have been right. Of course, he had no way of knowing that electronic music would be developed with such rapidity. It now seems clear that electronic music is going to coexist with jazz and all of the other elements, especially aleatory, that are in the current synthesis.

Of course the face of music is not going to be changed overnight. There will be composers who will continue to compose with notes and orthodox instruments, even tonally. There will be those of the extreme left who will continue to burn violins and hold happenings and do stripteases on stage. But more and more there will be the kind of event that was seen in Carnegie Hall the other week, a kind of total theater in which the human voice will be mingled with lights, electronic sounds, improvisation and a completely new outlook on what constitutes music.

And, judging from the reception, it is a kind of music that means a good deal to the restless young generation today. Up to now the musical avant-garde has only a minimal following, one composed mostly of professionals. Nobody really cares much for totally organized serial music, nor have the deadpan absurdities of John Cage and his followers meant much to any but another relatively small group. The new generation of composers, however, is taking some elements of the serial school, some elements of the Cage group, some elements of traditional music, something borrowed, something blue, a great dollop of electronic music, huge washes of jazz, and are blending it into something that quite literally is a new entertainment form.

I have a strong feeling that the form will take, and that in a short time it will be well established. It is not music of the absurd. Rather it is a serious attempt to blend tradition with modern technology. As yet the big man has not appeared, the one who will take these elements and make of them a strongly personal evocation. Of course it is quite possible that he will never appear. Music is becoming a joint effort these days, and the composer is allied with the physicist, the expert in film techniques, the electronic engineer. We will just have to discard some of our cherished old notions. But that, apparently, is exactly what the younger generation today has no difficulty at all in doing.

Mona Lisa II

Joel Chadabe

(Mona Lisa II, a videotape by Joel Chadabe, was made at the Institutional Resources Center of the State University of New York at Albany, in April 1967. The visual material, two eight-by-four-foot collages of magazine advertisements and illustrations, was done by George Wiesner. It was directed by Joanne Broderick.)

What we attempted to do was construct a visual composition based entirely on rhythm of movement, controlling both camera speed and direction, and duration of shot (control-room switching from camera to camera). Although we were aware of literary connotations in the visual collage (Fig. 1), our techniques were not aimed at making them explicit. We thought only of how to work with one stationary and two movable cameras to construct a time structure that would be interesting in itself.

The conception grew out of my observations on films in general, that although certain directors (Resnais and Fellini especially) are concerned with relative camera speed and direction of motion in successive shots (the first sequence of Last Year at Marienbad, for example), no one has used camera motion to constitute a complete and independent substructure of rhythm.

In Mona Lisa II, the camera acts as music does in an opera: it establishes pacing, temporal divisions, and makes the "dramatic comment". We limited our material to two-dimensional collages because there remains only the problem of camera motion over a surface, and not of camera-in-relation-to-moving-subject-motion. The rhythmic structure was conceived in three sections, the first and third using only the collages, and the second using a girl, sitting on a stool, smoking and talking to someone off camera. This provides a contrast in the second section as both camera and subject move (and it was an exception to our self-imposed limitation).

Durations of shot were determined by a "score" that was read by the director in the control room who switched back and forth between cameras according to a durational scheme. Durations were arrived at by the Fibonacci sequence (1, 1, 2, 3, 5, 8, 13, 21, 34,... where each term is defined as the sum of its two predecessors) because of certain obvious and attractive (for this purpose) characteristics of it. The total duration was 610 seconds, or 10 minutes and 10 seconds, which we were able to subdivide not only into large sections, but also into 3- and 5-second shots. The sequence assured us of easily perceived differences in shot and section durations.

The score also showed camera movement, broken down into components of pan, zoom, and hold (Fig. 2). The circle indicates a pan, the arrow its direction. The triangle indicates a zoom; depending upon the position of the triangle base, the zoom is in or out. Diagonal zooms can be indicated by a combination of symbols for panning and zooming. Holds are indicated by a square, and random motion by wavy lines.

FIG. 1A.
FIRST VISUAL COLLAGE.

FIG. 2A.
SECOND VISUAL COLLAGE.

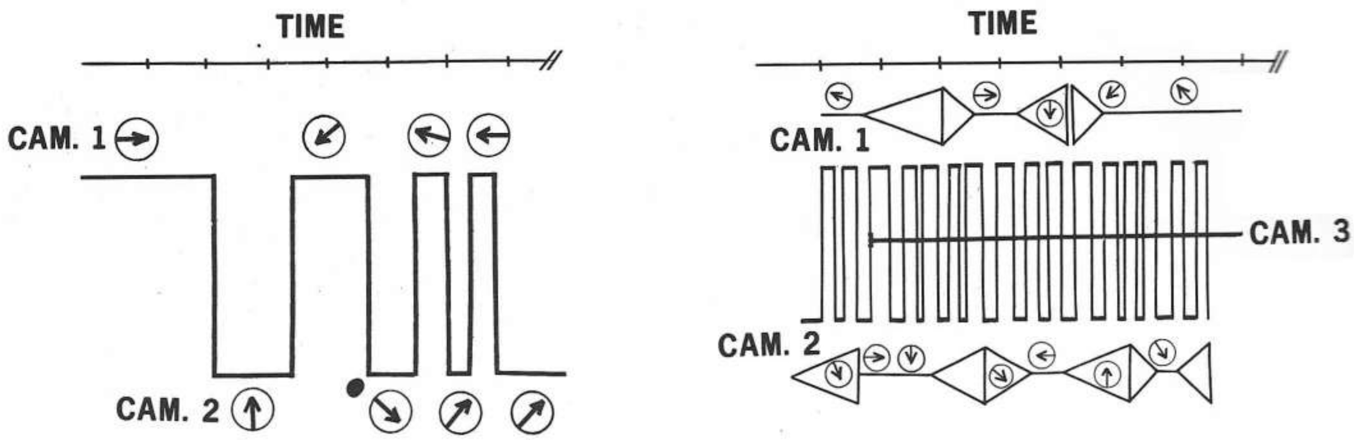


FIG. 2. EXCERPTS FROM THE SCORE.

The music was a collage of jazz, street sounds, poems, and a great variety of material including electronic sounds. The connection with the visual was on two levels, the "material" (both video and audio are collage) and the "procedural" (the rhythmic progression was more or less paralleled). It was, in effect, two different elements changing simultaneously but connected. It was hard to resist making the music comment directly on one or two scenes and I did not resist it, even though the abstruseness of combining shots of Vietnam with the tune Hurrah for Hollywood might prevent the technique from approaching something Verdian. There is a definite feeling of some literary message, even though the normal "story" dialectic is non-existent. The collage suggests (because of its material) a sterile, artificial environment, and the girl is the mute (there is no sound when the girl is onscreen) victim, surrounded.

There is a general "communications" aspect to the concept, namely, finding a way to meaningfully structure visual information, of any kind, in an electronic medium. Television documentary reports, including film clips of news events, communicate now in a dialectic unsuitable to that medium and often lose in directness and meaning because of it.

The television studio is here conceived of as an electronic music studio, except, of course, that the material is visual. The audio procedures and parameters are completely transferable, and have their own visual counterparts. Mona Lisa II is video concrète. Perhaps soon we'll be synthesizing video. By computer.

Letters

Sir:

This is to protest a point in Kurt Stone's review of my LP's in EMR No. 4. Mr. Stone doesn't like my work - OK, whale away. He also doesn't like what I said on the liner notes - which seems to me an odd thing to review, but OK. However, he makes his final score by misquoting me out of context by using the old brackets ploy, and I refuse to be enlisted in his cause in this way. I am quoted in his review as saying: "Now there's no [need for] musical training in making music out of that." What I said - in an interview on WBAI four years ago (as stated in the liner notes) - was: "I had the feeling, and I still have the feeling today, that the training I've had for what I'm doing is the best training, and if I had musical training I'm not sure it would help me; and I suspect it might hinder me. You see, I deal in a sort of chaos of sound: in *Apocalypse*, for instance, there's one little movement that has in it a cat screaming, a dime-store toy that moos when you turn it upside down, doors opening and slamming shut.... Now, there's no musical training in making music out of that."

Is there musical training in making music out of that? I might have acknowledged the *need* for musical training in making music out of cats and toys and doors, but I didn't know it was being offered. I had a piano of cats' tails to play, and I taught myself to play that kind of piano by becoming an engineer. Should I have gone to Juilliard to learn to play cats? Where would I have found a tempered set of cats? And if I had found one, would Mr. Stone have really wanted a sonata of cats, toys, and doors? Or would he have called it a Desecration of a Hallowed Form? For me it would have been a trick, and a waste of some perfectly good cats.

What's really wanted is for me to take my cats and get lost - in fact as well as form. So Mr. Stone has me say something stupid with a little help from those brackets. He doesn't need brackets; I said a lot of stupid things in those liner notes that he might have used verbatim, like: "We try more - lacking the heritage of agreed procedure Mozart had - and fail more often to create lasting interest; yet, how many compositional successes had the first man to try getting sound out of a string? We are those first men with first instruments, building ways of playing as we build the instruments we play. These pieces represent a few of the ways." My God, look at that! He's comparing himself with Mozart! - and he did it without brackets.

Tod Dockstader
Westport, Conn.

Sir:

First of all, congratulations to you and your colleagues for a very fine periodical. I have found both the January and October 1967 issues packed from cover to cover with interest at all levels. I like the balance you have struck between articles on the esthetics of electronic music, articles on basic electronic principles, and articles on a more advanced technical level. I have learned a good deal from all of them, and it seems to me that if you can keep this kind of balance you will catch (and keep) the musician, the technician, and the interested layman as your readers. Speaking professionally, as a technical writer of more than ten years experience, I have also the highest admiration

for the standard of writing you have obtained from your authors. To my mind it is technical communication at its best - simple, direct, accurate, interesting, and at times amusing. Your authors not only have interesting things to say, they know how to say it well, and EMR has already achieved its own distinctive style.

Christopher Terry
Director of Publications, Compat Corp.
Hicksville, N.Y.

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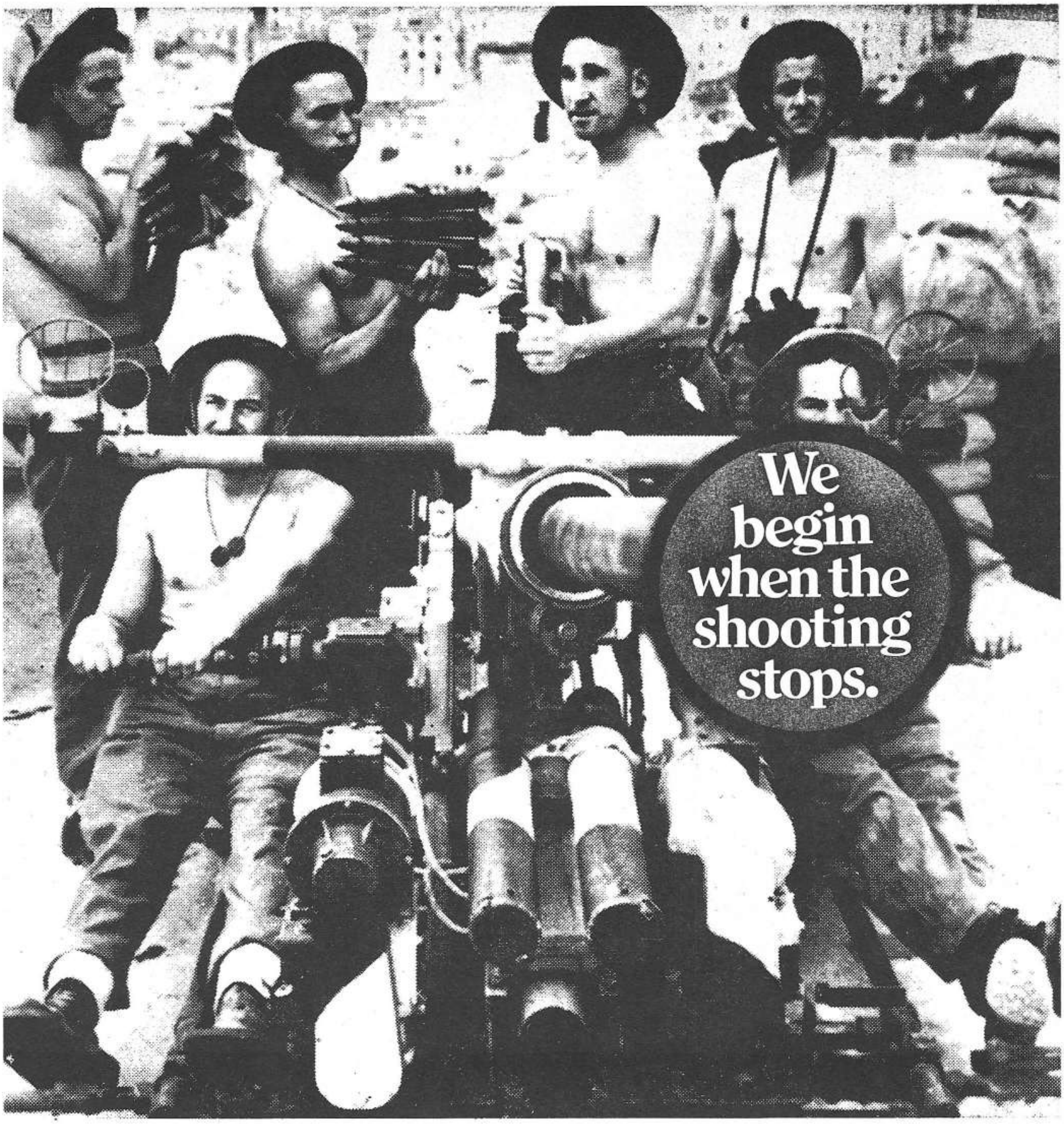
We begin when the shooting stops.

Electronic Music Review