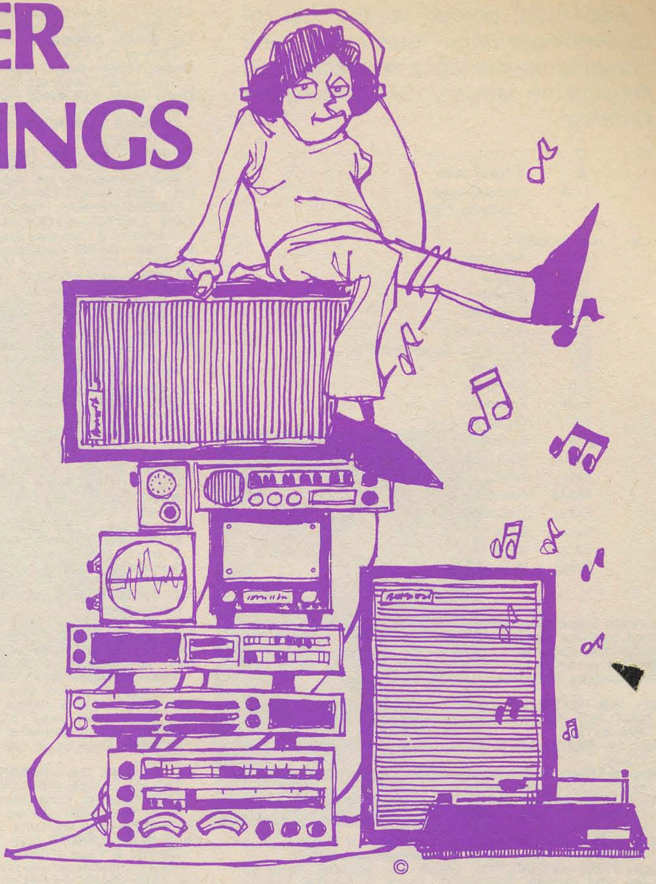
AN INSIDER'S GUIDE TO COMPUTER MUSIC RECORDINGS

John Selleck



Computer music appears to most people as a kind of apotheosis of electronic music. It can be thought of as fitting into the electronic music category, but it has many distinct features that are not found in electronic studio music or most synthesizer music.

Computer music is not oriented toward performer usage. It is a composer's medium and even if the processes can work in real-time, the forte of the computer is its data-processing capability as applied to all kinds of information, not just its ability to simulate a musical instrument. Real-time situations are at present more often used for preliminary organizations of musical materials, with the intent to use the more time-consuming but more flexible processes for a final result.

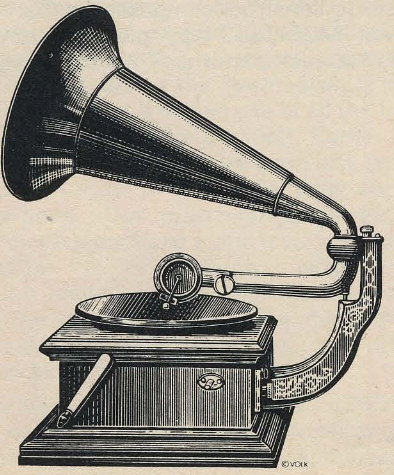
The story of computer music begins at Bell Telephone Laboratories with the efforts of Max Matthews and others. In the late 60's the essential characteristics of sound-synthesis programs were established and most subsequent improvements to this early work have been in the nature of user (composer) oriented modifications. Vladimir Ussachevsky, an undisputed master of the electronic medium, produced a computer piece as early as 1968 using preliminary efforts at digital sound synthesis made by Jean Claude Risset (known for his work in brass-instrument tone synthesis) and F.R. Moore, the resulting work titled: *Computer Piece No. 1.* Already we can detect certain new features of the computer medium. The agile display of complex textures, the subtle modifications in timbre, and the sophisticated rhythmic placements are all attributes of computer sound materials that are difficult, if not impossible to obtain with manually operated analog devices. The additional possibility of real-time examination of computer generated sound, allowing for more carefully considered composer decisions, is demonstrated by another of Ussachevsky's computer pieces: *Sketches for a Computer Piece.* Here he used the GROOVE program at Bell Labs, depicted in grossly simplified form in figure 3. Again the timbral changes (often in the course of a single note) are of a much higher level of complexity than that usually obtainable in an analog studio. This piece also demonstrates the synthesis of brass-like tones. There are several sequences of "pinging" sounds that were created by the use of random-number sequences (controlling rhythmic succession and amplitude), a feature also found on some synthesizers; but again the flexibility provided by the computer, i.e., the ability to program (symbolically construct) whatever kind of sound or sound sequence that one can conceive of, clearly demonstrates the power of the computer medium. Both the pieces of Ussachevsky mentioned above are available on CRI SD 268, an anthology of computer music from the Columbia-Princeton Electronic Music Center in celebration of their Tenth Anniversary.

The computer has to be programmed by humans to produce any kind of output. The crux of the matter lies in how many decisions are going to be the result of "filtered" randomness or a statistical application of order upon chaos, and how many of them are actually made by a human composer. *HPSCHD,* created in collaboration with John Cage (appearing on NONESUCH H-71224) is an example of how such music is used as material for further post-computer manipulations. The result is playfully charming and a clear example of certain aesthetic trends that think of music as a display of textures, a mosaic of bits and pieces, surfaces rather than dramas. The result of this bias is undoubtedly due to certain aspects of the electronic (including computer) mediums as is explained in the writings of Marshall McLuhan. The desire is to inter-mix and juxtapose materials that are not really discrete sequences of clearly defined elements, but are whole textures or sound-worlds in themselves.

Another of Hiller's experiments, the *Computer Cantata (1963),* (available on CRI SD 310) was an early effort and more a picture of a process than a composition as we normally think of it. After the preliminary decisions as to the probability of events happening were made, the results from the computer, of whatever quality or effectiveness, were retained as a record of the process. The output from the computer was not synthesized sound, although some of the music was performed subsequently by means of computer synthesis. The computer merely produced a printed output of its choices of events (notes and rhythms); see figure 6. Stylistically the piece is less of a texturally and mosaically perceivable structure than *HPSCHD*. The events forced themselves upon the listener in such a way as to stress the literalness and serious consideration of each discrete happening. The music lacks a sense of depth, although the rhythm presents the impression that something might be happening at one moment that is related to some subsequent events. In theory, at least, the idea of statistically generated musical sequences has been put aside owing to recent linguistic explanations of music which stress deep structural connections as motivating the construction of a musical work; it is not merely a matter of order (redundancy) applied in varying degrees upon a random situation. Nevertheless, the use of random structures in music for textural purposes is very prevalent, and Hiller's efforts cannot be casually dismissed without at least acknowledging that his hypothesis has stimulated serious thought about the nature of musical creation.

Other uses of algorithmically generated music that may or may not use random number sequences as a basis are found in a work by Barry Vercoe, to be discussed later, and in a work by Hubert Howe that appears on a recording put out by the American Society of University Composers as a supplement to Volume 7/8 of their *PROCEEDINGS* (it can be obtained from the society free by subscribing to that issue of their journal). Howe's contributions to computer music are extensive. He was involved in many of the programs created at Princeton University and has designed a modified version of Barry Vercoe's MUSIC 360 program (or one might characterize it as a substantial variant) called MUSIC7 (for the Sigma 7 computer). His piece, *Freeze (1472)* was, if my memory serves me, generated from relatively little initial material. I.e., the "composition" of the work involved the construction of algorithms whose employment was a composer decision, but whose resulting musical displays were logical consequences. The work has a static quality (perhaps determining the title of the work?), textures emerge and recede slowly; changes in general timbral quality are of a fairly complex nature.

Also appearing on CRI SD 310 is a computer piece by John Melby that makes use of the most widely distributed method of sound synthesis, the MUSIC360 program. The essential configuration of the system is shown in figure 1. *91 PLUS 5* for Brass Quintet and Computer was executed at Princeton University; the digital-to-analog conversion was done at Bell Labs. This piece and another of his works, FORANDRER (appearing on the American Society of University Composers recording) show the judicious use of the medium as regards instrument design and musical presentation. His music is easy to listen to and not without



interest. The clear polyphonic distinctions and timbral differentiations are a welcome relief to the overly complex surfaces in much computer music. The computer instrument (computer macro-instructions assembled to simulate the composer's idea of some instrument) behaves like an actual instrument, so it is logical to use it in conjunction with live instrumental players as in the Brass Quintet piece and what is rumored to be in a future release involving voice and computer.

Since the MUSIC 360 program, as well as its predecessors, are all set up to operate in terms of "instruments" and "notes", its use as a performer of instrumentally conceived music has occurred to several composers. In the case of Melby's piece, the result is the natural outcome of trying to produce a synthesis of live instrumental sounds and computer generated sounds. It has been suggested that the computer might be used to perform music that cannot receive an adequate performance by live performers, or to provide a model for live players, or to satisfy the composer's curiosity about the composition's performance when he has not yet found a viable live performance. Then too, the work may be too difficult for live musicians to handle, given the level of performance of some (or any) players. Benjamin Boretz' *Group Variations* (CRI SD 300) is a piece that originally had a live performance. Owing to the great complexity of the work, and to provide what might be termed an "ideal" or absolutely accurate performance, a computer version was made. The piece is termed "polyphonic ensemble music" and is a relatively difficult piece to get into. The wealth of sonic differentiation and association, only possible with the almost complete control over timbre that the computer offers, makes this piece an interesting one to study, not in the academic sense of analyzing it, but rather in the more casual sense of attempting to "absorb" the piece via repeated approaches. "Now I will listen for this idea and all of its appearances in the 'landscape' of the piece"; "now I will endeavor to relate all the passages that contain such and such an image," etc. The record jacket gives a somewhat provocative, if enigmatic ground-plan for such an attack. The sophisticated use of timbre in the piece must not mislead the listener into thinking of the piece as only a conglomeration of textures, although it can be approached (not too fruitfully) in this manner also.

A very agreeable first experience at listening to computer music might be to examine the *Extensions* for Trumpet and Tape by Charles Dodge (also appearing on CRI SD 300). This piece is also a work for live performer and computer. The nature of the piece is that of a soliloquy for trumpet interrupted by passages of a distinctly contrasting nature for the computer. These passages are all multiple glissandi containing myriads of notes. The remarkable thing about the computer passages is that they consist entirely of sine tones (the simplest waveform possible). If one listens closely he/she can detect the phase interference patterns caused by differing rates of glissando for the various tones. The effect is comparable to the op-art use of Moire' patterns. The ability to control precisely the rates of change of all parameters of a desired note can result in very surprising effects from simple means.

Charles Dodge is perhaps one of the best examples of a composer that is fully committed to technological-artistic interaction. His activities are almost always the result of the quite playful interpretation of some new and as yet unexplored technological vista. In his work *Earth's Magnetic Field* (NONESUCH H-71250) the tri-hourly fluctions of the earth's magnetic field (as measured from several points on the globe and charted on a discrete scale of 28 values) are interpreted as musical pitches. Taking the period of time from January 1st to February 4th of the year 1961 these readings serve as material for a heady composition in C major (side 1). The attractiveness of the piece comes about from a sort of heterophony produced by differing decay rates and slow changes of timbre on various notes of the sequence. The resulting diatonic field produces a strong hypnotic effect that is curiously missing from side 2 where similar treatments, compositionally and timbrally, are used with the scale of values being interpreted as a chromatic (12-tone) scale. Dodge's real claim to fame rests, mainly, not in his work with MUSIC360 (and other similar programs) that he has used at Princeton and Columbia Universities, but rather in his work with speech synthesis.

Speech analysis and synthesis has a history which would be beyond the scope of this article even to summarize. Suffice it to say that fixed formants are the key to the recognition of a timbre as voice-like; i.e., a vocal sound is recognized not by some particular relative relationship of the components of its frequency spectrum, but rather by certain fixed bandwidths that are emphasized no matter what fundamental frequencies occur in the vocal range. Vowel sounds are so characterized. Consonants are produced by transients (sudden changes in the frequency spectrum). An analysis program developed from digital filter technology by Dodge and Richard Garland at Columbia and Kenneth Stieglitz at Princeton partitions a sequence of speech sounds into .01 second summaries or transforms that represent the frequency characteristics for that segment of time. These "windows" are then used to re-synthesize the speech sounds by a process of filtering either a buzz waveform (vocalized speech) or white noise (aspirated speech) with the information in the sequence of "windows" thus restoring the original speech pattern. The windows differentiate between the transient characteristics (consonants or articulation) and the overall timbre and pitch of the voice (vowels). Since this differentiation has been made one can modify the synthesis procedure in the computer by requesting either modifications of the basic vocal quality (say to produce a hi-fi recording of Caruso) to complete substitution of the vocal quality (having Beethoven's Fifth speak Shakespeare). Such a procedure (depicted roughly in fig. 5) allows the composer to construct compositions that have the precise control of MUSIC360-type pieces, but with the added overlay of speech patterns. Thus the image of the human

voice is introduced into computer music. CRI SD 348 contains three pieces of Dodge that utilize the above technique. *The Story of Our Lives* is the most involved work containing a female and male voice (as well as a neutral "book" voice) and has been termed by Dodge an "operatic dialogue." It has been performed as an opera (with actors miming the computer produced speech) and is available on video-tape. The other works on the recording, *In Celebration* and *Speech Songs* are more experimental, but quite humorous speech mosaics.

The technique of filtering complex waveforms to produce new sounds is a built-in part of all sound-synthesis programs and appears as a factor in most of the pieces examined here. An early use of this technique appears on NONESUCH H-71245 in a piece called *Changes* by Dodge. Also included on this recording are pieces by J.K. Randall and Barry Vercoe, the designer of MUSIC360.

The widespread use of MUSIC360 would seem to demand that compositions by its major proponent be available on recordings. So far his *Synthesism* is the only one commercially available. It makes use of all the features of MUSIC360 that motivated its creation. Earlier sound-synthesis programs of a similar nature were less flexible in terms of the user (often a composer with not much computer know-how). The macro-language facility of MUSIC360 and its variants have made it very popular with users. *Synthesism* is a bravura, virtuoso piece demonstrating the capabilities of this improved system. Compositionally the work employs another distinct feature of computer sound-synthesis programs, the ability to generate musical materials algorhythmically.

Vercoe's work has not stopped with MUSIC360. One of his reasons for writing that program was to allow for more rapid and efficient generation of the digitalized sound output. This has been further extended by his work at M.I.T. into a system similar to MUSIC360 that can work in real-time. The system is depicted in highly simplified form in figure 2. The important thing to stress about this new development is that it is very composer-oriented. The score of a work-in-progress is stored in the computer and can be displayed upon demand in terms of a musical score, rather than in the usual numbers representing parameters of musical notes. This allows the user to modify his work without having to use the computer's language — and he can hear the result of any work he does immediately.

Also appearing on NONESUCH H-71245 are three pieces by J.K. Randall of Princeton University each of which makes use of a different version of the original MUSICIV program created at Bell Labs. These programs are slightly more cumbersome to use but essentially operate like MUSIC360. Their main disadvantage is that they consume vast amounts of computer time.

Even with these early versions of MUSICIV the subtly and composerly control of timbre, a hallmark of Randall's computer music, are already strongly in evidence. This is also the experience obtainable from another major work of Randall's, *Lyric Variations* for Violin and Computer (CARDINAL VCS-10057) where timbral relationships between the violin and the computer-produced sounds are exploited. Owing to the relatively large variety of timbral effects possible on the violin and the basic complexity of string tone, the challenge here seems to have involved an attempt to extend the timbral qualities of the violin even further. (One recalls the *Synchronisms* of Davidovsky for live instruments and tape).

Randall's most recent endeavor in computer music composition is his music for the film "Eakins" (CRI SD 328). (Eakins was a Philadelphia artist, a painter of nudes, whose life and works are examined in the film.) Here we have music that is admittedly "background" in nature. Randall states that it is literally background (in the music-theoretic sense) in that it is not to be noticed even as music in relation to the "film-world" which it inhabits. Something akin to a Paul Weissian kind of definition of music comes to mind: music can be thought of as a kind of abstract matrix that more concrete human events easily fill, in whose ambiguous depths they find a kind of existential time flow that subliminally highlights the surface (foreground) of the "reel" world (in this case) as it passes before us. The effect of hearing this music without any foreground elements (i.e., the film) is very curious indeed. It is mildly sensuous, *extremely* heady music that has a very engaging surface. In concert (several years ago in Town Hall) the piece was even moving despite (or because of?) its very repetitive nature. Randall's computer music is of high artistic merit and he has used the computer with full knowledge of its implications as a medium. (Please read the jacket notes and his *Compose Yourself,* serialized in *Perspectives of New Music,* to gain insight into this remarkable personality.)

Computer technology has had its influence on the electronic music scene in more modest ways. Memory devices that store sequences of control voltages are found on several electronic music synthesizers. These devices, however, provide only a more flexible approach to the organization of musical events, but do not alter the steady-state sounds of analog devices that the ear immediately detects as mechanical and accoustically unconvincing. The ability to modify the timbre of a sound during the course of a single musical event is the real breakthrough in computerized electronics. After all, accoustical instruments as well as the sounds of our environment ("natural" sounds) have a great deal of complexity. With computerized control, electronic music can now start to delve into this relatively unexplored region of music.

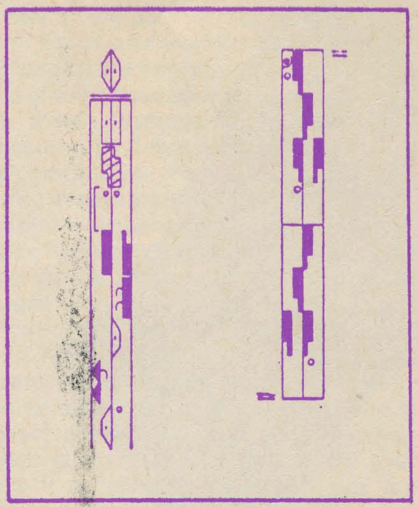
For those who are interested in the use of computerized synthesizer music, FOLKWAYS FTS 33435 offers the efforts of J.D. Robb. Except as a curiosity, this recording is definitely "pour les enfants."

A much more "with it" attempt is to be found on FOLKWAYS FTS 33437 by Jon Appleton. It is a sort of musical travelog (titled "World Music Theatre") evocative of the "hot" medium of the radio (such "tribal" musings no doubt appealing to FOLKWAY'S ethnomusicological bias). This recording should not even be mentioned in a review of computer music except for the fact that a forthcoming release, *The Dartmouth Digital Synthesizer* (FOLKWAYS FTS 33442), which will contain pieces by Appleton and others, was done on the newly completed system at Dartmouth that contains computer controlled digital modules. This system should provide the ultimate in real-time construction of electronic music. (See figure 4). In any case it should once and for all rid us of the flat, two-dimensional sounds of most conventional synthesizer music.

It is difficult to speculate on the future of computer music since its very definition changes daily. With the current rapid increase in technology, possibilities that seemed remote are now happening. Computerized equipment of all descriptions is mushrooming into existence. The most promising developments in technology, both the hardware and programming, are in the area of digital filters and miniaturization. The performance end of electronic music is absorbing developments initiated by researchers and composers with access to larger installations. It is not inconceivable that soon one will be able to purchase a kit to build his own equipment for sound synthesis. The proliferation of electronic instruments with digitally controlled timbres is to be expected. And continuing research both technically and artistically will expand the vocabulary of what we now think of as music to include elements heretofore taken for granted. Texture, timbre, and rhythm especially fall into this category. ■

Dance Notation

By EARL UBELL



Picture Leonard Bernstein rehearsing Beethoven's "Fifth Symphony." There are no music stands; no music scores. Instead, Bernstein teaches each instrumentalist his or her part by picking up and playing each instrument or by humming passages. Slowly he works through the strings, the brass and the tympanists.

Feasible? Yes. Crazy? Of course. No symphony orchestra learns a new piece that way. It would consume vast amounts of rehearsal time. Instead, as we all know, each player sight reads the score. The conductor then molds and polishes the ensemble playing into a work of art.

Yet every ballet and dance company in the world normally stages performances by the first, the crazy method. Choreographers or balletmasters teach each dancer his or her role by the monkey-see-monkey-do technique. Only after hours of stepping and counting can ensemble playing begin. Which is one reason why dancers make about a third the pay of symphony players.

In the past few months, I have witnessed two events that can alter forever the crazy artistic and economic course of the dance.

Event No. 1: A small professional ballet company in Syracuse, N. Y., has learned in three weeks to read written dance scores so that they can now perform any written ballet. This is the beginning of true dance literacy.

Event No. 2: A computer specialist, who is also a composer, has programmed a computer to speed up by at least five-fold the writing down of a ballet. This may be the Gutenberg leap for dance.

In short, these two developments have simplified the reading and writing of choreography to give dancers the equivalent of sheet music.

To those unfamiliar with rehearsal halls, it must come as a shock that one can even write down an ephemeral dance movement or that dance scores exist from which dancers can re-create a stage work. Dance, in its infinite variety,

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