A notation system for sound diffusion gestures

By Douglas B. Holmes

Composers have concerned themselves with space, sound location and acoustics as compositional variables through time. For instance, the Venetian polychoral motets of the early sixteenth century were performed in large reverberant halls such as St. Marks Cathedral in the great piazza in Venice. Divided choir, cori spezzati, is a technique used in ecclesiis, by Giovanni Gabrieli (Grout and Palisca, 339). Contrast and opposition of sonorities between the groups help to emphasize the division. The material that the building is constructed of, the size and shape of the room and the dynamic level of the ensembles will also effect the coloring and reverberation of sound. Composers of electronic music have precise control over the placement of sound within a texture. By mixing together isolated sounds to crate the texture, the composer is able to control mathematically the spatial aspects. This is achieved by creating filter and delay coefficients for each of the individual components.

Sound localization cues help the listener to assign directional focus to a sound. When a listener hears a pitch, from about 200 hz to 2000 hz, the brain interprets the phase offset and assigns location (Moore, 6). With the tones under 200 hz, the length of the sound wave itself moves too slowly to determine phase offset and is suited to be isolated to a separate channel and routed to a base bin (Fedorkow Fedorkow, Buxton and Smith, 35). The amplitude and filtration are used to model the acoustic qualities of virtual space, causing the listener to assign spatial placement. The listeners shoulders, ear design and head direction are also contributing factors in the perception of locational sound. The Head-Related Transfer Function (HRTF) was developed scientifically to place sound in virtual listing space. The algorithms allow the user to define coordinates (zenith and azimuth) that set digital filter banks. The filtering causes the illusion that the sound is in the desired virtual location. The HRTF varies for each individual (Roads, 467) and is optimized for use with headphones, the isolation of two channels of audio is enhanced with a byte plate and noise piece (Moore, 7). Because of randomness of the listener head position, when a work is performed over loud speakers, much of the precision of the HRTF is lost. Ambiosonic techniques are concerned with the placement of sound in a three dimensional space. The realization of ambiosonics is facilitated with a performance space design that incorporates zenith and azimuth placement of speakers.

At times, isolated sounds are combined into a strictly controlled texture. Each of the component sounds in the texture can have its own placement in the listing area. Multiple channel systems are the usual choice of medium for mastering this sort of sonic effort. A system with three or more desecrate channels is needed to increase the control of localization cues in an auditorium. Computer mixing programs are available to the composer for mixing and mastering digital electronic compositions. Each program approaches the user interface, sonic aspects and format issues using various approaches. “SoundHack” by Tom Erbe and “Csound” developed by Berry Vercoe are examples of currently available programs that incorporate binaural or HRTF filtration and run on home computers.

A special unit generator in the “Cmusic” sound synthesis program is interesting. It allows the user to describe a virtual two dimensional listing space (Moore, 8). The user creates two virtual rooms one inside of the other. The inner room represents the performance space. The outer room represents the virtual space in which the sound will exist. Sound is allowed to enter the inner rooms via holes (speakers) in the walls (described by user control). The system in this way is flexible and can be optimized for the specific performance space design, yet the programmed sound paths existing in the virtual outer room are invariant. The reflection path of sound in the outer room can also be programmed giving the composer more control over the aural illusions.

The “Lucas Film ASP” is a console mixing system that employs a master computer with seven slave satellite computers (Abbott, 188). The system was developed to synchronize the complex engineering gestures during mixing and mastering of audio in film production. The engineer’s gestures on each of the satellite computers can be recorded, saved, manipulated and auditioned. The engineer’s recorded control gestures are displayed on the screen for audition during playback. The information from the satellite consoles is interpreted by the main computer where most of the controls are realized. Localization techniques in works that utilize multiple channel formats (three or larger) are generally completed during the composition and mastering processes. The sound is mixed and mastered to exploit specific performance systems. The audio engineer is restricted to making the correct routings and fine tuning the system.

The mastered recording is amplified for performance by interfacing the output of a play back machine to the input of the mixing console. The signal is filtered, routed, bussed and gated through the mixing desk. In this way, the signal is distributed to the correct amplification devices. With the correct routing it is possible to split a stereo signal into discreet groups of channels. One might decide to split the stereo signal (right and left) into two groups of four channel (r,r,r,r and l,l,l,l). This allows the engineer to control the stereo signal as a master, and use the auxiliary sends to control the amount of signal output to each of the discreet amplifier/speaker components in the set up. Using this kind of design scheme, the engineer can mix the stereo signal in such a way to create the illusion of a quadraphonic or larger system. Speaker placement in the performance space is best optimized for the particular types of illusion that the composition exploits.

A typical quadraphonic set up will surround the audience with the speakers at ear level and an equal distance, usually about 10 meters, from the listener. This form can be optimized for distance emphasis by adjusting the height of the front and back speakers (Roads, 456). Furthermore, speakers can be added around the azimuth (horizontal) and zenith (vertical) of the performance area facilitating more accurate localization control. Spiral was written for the Osaka Auditorium for the 1970 world fair by Stockhausen (Wishart, 194). In this work, the instruments are microphoned and the signal is amplified and routed. The performance stage is suspended from the ceiling of a geometric dome. Speakers are attached to the inside of the structure, including underneath the audience, surrounding the audience in a web of speakers. The amplified sound is sent/routed through and around the listening space.

Varese's Poeme electronic (1956-58) was composed to be realized in a structure designed by Le Corbusier and Iannis Xenakis for the 1958 Worlds Fair in Brussels (Cope, 243. 1993). Some four hundred speakers were designed into this structure. The output from a three channel play back source is routed to the various speaker combinations (Simms, 392). Telephone relays controlled by a 15 channel tape are used to implement the routing. Each of the 15 channels on the controlling tape has eight bit resolution producing 180 separate control signals.

The Gmebaphone is a performance space developed by The Group de Musique Experimental de Bourges. A large battery of speakers is set up on a stage in front of, and surrounding the audience. The speakers are arranged in the auditorium similar to an orchestra of speakers surrounding the audience. The frequency spectrum is divided and isolated. According to a speaker placement design, the isolated frequencies are sent to individual speaker groups through the auditorium. Colourfull-spacial illusions can be achieved with the control of speaker bandwidth.

When electronic composition includes live performers, some sort of score must be supplied in order for the players to reference their position in the composition. Electronic music in tape format typically progresses from start to finish living ensemble timing adjustments to the players as they follow the tape. Instrumental notation, in the works including tape and live performers are usually aligned to a proportional or linear time-line derived score showing elapsed seconds and or milliseconds. If the electronic portion is not scored, a click track may be used to cue performer actions. Click track synchronization technique leaves the performer with little visual reference of the textures and timbres which they will need to mix.

Traditional notational symbols and rhythmic values, implicit graphic symbols and text are all used to transcribe electronic sound. In Nr. 12 Kontakte (1959-60), by Stockhausen, he creates a score using a timeline that informs the performer not only the elapsed time but the length of individual electronic textures. The tape part is graphically represented using the x axis for time and the y axis for pitch. For the performers benefit, he uses traditional dynamic markings and wedge shaped symbols to show changes and contrasts of signal amplitude. Roman numerals are used to show which speakers are being used. Transition between speakers is shown with an arrow connecting the numerals. The diffusion of the work is mastered in the recording.

At one point in Vox I, Stockhausen composes a single stream of recorded voice that comes to the foreground from a complex texture of sound

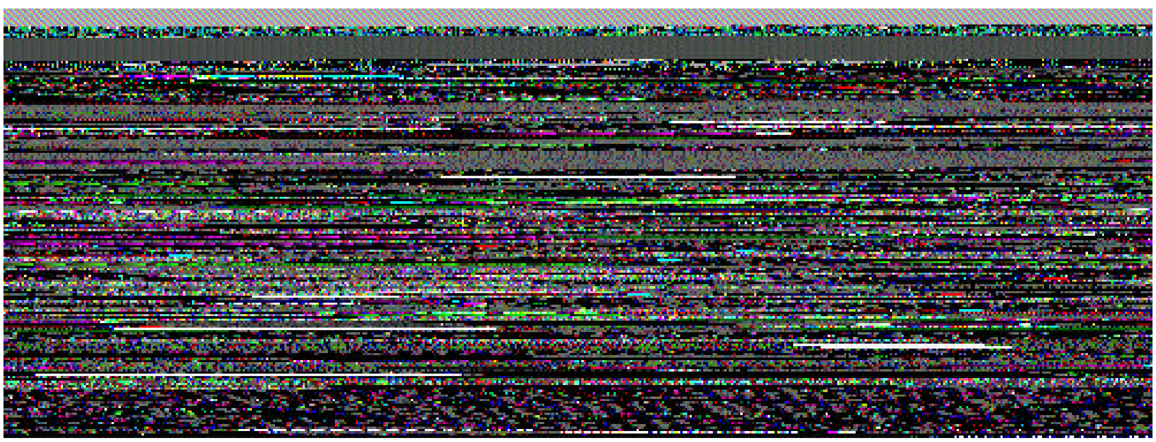
(Wishart, 195). Once the voices are in the foreground, they split and each are moved in, around and through the virtual sound space. The score for this work uses a combination of text descriptions and implicit graphic notation to relate what the recorded music is doing relative to their own instructions. Again the diffusion of sound is precomposed.

In Penetrations V (1970-IV) by Alcides Lanza, the score includes text for lighting control, text and graphic information for the audio engineers, conductor cues, and implicit graphic notation for the live performers and the audio performed by the tape. Time is represented linearly on the x axis which is divided into chunks of 30' material. Lanza includes a "notation indications" page describing sonic actions associated with the symbols and lines. The format of this 5 page oversized score is clear and straight forward in the use with these ensemble forces. The lack of live instrumentalists causes purely electronic music to be a special case when it comes to traditional score formation.

Typically a score is made for study or to give special instructions or cues to engineers controlling lights, audio, effects and the like. The symbols used for graphic notation of sound are by no means standardized, lengthening the preparation time needed to interpret a score. A talented audio engineer need not be a classically trained musician. In Studie II (1958), Stockhausen scores the sound on two graphs. One graph represents pitch and the other represents amplitude. Time is represented linearly. Boxes are used in the pitch graph to band together the range of a complex sound. This score shows the mixture to textures as an aid in realization.. In the transcription of Ligeti's Artikulation by Wehinger 1970, the music was electronically analyzed and the data was used to compose an artistic score. The colorful interpretation of the electronic sounds is useful in the study of the composition, but was not created to align and to secure real-time gestures.

Computer programs have been developed that can aid in the transcription of electronic music. Digital audio can be translated to graphical representations of amplitude and spectral analysis information portraying the nuances of timbre pictorially. The basis of many programs represent time in a linear fashion on the x axis and chart timbre, frequency, amplitude or envelope of sound in some fashion on the y axis. In the fifties, Piere Schaeffer made transcriptions of tape works from trace amplitude graphs (Roads, 730). The "Acousmographe" developed by Olivier Koechlin and Hughes Vinet uses a spectrogram as the basis for a graphical representation of frequency level and amplitude tracking through time (Roads, 730). Two dimensional graphs are limited to interpreting a finite number of sonic characteristics usually in a composite form. To accurately notate a multiple channel composition, one must increase the amount of information supplied in the score. The engineer must be able to receive action cues from each of the channels in order to accurately perform.

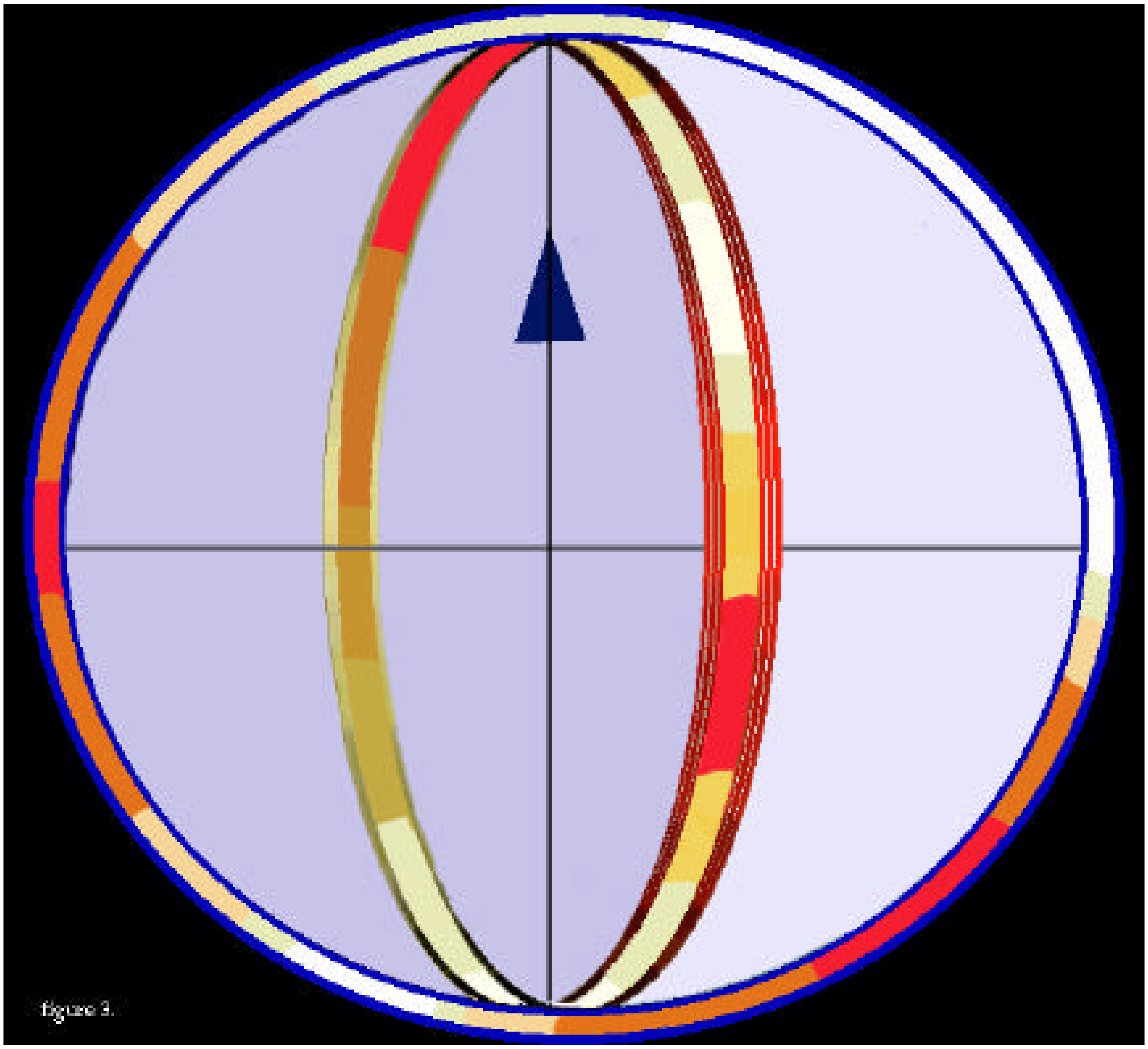
When setting up the mixing console for the operation of faders for the diffusion of recorded sound, the performer/engineer is able to route the fader in any preferred order. Also, the equipment itself has it's own unique lay-out or placement of controllers. When notating fader position, this becomes a score format problem. The composer must determine an ordering and make notations in the score to relate these choices. For instance, in an eight independent speaker configuration, if there are eight auxiliary faders being used the first one can control any one of the eight speakers depending on routing (see figure 1a). An alternative might be to notate systems representing the speakers in the room and leave the gesture association to be sorted out by the performer (see figure 1b). However, as more speakers are used more information must be given to the engineer in order to control the performance.



At any rate, this is a point of concern because it limits the effectiveness of the score as a live notation device. Another idea might be to have circles with shaded pie slices representing the speakers. The area would show a degree of shading instructing degree of the speakers intensity or prominence. Transitions from one fader state to another can be shown by arrows, lines and dashes each describing the way in which one make the connection (see figure 2a and 2b).

A graphic system of notation for electronic music that is displayed on a computer monitor can advance at the same rate as the audio. I have chosen a screen design that utilizes two circles representing the azimuth (horizontal) and zenith (vertical) around the audience. The viewer looks down upon the auditorium and through the rings which the listeners are encased (see figure 3). The rings change color from off white (cool) to red (hot) and are graded showing the relative percentage of signal being sent to that area of the performance hall. The program controlling the change of color can have sliders that are programmed in real-time.

The gestures or movement of slider position can be saved and retrieved. The composer can select the number and/or location of speakers in the desired performance space. If the performance equipment does not match the configuration intended by the composer the performer will still be able to interpret graphic instructions. For instance, if the composer has chosen an 8 azimuth and 4 zenith configuration but the mixer utilized for performance is not that large, the program will still portray the general spatial intentions of the composer. The sequence of events showing changes in speaker priority can be edited and composed. At the time of performance, the computer monitor would display the rings on a black screen adding little disturbance to the lighting in the auditorium.



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