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AN AUDIO-VISUAL GUIDE TO ELECTRONIC MUSIC FOR THE ELEMENTARY SCHOOL

by

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Chapter 1

INTRODUCTION

In recent years almost every publishing company dealing with elementary school music education materials has published a new series of classroom music books, many with accompanying records for listening experiences. The audio-visual companies have published vast amounts of material on composers, instruments, music theory, and major compositional works. Yet, with the extensive material available in these various areas, there is a dearth of material available for instruction in electronic music.

An Audio-Visual Guide to Electronic Music is an attempt to fill this gap by offering a teacher's guide for instruction in electronic music complete with audio-visual material and a teacher's handbook. It is a course of study designed to give the student a view of the history and basic compositional processes of electronic music. The guide includes the history and development of electronic music, the compositional techniques and language of electronic music, exposure to major works and names in this area, and the opportunity for participation in the creation of an original composition.

An Audio-Visual Guide to Electronic Music includes an audio-visual exposure to the major modules of the ARP Synthesizer and various tape recorder techniques.

Included also is a suggested course of study and suggested classroom experiments in tape recorder manipulation. The primary objective of the experiments is to stimulate creative spirit in the student, therefore, in as many areas as possible, the student must be permitted to make the decisions and operate the equipment. The study course consists of ten lessons designed specifically for fifth and sixth grade levels.

Suggestions for listening, a glossary of electronic music terms, a guide for purchasing tape recording equipment, and a bibliography of additional reading sources are included for the teacher's convenience.

Chapter 2

A BRIEF HISTORY

The following synopsis is by no means a complete history, but is intended to give a brief overall view of the progression in the development of electronic music.

New movements in music have resulted from composers expressing their ideas in new ways. This is seen in the movement to Baroque harmonic structure from the earlier modal system, the extension of chromaticism by Romantic composers, and the complete dissolution of former harmonic structures by modern composers. Likewise, between 1950 and 1954, electronic music grew from serial or twelve-tone techniques of the Post-Webern generation.

Among the pioneer composers of electronic music are K. H. Stockhausen, H. Eimert, G. Ligeti, and G. M. Koenig at the West German Radio Studio in Cologne, L. Berio and B. Maderna in the Italian Studio of Milan, and H. Pousseur who worked at both centers.

The musique concrete studio of the French Radio Station in Paris contributed largely to the development of electronic music. An engineer at this studio, Pierre Schaffer, was very influential in the field. He began experiments in reproducing all kinds of sounds on magnetic tape; then, by modifying and combining them, he devised all sorts of strange noises. Convinced of their musical value, he proceeded

with his first piece, "Symphony for the Single Man," in which he took the sounds heard by one man in a single day, modified them and arranged them in specific rhythmic patterns.

In the United States, research in tape music was being conducted by such men as Vladimir Ussachevsky, Otto Luening, Milton Babbitt, and John Cage. The first public concert of tape recorder music in the United States occurred on October 28, 1952, at the Museum of Modern Art in New York. Ussachevsky's "Sonic Contours," and Luening's "Low Speed," "Invention," and "Fantasy in Space" were introduced.[1]

Since that time, new developments in solid state and integrated circuitry have increased the availability of studio equipment, and at the same time greatly reduced its cost. Electronic music studios have been formed in all parts of the country, the oldest and most prominent of which is the Columbia-Princeton Electronic Music Studio in New York. Currently, electronic music is being used in both artistic and commercial endeavors, including live performances, radio, television, and motion pictures.[2]

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[1]Otto Luening, "An Unfinished History of Electronic Music", Music Educator's Journal, (November, 1968), 42.

[2]A list of historical sources appears in the Bibliography, p. 42.

Chapter 3

NECESSARY EQUIPMENT

Three phases of this course, the audio-visual, classroom experimentation, and listening will require the use of certain materials and equipment. This course has been designed with the assumption that this equipment will be available.

Audio-visual. The audio-visual section of the study course on electronic music and tape recorder techniques will require the use of a tape recorder and slide projector. The demonstration tape has been recorded in a full track monaural format and is suitable for playback on monaural or stereo machines at the speed of $7\frac{1}{2}$ inches per second, ips.

Classroom experimentation. The section on classroom experimentation will require the use of at least two stereo tape recorders and high quality microphones. The microphones which accompany the recorders are often inadequate and contribute to impure or distorted sound. The monitoring and playback system should be comparable to the quality of home high fidelity equipment.

The tape used in studio work should be polyester tape, high output, low noise, and of 1.5 mil thickness. The recording time of this tape will not be as great as that for thinner tapes, but the durability of thicker tape results in less distortion and fadeout under the stress of dubbing,

editing, and extensive handling. Because of the time and effort that will be invested in the experiments, it is advisable to refrain from using bargain tapes. Three reels of tape should be available as well as several empty reels in order to avoid excessive dubbing.

Equipment necessary for tape manipulation and editing includes a tape splicer or an editing block, marking pencil, safety razor blade, good scissors, splicing tape, and tweezers. Cellophane tape is inadequate for editing as it has a tendency to ooze onto adjacent layers of tape. The use of scissors in place of a razor blade may be advisable when working with children, however, the scissors must be sharp, as rough edges, gaps, or overlapping will cause pops or loss of signal.

Magnetic tape is coated on one side with a thin layer of magnetic particles. During the recording process these magnetic particles are aligned to correspond to the input signal. It is essential, therefore, that the splicing equipment be free from any residual magnetism, as magnetized splicing equipment will also cause pops. A bulk tape eraser may be used for demagnetization, but should not be used in close proximity of any tapes which are to be preserved.

For experimentation purposes a number of sound sources should be available for tape recording and modifying. These may be sounds of any variety: the sounds produced by beating on the bottom of a waste paper can will be as useful as those produced by traditional musical instruments. Because

the experiments are designed to stimulate creativity, the choice and organization of the source sounds must be the responsibility of the student.

Listening. A record player will be necessary for listening to the suggested material. An attempt should be made to procure as many of the examples listed in the course outline as possible.[1]

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[1]See "Course of Study", p. 25.

Chapter 4

AUDIO-VISUAL

Voltage control. Synthesizers consist of a collection of various units or modules, most of which may be removed or replaced at any time without affecting the other modules. Each module has a particular function and is independent of other modules, having its own input and/or output lines. Every synthesizer has some provision for connecting the various modules, in most cases with patch cords or matrix switches.[1] The synthesizer in reality is a voltage control system. Voltage control reacts in the same way as an eardrum reacts in an analog fashion to pressure waves.

Two basic ideas are involved in the generation of electronic sound. First, acoustical waveforms can be generated and modified by electronic means; second, all generating and modifying equipment can be controlled electronically by voltage.[2] Voltage control is then analogous to "remote control," where one piece of equipment can control with a signal the operation of another.

Voltage control is an extension of manual control. Theoretically, anything possible with voltage control

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[1] See Slide 5.

[2] Owner's Manual, The ARP Electronic Music Synthesizer Series 2500 (Newton Highlands, Massachusetts: Tonus, Inc., 1971).

should be possible by manual adjustment of control attenuators. The difference between manual and voltage control lies primarily in the speed and accuracy at which control is activated. The hand cannot possibly react in a controlling situation as rapidly or as accurately as a voltage signal from a control device.

Patch cords/Matrix switches. The use of patch cords is an external system of connection, whereby two or more connecting jacks are inserted in the appropriate input or output receptacles. Matrix switching is an internal system of connection, where the modules have been plugged into a prewired cabinet and each horizontal line on the matrix board corresponds to a free connecting line. For instance, there may be twenty lines and an "off" position. Any input and output sliders moved to the same horizontal line are interconnected.[3]

The process of "setting up a patch" involves devising a path for either a signal input or output or for a control process. Each path is either a signal path or a control path; no one circuit, or horizontal line on the board, can be both a signal and control path at the same time. However, one output may be patched to several inputs.

Nearly all synthesizer modules have both input and output lines for carrying electrical audio-signals into and out of a number of modifying devices. The final form

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[3]See Slide 6.

of the signal must then be patched out of the synthesizer into a monitor system (audio amplifier and speakers), where it is transformed into audible sound.

SOUND PRODUCERS

A synthesizer offers two sources of sound, oscillators and noise generators.

Oscillators. Various voltage controlled oscillators produce up to five waveforms: sine, triangle, square, sawtooth, and pulse. Each waveform has its own characteristic sound based on its harmonic content. Sine waves are pure tones which contain no overtones, similar to tones produced on a flute. The triangle wave consists of the fundamental and all odd numbered harmonics, the square and pulse waves consist of the fundamental and all even numbered harmonics, corresponding to the sound of a clarinet. Square and pulse waves are harmonically the same but function differently in control situations. Sawtooth waves contain the fundamental and all harmonic overtones, similar to tones of a string instrument.[4]

Noise Generators. A second producer, the noise generator, produces white sound, which is a mixture of all audible frequencies at random amplitudes. White noise is sound resembling a hiss or wind. Pink noise, also generated by this module, is similar to white noise except that

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[4]See Slides 8 and 9.

frequencies at the lower end of the spectrum are boosted and higher frequencies are filtered, resulting in a deeper sound, as of rushing water.[5]

Outside sources. A third source of sound for synthesizer use may come from outside the unit. Prerecorded or live sound may be fed into the synthesizer to be modified by the sources available in the control modules.[6]

SOUND MODIFIERS

All sound has four basic characteristics: frequency, amplitude, timbre, and duration. Control devices of the synthesizer can affect all four characteristics.

Frequency control. The frequency or pitch of a sound corresponds to the number of completed cycles per second as seen on an oscilliscope. The human ear is capable of hearing sounds whose frequencies range from twenty to 20,000 Hertz, or cycles per second, and the oscillators are capable of reaching far above and below this audible range.[7]

Amplitude control. Also, as seen on an oscilliscope, the amplitude of a sound will correspond to the height of the vibration. Volume is controlled by limiting the amount of voltage applied to a signal in the same way as

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[5]See Slides 10 and 11.

[6]See Slide 12.

[7]See Slide 14.

volume is controlled on a radio. Amplitude may be regulated by the controls of several modules on the synthesizer and/or by the volume control of the amplifier into which the synthesizer output is fed.[8]

Random control. Some synthesizers possess a control feature for filtering the white noise to the extent that no audible components remain. The signal becomes sub-audio and the signal power fluctuates between one and ten Hertz, producing a random control signal. This signal is useful for control of pitch, timbre, and duration.[9]

Oscillator control. Any waveform produced by an oscillator, when tuned to sub-audio range, may be used as a control device. The frequency of sound which is being controlled by a sub-audio waveform will follow the shape of that particular waveform. The control may be as subtle as vibrato or as extreme as to reach beyond either side of the audio spectrum. The square and pulse waves when used in control situations are either positive voltages or off, acting as on/off switches. They can therefore be regulated to trigger certain responses at preset intervals.[10]

Filters. Synthesizers possess several types of filters: high-pass, low-pass, band-pass, and band-reject, each with a

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[8]See Slide 14.

[9]See Slide 15.

[10]See Slide 16.

function to eliminate certain frequencies or bands of frequencies. The high-pass filter will allow only predetermined high frequencies to pass while blocking the lower frequencies. The low-pass works inversely. The band-pass filter permits a certain range to pass while blocking out the frequencies both higher and lower. The opposite filter is the band-reject or notch filter, which blocks out only a certain band of frequencies.[11] Filters are more effectively used with waveforms which contain a greater overtone content, such as square, triangle, and sawtooth waveforms.

Envelope generators. The contour or shape of the sound is referred to as the envelope. For instance, the shape of a plucked string would indicate a fast peak in volume (as the string is plucked), and a long decay (as the amplitude decreases). The module controlling the contour of the sound is the envelope generator. When the envelope generator controls amplitude, it controls the length of time for the peak amplitude to be reached, the length of time it is sustained, and the length of time for its decrease and decay back to zero amplitude.

ARP envelope modules possess five control features: gate delay, attack time, initial decay time, sustain level, and final decay time, all affecting the shape of the sound.[12]

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[11]See Slides 17 and 18.

[12]See Slides 20 and 21.

Mixers. A synthesizer is likely to have several means whereby various inputs or signals may be combined for a single output. On the ARP Synthesizer the Filtamp module is probably the most commonly used module for mixing. It has four input lines with amplitude control for each. This module also possesses a low-pass filter and an amplifier, both of which may be controlled manually or by outside voltage.[13]

Sequencer. A sequencer is a voltage generator used for controlling oscillators, filters, amplifiers, and other modules of the synthesizer. A sequencer possesses a counter which automatically steps from one preset voltage to the next at a predetermined speed. Rows of potentiometers or controllers may control pitch, timbre, or duration. Sequencers may be set to continuously repeat the sequence, to stop at a specific step, or skip over certain steps. It may also be manually controlled whereby the operator triggers each step.[14]

Keyboard control. The keyboard on a synthesizer is another of its control devices, having a variety of functions. Connected to an oscillator, it may be used in a similar fashion as a regular keyboard. Each succeeding key changes the level of voltage, creating a different pitch. It may

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[13]See Slides 23 and 24.

[14]See Slides 25 and 26.

be adjusted to play with portamento (sliding from one pitch to another), or it may be used as a triggering device to control another module.[15]

Outside sources. Any number of outside sources may be incorporated in the process of creating electronic music. The synthesizer itself may be controlled in total by external sources. For instance, the entire program for the synthesizer may be set up and activiated by an outside source such as a computer. The output of a synthesizer may be fed into a reverberation unit where echo may be added, or the output may be fed into a tape recorder where even further modification is possible.[16]

TAPE RECORDERS

Reel to reel recorders are indispensable equipment in the composition of electronic music, and are used in the collection of source sounds, the modifying, mutating, and mixing processes, and finally, the editing and dubbing of the finished work. Except in cases of live performance, tape is invariably used for storing the created sounds for later reproduction. It is imperative to realize that the quality of the finished product in electronic music is directly proportional to the quality of tape, machines, additional equipment, and of course, the composer's technical

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[15]See Slides 27 and 28.

[16]See Slide 29.

ability to properly use this equipment. The work will only be as good as the weakest link in this chain of equipment and technical skill.

It is not within the scope of this project to consider all features of all audio tape machines currently offered for sale, however, there are certain features common to most machines which should be discussed. It is naturally assumed that anyone working with studio equipment will first consult the owner's manual of his machines for proper operating instructions.

Studio equipment. An electronic music studio should be equipped with at least two versatile reel to reel tape recorders, high quality microphones, headphones for monitoring, high quality tape, splicing equipment, and if possible an audio amplifier and speaker system.[17]

Jack field. If several machines, recorders, record players, tuners, classroom synthesizers, etc., are available for permanent use in a studio, it may be more convenient to have the input and output lines permanently wired to a patch panel, giving easy access with patch cords to the various circuits, rather than constantly reaching behind the machines to make connections.[18]

Reel tension. Most tape machines are built to accomodate a certain size reel, generally seven inches in diameter.

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[17]See Slide 32.

[18]See Slide 33.

The machines which also accept larger size reels will invariably have a tension adjustment control. Improper tension may cause damaging pressure to the tape.

Speed. In most cases, tape recorders offer the choice of two speeds, many offer three; machines which offer a choice of three speeds are more of an advantage when working with tape manipulations. The speed selector indicates in inches per second the amount of tape that passes the record head: the most commonly used speeds are 3 3/4 and 7 1/2 inches per second (ips).

Counter. Tape recorders possess some form of digital counter for relocating particular points on the tape. These counters are not set to a standard measurement as the tape speeds are; therefore, when using more than one machine, it will be necessary to notate to which machine the counter number refers.[19]

Input/output. Tape recorders are usually equipped with one set of high level input and output jacks, used primarily for transferring the signal directly from one high level circuit to another (synthesizer, tuner, or another tape recorder). Stereo machines will have a separate input and output for each channel. In addition to these, there are microphone inputs and a headphone monitor output, usually located on the front or side panel.

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[19]See Slide 34.

Volume unit meter. The recorder should have some form of VU (Volume Unit) meter. A few models have electronic eyes to indicate volume level; however most machines have scaled meters which show the decibel (db) level of volume. These meters may also include a second scale reading from zero to 100 per cent, the 100 per cent mark coinciding with zero on the decibel scale which is the loudest level at which a signal may be recorded without distortion. Caution should be taken to prevent the needle from remaining in the red, or danger zone, of the meter. All recording, however, should be done at a relatively high level, a point just below the danger zone. This will prevent tape noise from becoming objectionable to the ear.[20]

Heads. Tape recorders for studio use should be equipped with at least three separate heads: erase, record, and playback. A three-head machine will permit more possibilities for modifying recorded sounds, and also it will allow for direct monitoring of the sound being recorded.[21]

Head-Track format. The track format of the recorder heads determine whether a machine records in half-track, quarter-track, or full-track. Full-track monaural format records one track in forward direction and one track in

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[20]See Slide 35.

[21]See Slide 36.

reverse. Half-track stereo records two tracks in forward direction only, and quarter-track stereo records two tracks in forward as well as two tracks in reverse.[22]

TAPE RECORDER TECHNIQUES

An ideal way to introduce the student to organizational principles involved in the process of composition is to decide with him the format for the original piece of electronic music. After having been exposed to the simpler forms of music, such as ABA, the student should decide what form is to be used in the piece. The student should then decide what sounds will be incorporated, what will be done in the way of mutation for each or any of the sounds, and how the material will be combined.

The selected source sounds should be recorded at a relatively high volume level and those sounds which will require no tape speed changes in the mutation process should be recorded at the fastest available speed. For the sake of convenience, continuity, and consistency of background noise, the original sounds should be recorded in one session.

Cataloging. A catalog should be made which includes the counter number for each sound, the speed at which it was recorded, and a description of each. This procedure facilitates easy relocation. Further, since counters vary

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[22]See Slide 37.

from machine to machine, a note should be made as to which recorder was used. The catalog of sounds may be expanded with each new composition.[23]

Splicing technique. The composition of electronic music involves a considerable amount of editing, and therefore requires adequate splicing technique. Proper equipment will help make this a simple and successful task.

Tape splicers and splicing blocks are simple devices for securing the tape while cutting and taping is done. Cutting guides or knives of the splicing devices are usually set at a forty-five degree angle, allowing for a smoother transition from one section of tape to the next. Should a sharper attack in sound be desired, the tape may be spliced at a ninety degree angle; however, the blunter splice (ninety degrees) will not be as durable.

After cutting the tape at the appropriate points, the ends should be secured and the splicing tape placed over the cut. Any excess splicing tape overhanging the edges of the recording tape should be trimmed away.

While splicing, the tape should be handled as little as possible, and for best results, the splicing equipment should be clean and demagnetized.[24]

Speed changes. Most mutation processes require the use of two tape recorders. An excellent method for mutating

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[23]See Slide 40.

[24]See Slide 41.

pitch, timbre, and duration of sound is to vary the tape speed, a procedure requiring several steps. For example, record a sound at 3 3/4 inches per second on one recorder, playback the sound at 7 1/2 inches per second and record it on the second machine at 3 3/4 inches per second. This process may be repeated several times; each time the duration of the sound is halved, the pitch raised an octave, and the envelope changed proportionately. By reversing the speed sequence, sound duration and envelope may be doubled while lowering the pitch by octaves.[25]

Reverse playback. Another interesting means of sound mutation is reverse playback. Instead of the usual attack and decay of a particular sound, reverse playback will reverse the envelope, creating a gradual increase in the volume of the sound leading to its sudden disappearance.[26] This procedure is applicable to half-track stereo or full-track mono; it may be used with tape recorded on quarter-track machines if played back on half-track or full-track machines, although some loss in signal will result.

Splicing. Some interesting effects can be achieved by splicing into a recorded sound. A sharp attack may be eliminated, a melody may be cut into fragments, and periods of silence may be injected. This process requires

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[25]See Slides 42 and 43.

[26]See Slide 44.

more care than others in that it calls for precise splicing and pinpoint location of particular positions on the tape. The reel should be "rocked" by hand so that the tape passes the playback head very slowly and the specific part of the sound may be accurately located.[27]

Tape loop. Different ostinato figures may be created by making tape loops. For example, record a section of desired sounds, locate the exact points for starting and stopping, cut, and splice the ends together. Depending on the length of tape used, the loop may be fed past the playback head by hand or looped around empty reels. The result is continuous playback.[28]

Echo. Echo or reverberation effect may be created on some stereo machines which possess independent controls for the record and playback heads. The method of operation differs from machine to machine, therefore, the owner's manual should be consulted for appropriate operating instructions.[29]

Mixing. As each recording pass across the tape adds to the tape noise, it is advisable to formulate an outline for mixing that will eliminate extra passes. Assuming that there are six sounds and two stereo tape recorders available, the mixing process might be done in the following

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[27]See Slide 45.

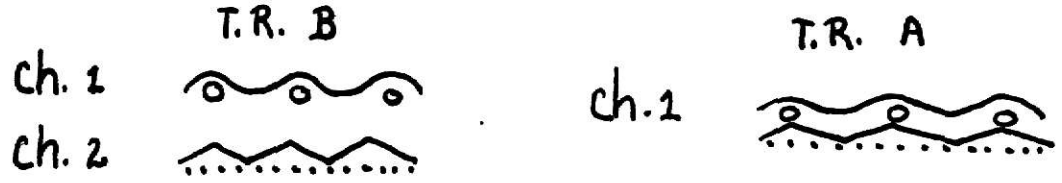
[28]See Slide 46.

[29]See Slide 47.

way. Record sound one on channel one and sound two on channel two of tape recorder A. Mix these two sounds to channel one of tape recorder B.

In the same way mix sounds three and four onto channel two of tape recorder B.

At this point mix channels one and two of tape recorder B to channel one of tape recorder A, giving this channel a mixture of the first four sounds.[30]



Sounds five and six may then be recorded on channels one and two of tape recorder B and mixed to channel two of tape recorder A.

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[30]See Slide 48.

Channel one of tape recorder A now contains sounds one through four and channel two contains sounds five and six. The results may be played in stereo form or mixed once more to a monaural format.[31]

Fade-in and fade-out effects can be achieved in the mixing or dubbing process by manipulating the volume controls for the tape recorders.

Editing. In most cases the recorded sounds will require editing before and after the mixing process; this involves removing clicks and pops, adding or deleting material, and combining sections. Except when the composition requires leader tape for marking purposes, the final dub should contain no splices.

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[31]See Slide 49.

Chapter 5

COURSE OF STUDY

The suggested course of study has been divided into ten lessons, each requiring approximately twenty minutes. However, the length of each lesson will vary according to the time allotted for discussions and listening. If circumstances require, the audio-visual material may be presented in two longer sessions, one dealing with tape recorders and one with the synthesizer.[1] The value of the listening, discussion and review should not be underestimated. Enough time should be spent with the first five lessons to enable the student to confidently participate in the actual composition of electronic music.

This outline is merely suggestive, and the teacher should feel free to adjust the curriculum to suit the situation.

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[1]The first slide should be projected as the tape begins. The electronic bleeps on the tape signal when the frames are to be advanced.

Lesson One

1. Discussion of various facets pertaining to electronic music.

   Definitions:

   a. Electronic music. Music made by producing, modifying, and recording sound, and reproducing it by electro-acoustical means.

   b. Electronic sound. Sound created exclusively by electronic means.

   c. Musique concrete. Music made from recorded sounds which already exist. Acoustical sound.

2. Audio-Visual Section One - Sound Producers.

   Refer to the audio-visual section of the handbook.

3. Suggested listening: Edgar Varese, "Poeme Electronique".

Lesson Two

1. Review of Lesson One.
2. Audio-Visual Section Two - Sound Modifiers.

   Refer to the audio-visual section of the handbook.

3. Suggested listening: Selections from Carlos, The Well Tempered Synthesizer, and Beatles, Sgt. Pepper's Lonely Hearts Club Band.

Lesson Three

1. Review of Lesson Two.
2. Short history of electronic music.

   Refer to the section on history in the handbook.

3. Suggested listening: Selections from Ussachevsky, Tape Music - An Historic Concept -- "Sonic Contours", "Incantations".

Lesson Four

1. Audio-Visual Section Three - Tape Recorders.
   Refer to the audio-visual section of the handbook.
2. Discussion of features present on the classroom tape recorders.
3. Suggested listening: LeCaine, "Dripsody", Ussachevsky, "Piece For Tape Recorder".

Lesson Five

1. Review of Lesson Four.
2. Audio-Visual Section Four - Tape Recorder Techniques.
   Refer to the audio-visual section of the handbook.
3. Discussion of texture of electronic music as compared with the texture of modern art. Discuss both as collages, of timbres or colors and forms.
   Examples: Jackson Pollock, "Convergence", Chagall, "I and the Village", Klee, "Twittering Machine" and "Diana", Ernst, "The Mysteries of Love", Kandinsky, "Picture With White Edge, No. 173".

Lesson Six

1. Review of Lesson Five.
2. Discussion of format.
   a. Length. It will be necessary to keep the piece within two to three minutes in length.

b. Form. Short sections such as an ABA form where each section can be taped independently and then spliced together would be one of the least complicated structures.

c. Sounds. The source sounds should be limited in number to six or less for the first experiments.

d. Mutations. Decide which sounds will be used for each section, and which mutation processes will be used for each sound. For example, the two A sections may contain the same sources but be altered in different ways. The B section may contain altogether contrasting sounds.

3. Collection of source sounds.

Note the mutations which will be used for each sound so that the initial recording can be done at an appropriate speed.

Lesson Seven

1. Review procedures for mutation.
2. Review collected sounds.
3. Establish a format for mutating the sounds, beginning with speed changes and reverse playback.
4. Collect the completed work on a separate tape so as to avoid confusion.

Lesson Eight

1. Review completed material.
2. Continue mutation using tape loop and echo.

Lesson Nine

1. Review completed material.
2. Begin mixing. Mix each section separately.

Lesson Ten

1. Complete the mixing processes.
2. Edit the sections and splice them together.
3. Make a final dub.
4. Discuss class reaction to the piece.
5. Give the piece a title and construct a score.

Chapter 6

SUGGESTED LISTENING

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Chapter 7

GLOSSARY OF TERMS

Acoustics. The study of the production, transmission, and reception of sounds.

Aleatoric. Risk or hazard. In music, those compositional techniques in which one or more elements is not controlled by the composer's notation. "Chance" music.

Amplifier. A device used to increase the power, voltage, or current of a signal.

Amplitude. Usually equated to the "loudness" of a pitch; the dynamics of sound.

Amplitude modulation. A periodic variation of amplitude creating a tremelo.

Analog computer. A computer whose information is stored and processed using electro-magnetic energy on wires or tapes.

Atonality. Literally, the absence of tonality.

Attack. The beginning of a sound or signal.

Audio generator. A device that produces complex signals at frequencies between 20 and 20,000 Hz.

Audio oscillator. A device that produces sinusoidal (sine) signals at frequencies between 20 and 20,000 Hz.

Audio spectrum. The range of oscillations that can be heard by the human ear, the extremes are about 20 - 20,000 Hz.

Augmentation. Expanding the duration of a group of notes or sounds without disturbing the relation of the elements, doubling or tripling the value of each element.

Avant-garde. A term applying to those who work in the newest areas of creativity.

Band-elimination (reject filter). A filtering device which eliminates a particular band of frequencies while allowing the remainder to pass through.

Band-pass filter. A filtering device which allows a particular band of frequencies to pass while rejecting the remainder of frequencies.

Black sound. A term used to denote silence.

Cluster. A chord or sound which contains two or more intervals of a major second or less.

Contact microphone. A type of microphone which requires physical contact before creating electronic signals for reproduction as sound.

Cross-coupling. A tape recorder technique of attaching the play-back of one channel to the record of the other and vice-versa to create an echo effect.

Decay. The contour of the sound in which the amplitude is decreasing.

Decibel. The standard unit of amplitude measurement. An expression of the notable difference of intensity between two sounds or signals.

Digital computer. A computer whose information is stored and processed using numbers.

Dodecaphonic. A term used to refer to twelve-tone music.

Drift. Any unintentional shift of frequency due to equipment inaccuracy.

Echo. A repetition of sounds usually at a lower amplitude.

Electrosonics. A term used to refer to the whole realm of electronically produced sounds.

Envelope. The amplitude characteristics of a signal; attack, initial decay, sustain, and final decay.

Erase head. The head on the tape recorder which erases previously recorded material on the tape prior to its passing the record head.

Event. A particular musical entity with its own characteristics.

Feedback. The practice of sending a portion of the playback signal back into the input.

Filter. A device which permits the transmission of selected frequencies only by the attenuation of the undesired frequencies.

Four-track tape. Recording tape on which four separate sound paths can be utilized, two in each direction.

Four-channel recorder. A recorder which has the capability of recording four separate tracks in one direction.

Frequency. Number of signal vibrations per second, usually determining the pitch.

Frequency modulation. A periodic variation of frequency affecting pitch.

Gain. A term used to express the degree of amplification.

Gate. A device for controlling the amplitude of a signal path.

Generator. Source of all types of electronic signals except pure sine waves.

Half-track recorder. A tape recorder which records and plays back on one half of the recording tape.

Half-track head. The head on a half-track recorder.

Harmonic. An overtone, or frequency component present in complex sounds.

Hertz. A term used to denote "cycles per second".

Input. A signal fed into a circuit.

Jack. A plug-in type terminal such as the type used at telephone switchboards.

Laser. An intense beam of light connected by its beam to a receiving device.

Magnetic tape. Iron-oxide-coated plastic tape used in magnetic recordings.

Microtone. Any two tones which are less than an equal-tempered half step apart.

Mixer. A device for combining several input signals into one output signal.

Modulation. The process which varies the characteristics of a waveform.

Montage. A visual overlapping of images.

Monitor. A device used for checking the audio signal, usually during the recording process.

Multimedia. A work which employs two or more art forms.

Musique concrete. Music which is constructed from recorded sound sources, other than electronic.

Mutation. The transformation of sound by changing its characteristics.

Noise. Sounds whose complexity is such that individual frequencies are no longer determinable or audible.

Oscillator. A device designed to create sine waves.

Oscilliscope. An instrument that reproduces on a screen the graphical representation of the characteristics of a signal.

Ostinato. A grouping of sounds which is repeated many times.

Output. The signal which comes out of a circuit.

Overtone. The secondary tones in all sounds except sinusoidal tones.

Panchromatic. Inclusive of all chromatic tones.

Pandiatonicism. Inclusive of all diatonic or key-scale notes.

Pantonality. Inclusive of all tonalities.

Parameter. Any aspect of sound which can be controlled.

Partial. A frequency component.

Patch cord. A cord with a plug at both ends used to connect an input and output.

Peak. The maximum value of amplitude.

Permutation. The alteration or changing of variables in sounds or structures.

Pointillism. A term applied to music in which each sound becomes an entity in itself, separated from those before and after by frequency, silence, and/or timbre.

Portamento. A gradual glide from one note to another.

Potentiometer. Commonly used to denote a volume control on audio equipment.

Prepared piano. A piano the timbre of which has been changed by the use of foreign objects between, on, or around the strings.

Programming. The directions for the behavior of an electronic system.

Psycho-acoustics. The study of sound and its influence on man.

Quarter-track recorder. A recorder which used one quarter of the width of the tape for each recording path. Tracks one and three go in one direction and two and four in the opposite direction.

Real time. A term used to denote composition time equivalent to performance time.

Recording head. An electromagnetic transducer used to implant magnetized patterns on recording tape.

Retrograde. Backwards.

Reverberation. Quick repetitions of a sound which cannot be individually distinguished. The effect is that of an echo.

Ring modulator. A multiplier circuit that combines signals to produce the sum and difference of their frequencies.

Sawtooth wave. A signal consisting of the fundamental and all the harmonics.

Sel-sync. A system for synchronization whereby one or more tracks of the record head may be switched to playback at the same time the other tracks are recording.

Sequence. A device that is used to produce a preset voltage sequence for the purpose of controlling a series of events with voltage-controlled equipment.

Serialization. The intellectual logic applied to any or all compositional techniques.

Signal. Electrical current.

Signal generator. The source of sound, such as an oscillator or a tape recorder.

Sine-wave. The waveform corresponding to a single frequency oscillation.

Sound. Pressure waves of a frequency audible to the human ear.

Sound mass. A block of sound in which individual pitches are no longer perceptible.

Source. The entity which supplies the signal.

Splicer. An instrument to cut and put together segments of tape.

Square wave. A signal consisting of a fundamental frequency and all odd-numbered harmonics.

Synchronization. Coordinating in time one set of events with another.

Synthesizer. A system of electronic instruments for the production and control of sound.

Timbre. Tone-color.

Transient overtone. Overtones momentarily present, usually during the attack.

Variable speed unit. A device used to control the speed of a tape recorder.

Voltage-controlled amplifier. An amplifier whose gain may be varied by means of a change in a control voltage.

Waveform. The shape of a wave in the sense of a graphical representation.

White noise. A signal that may be considered to contain all audible frequencies.

Chapter 8

GUIDE FOR PURCHASING RECORDERS

An electronic music studio should be equipped with at least two or three high-quality versatile tape recorders. The production of electronic music requires several stages of construction, all directly related to and dependent on taping techniques. Therefore, the ultimate success of the studio depends on the number of modifying operations possible with the equipment. In the selection of appropriate professional equipment, consideration must be given to include as many necessary features in a tape recorder as is possible within a particular budget.

The following specifications for the electronics and mechanics of professional recorders are the requirements that can and should be met by the higher priced machines on the market. These will in many cases be less rigorous for lower priced models.

Electronic Specifications

1. Frequency response of 30 to 20,000 Hz ($\pm$ 3 dB) or better.
2. Signal/Noise ratio 60 dB or better for full-track monaural or half-track stereo, 58 dB for quarter-track. The average range is between 50 and 58 dB.
3. Wow and flutter less than 0.25 per cent with 0.1 to 0.2 typical of modern equipment.

4. Calibrated VU meter whose zero VU point corresponds to a level at least 6 dB under tape saturation but with 10 dB headroom preferred. A peak record level indicator with a scale of 0 to -40 dB is ideal, 0 to -20 dB is standard.
5. Maximum speed error of 3 seconds per 30 minutes of tape at $7\frac{1}{2}$ ips, using 1.5 mil tape.
6. Adjustable bias accommodating all the recording tapes in use, and complete record and play equalization adjustments.
7. Three heads for simultaneous playback monitoring during recording, and line level inputs and outputs. For convenience in mixing live sounds such as the voice with electronic inputs such as the synthesizer or another tape deck, the recorder should have two sets of inputs, one marked for microphone, and the other marked for Audio-in. Both sets must be able to function simultaneously.
8. Low impedence microphone inputs and low impedence microphones. The microphones which are furnished as part of the system are often inferior to the machine. A set of various high quality condenser microphones should also be included in the studio recording system, these are usually priced at over $100.00 each.

Mechanical Specifications

1. Three motor drive which approaches ideal tape tensioning from beginning to end of the reel and also makes possible a fast forward and rewind.
2. Solenoid operation of all functions, eliminating rubber drive wheels, spring tension adjustments, extra mechanical parts and trouble in general.
3. A 10½ inch reel capacity without extension adaptors, and a tension switch to adjust for reel size. In most cases the 7 inch capacity is sufficient.
4. An open tape path for marking at the playback head, and a brake release to make possible "rocking" the tape for editing purposes.
5. Ruggedness of construction, and unbendable deck, heavy duty parts that can endure continual use.[1]

A studio should contain a recorder which operates at two or preferably three speeds. A machine that incorporates all three is good for modifying source sounds by playback at different speeds. The process of editing is made simpler by using a machine with a speed of 15 inches per second. Because the sound signal is spread over a longer length of tape, it is easier to locate an exact point for editing.

Another very important feature for consideration in studio recording equipment is the head configuration. Most recorders are equipped with three heads. Many three-head

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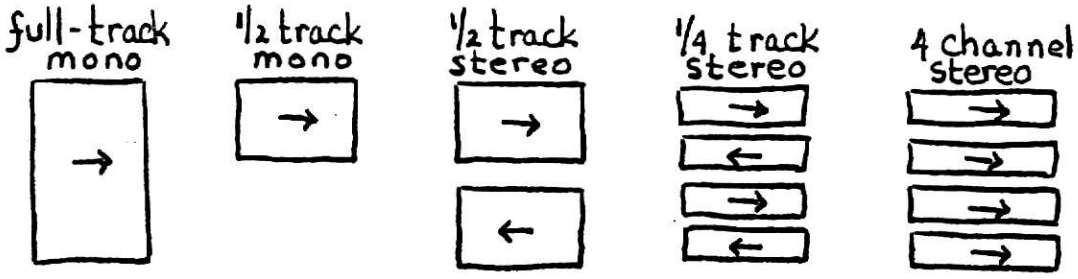
[1]Herbert Friedman, "What Makes A Tape Recorder Professional?" High Fidelity and Musical America, (Great Barrington, Mass.: Billboard Publications, Inc., August, 1971), 50.

recorders offer special modes of operation, such as sound-on-sound, sound-with-sound, and echo effect. These modes are very useful in constructing electronic music, and should be included in some or all of the recorders in the studio. Some of the higher priced models have as many as six heads, making possible automatic reverse, and reverse recording. Although perhaps convenient for home use, these features are not necessary for studio work.

Consideration should be given to the selection of the track and channel systems of the recorder. The following examples are the most common head formats for quarter-track tape.



Of these the most useful for studio work is the half-track stereo format. In this track system two channels can be recorded simultaneously or dubbed from one to the other. The most valuable format is the four channel system, where four tracks are moving in the same direction. Some machines with four channel stereo offer a feature for synchronizing all four tracks, changing any selected track on the record head to a playback track. Thus, prerecorded timing bleeps can be heard as the other tracks are being recorded. This is an invaluable time saver in composition of electronic music, and is a requisite for a professional studio.

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AN AUDIO-VISUAL GUIDE TO ELECTRONIC MUSIC FOR THE ELEMENTARY SCHOOL

by

JEANNE E. HANSEN

B. M., Nyack Missionary College, 1966

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF MUSIC

Department of Music

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1972

In recent years almost every publishing company dealing with elementary school music education materials has published a new series of classroom music books, many with accompanying records for listening experiences. The audio-visual companies have published vast amounts of material on composers, instruments, music theory, and major compositional works. Yet, with the extensive material available in these various areas, there is a dearth of material available for instruction in electronic music.

An Audio-Visual Guide to Electronic Music is an attempt to fill this gap by offering a teacher's guide for instruction in electronic music complete with audio-visual material and a teacher's handbook. It is a course of study designed to give the student a view of the history and basic compositional processes of electronic music. The guide includes the history and development of electronic music, the compositional techniques and language of electronic music, exposure to major works and names in this area, and the opportunity for participation in the creation of an original composition.

An Audio-Visual Guide to Electronic Music includes an audio-visual exposure to the major modules of the ARP Synthesizer and various tape recorder techniques.

Included also is a suggested course of study and suggested classroom experiments in tape recorder manipulation. The primary objective of the experiments is to stimulate creative spirit in the student, therefore, in as

many areas as possible, the student must be permitted to make the decisions and operate the equipment. The study course consists of ten lessons designed specifically for fifth and sixth grade levels.

Suggestions for listening, a glossary of electronic music terms, a guide for purchasing tape recording equipment, and a bibliography of additional reading sources are included for the teacher's convenience.