

BIO-MUSIC
Manford L. Eaton

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PREFACE

Bio-Music is the term used by ORCUS Research to describe a class of electronic systems that use biological potentials in feedback loops to induce powerful, predictable, repeatable, physiological/psychological states which can be elegantly controlled in real time. The types of states that can be programmed are as powerful as chemical (drug) states, and the hallucinogenic powers of electronic sensory feedback systems can be controlled and guided with a precision utterly impossible with chemical methods.

We use the term Bio-Music because the stimulation of bio-organisms, through sensory (aural and visual) and electrical stimulation in feedback loops, is presented by programming stimuli, in real time, and in a definite time-rhythmic sequence — music is the traditional art most involved in real-time organization of sensory stimulation (individuals go to concerts to see as well as to hear sensory stimuli). The other traditional arts are less immediately related to real-time sensory feedback.

It is the purpose of this book to provide some guidelines for researchers in this fascinating field

and to attempt to prevue the types of systems that are now or soon will be within the state of the electronic art. We hope that this book will be read by those within the arts who hold as their thesis that only through the development of arts as powerful as the technology around us will we ever be able to regain any of the peace and understanding that was ours in a more pristine world.

—*Manford L. Eaton*

BIO-MUSIC

INTRODUCTION AND HISTORY

In 1934 E. D. Adrian and B. H. C. Matthews published an article in *Brain* magazine which disclosed that a part of their experimentation with the alpha rhythm brain waves was the conversion of the alpha rhythm into sound. Earlier, someone tried to patent a nebulously-described gadget that would transform brain waves into control signals for a player piano. This turn-of-the-century brain storm was rejected by the U.S. Patent Office.

Immediately after World War II a number of researchers in the field of brain wave study constructed various conversion circuits for making brain rhythms audible or visible. None of these had artistic goals in mind. They were intended primarily to provide the researcher with a form of data presentation that would yield more information than ink writing pens or oscillographs. Even though the experiments were some improvement over the graphs, they left much to be desired with respect to the processing of activity (either inter-

nally generated by the organism or by external sensory or electrical stimulation). Also, the time between the conversion of brain waves into sound and the time when new stimuli was presented was ineffectual except in instances where the subject could hear or see the conversion into sensory stimuli. When this occurred things became even more mystical. Just what was the correlation between the spontaneous activity of the organism, the effect of stimuli presented, and the effects of the visual and aural feedback?

About ten years ago there was another surge of interest in the general field of biological potential to sensorial form conversion. At least one of these was artistically oriented. This was an effort by Alvin Lucier of Brandeis University to convert biological potentials into sound.

In 1964 the Compagnie des Lampes Mazda in Paris conducted a number of experiments in the utilization of the alpha rhythm of the brain to actuate relays, and the past few years have shown a rapidly-growing interest in the conversion of physiological parameters into aural and visual sensory information, which is fed back in real time. Generally, these experiments have centered around the idea of enabling the subject to gain conscious

control over a physiological parameter whose control is usually unconscious. For example, some of this experimentation has involved the conversion of the alpha rhythm of the brain into sound where the intensity of the sound will increase if the subject increases the amplitude of his alpha output. Most subjects can learn to enhance their alpha output readily by using this technique.

ORCUS research into the utilization of bio-potentials for artistic purposes dates back to 1960. At that time, we began to investigate the possibilities for generating a spontaneous music based upon the conversion of various bio-potentials into sound. The goal of this effort was to devise a type of spontaneous improvisational system which would not be tied to acoustical/mechanical limitations of conventional instrumentation. As experiments and cogitation progressed, we began to discover that we were getting into an area much more powerful than we had originally thought: the area of physiological parameter control through sensory and electrical stimulation. Because physiological parameter control through sensory and electrical stimulation could be monitored in real time, and we had some basis for knowing the effects of stimuli which could be monitored, we found that we could control the

physiological/psychological state of the listener! It became apparent immediately that one of the most frustrating and abiding problems of communication could be solved with these techniques — the problem of the same physical/sensory stimulation having different effects and meanings to various individuals. With biological real-time monitoring and electronic generation of visual, aural, and electrical stimulation, it would be possible to adjust (in real time) the stimuli presented to the organism in such a manner so that we could write, not compositions of musical notes that would have some indeterminate effect upon the listener, but a physiological/psychological state program that would control the generation of whatever sensory and electrical stimuli needed to realize this program!

We realized that we had stumbled onto something powerful, awesome; so, we let it be for some time, until we began to detect a growing realization on the part of others in various fields (psychology, neurology, pharmacology, psycho-acoustics, etc.) of the power in bio-electronic feedback stimulation. Bio-Music is arriving with a speed and a force that makes the dissemination of useful, accurate, and honest information about these techniques essential. It is devoutly hoped that the course of bio-

logical/electronic feedback will not become enmeshed in the vast mish-mash of mis-information that we now have about drugs.

Ever since the discovery of bio-electricity, researchers have pondered over the significance of the electrical signals that emanate from biological organisms; and now we are at a point where a coming-together of the various disciplines (biology, medicine, psychology, electronics, music, etc.) makes it possible to utilize bio-electronics in a quite wide variety of endeavors. It is axiomatic that virtually every parameter of human activity is accompanied by unique electrical signals. Over the years, it has become possible to diagnose many types of diseases that would have otherwise gone undetected until it was too late to treat them. It has become possible to make considerable advances in the study of sensory perception by monitoring physiological/electrical parameters, and, through the use of the polygraph, to achieve a high degree of accuracy in detecting truthful answers to questions.

These are the physiological parameters of Bio-Music:

- 1) The Galvanic Skin Response (GSR)
- 2) The Electrocardiogram (EKG)

- 3) The Electroencephalogram (EEG)
- 4) The Electromyogram (EMG)
- 5) The Eye Movement Potentials (EOG)
- 6) The Blood Pressure
- 7) The Respiration

From these electrical signals we can accumulate a great deal of information about the state of consciousness — mental activity, audio and video perception, and the emotional state of the subject. Through sensory and electrical stimulation in real-time feedback loops, we can control these states.

A few words about the EEG — the discovery of brain waves by Hans Berger in 1937 brought about a flurry of enthusiasm concerning the possibilities of “think work,” of detecting unique signals that could be easily correlated with specific thoughts. However, the EEG remains certainly the most enigmatic of the bio-potentials described herein. For some significant information about cerebral functioning, see: *The Cerebral Cortex of Man* (1950) by Penfield and Rasmussen, published by MacMillan Company, N.Y. One of the more serious problems in EEG research is caused by the fact that it is only rarely possible to monitor the EEG

by direct insertion of electrodes into cortical tissue; thus, almost all information about the electrical signals of the brain is obtained by using electrodes on the skull surface several centimeters from the source. This complicates greatly any assessment of the significance of the signals. Penfield and Rasmussen did have the opportunity to monitor and electrically stimulate the exposed cortex of a large number of human subjects and their book is a classic on the functioning of the cerebral cortex.

It is a basic tenet of this book that if physiological parameters can be monitored in detail, they define psychological states. This thesis is open to argument. The discussion as to whether physiological states portray psychological states has been going on for a long time and probably will continue far into the future. For our purposes, however, it is significant that conventional music is almost totally helpless to predict and/or control either physiological or psychological states in any very sophisticated manner. If we can, through biological feedback stimulation, use biological potentials as control signals for the presentation of sensory stimuli, and by monitoring physiological parameters to determine the efficacy of our efforts, arrive at a point where we can predict, repeat, and change, at will,

physiological states and the accompanying psychological states, we will have a music with great power. This is exactly what we can do with Bio-Music. The fact that present biological music systems are crude in comparison with our ideal pales when one realizes the power of even such crude systems, especially as compared to the power of traditional musical techniques.

Some of the biological signals are quite easy to correlate with sensory stimuli. For example, if an electronic flash lamp is placed in front of and to the left of a subject, and his head is held so that he cannot move it to look at the flash, we can, by monitoring his eye movement potentials, determine if he has moved his eyes to look at the flash. If we apply any sensory stimuli on a continuous basis, we are told by the EEG if the subject has perceived anything. However, the EEG will tell us only that the subject has perceived "something;" and generally, but not always, it is not possible within the present art to determine from the EEG what the subject perceived. Moreover, the response to a given stimulus will vary from one subject to another, even with the same subject from one time to another.

All this would be quite discouraging were it not

for the principle of bio-feedback. In addition, we can control physiological parameters to maximize the possibility that particular sensory stimuli will be perceived. By such techniques as electro-narcosis, we can maintain consciousness at a level where the organism is particularly receptive to acoustic and verbal stimuli. (Electro-narcosis is a term used by Sylvestre Leduc, the pioneer researcher on the subject, and is a more useful term for our purposes than electro-anesthesia since we are not using the technique to induce unconsciousness. Instead, we want to induce an alpha rhythm characteristic such as one might achieve in a quiet room with his eyes closed, in a state of repose with no internally generated intellectual stimuli. It is into this type of alpha state [a Consciousness Field] that we inject a sensory stimulus.) By monitoring the EEG for attentiveness, we can present signals to the organism only wherein the brain is attentive. If we present a stimulus and learn from the EEG that this signal was not detected by the organism, we can repeat the stimulus under different physiological control conditions until we achieve recognition of the stimulus by the organism. Even though it is true that it is difficult to detect from the EEG (for example) that the organism has perceived one

sound rather than another, we know what sound is being presented, and we address ourselves to engaging and monitoring all of the physiological parameters and to creating physiological conditions maximizing receptiveness on the part of the organism. Thus, we achieve music systems which can induce quite powerful psychic states—states which can be changed in real time much more elegantly and quickly than with chemicals.

It is important to remember that with Bio-Music systems we are programming the subject through a specified series of physiological states as defined by the biological parameters that we are monitoring. The actual sensory stimuli presented to the organism to achieve these states may well vary from one subject to another, and from one time to another with the same subject. The efficacy of any given system can be greatly increased by adding a memory to it. For example, if a given subject reacts in an abnormal manner to a certain sensory stimulus, leading to considerable searching by successive approximation to achieve the desired state, this memory, after storing data on this subject for some time, can make appropriate changes in the control circuitry to compensate for this abnormal response in the subject.

It follows that through physiological parameter monitoring, biological feedback, and physiological parameter control, we can approach our ideal of controlling the psychological/physiological states of a subject in real time and that we can predict, repeat, and change at will these states in the majority of subjects. The power of such systems is fantastic. The contrast between Bio-Music and any type of conventional music is startling, exciting!

O N E

UNDERSTANDING THE DANGERS AND AVOIDING THEM

If we have a signal source of any type (electrical, mechanical, physical, etc.), and we amplify it, we can gain control by re-applying all or a part of it to the original signal source. If the signal we re-apply to the original signal source is inverted with respect to the input signal, we will decrease the amplitude of the input (negative feedback). If we feed back enough inverted signal to the input, the original signal will be almost completely attenuated. However, it can never be completely attenuated because we will eventually arrive at the point when the original signal will not have sufficient amplitude to produce an effective controlling feedback. Literally, the amplifier, in order to overcome this limitation, would have to be capable of infinite amplification.

If the feedback signal has the same polarity as the original, it will augment the original (positive feedback). If we feed back enough of the amplified non-inverted output, the amplifier will become saturated; that is, it will no longer be possible for

the amplifier to respond to additional increase in signal input.

Warning: Excessive biological feedback (either positive or negative) can be quite dangerous, and limits must be built into any biological feedback system. In completely electronic feedback networks, maximum negative feedback results in a circuit which is in effect doing nothing. In maximum positive feedback networks, the result is a circuitry which is destroyed by inputs which are much too large for it. *In the case of biological feedback, however, excessive negative feedback to vital body functions can cause permanent damage or death by halting that function. Excessive positive feedback can also cause permanent damage or death by driving the body function to a point where it destroys itself.* For example, negative feedback to the heart can cause it to stop. Positive feedback can cause palpitations and irregularities which themselves can be damaging and will result in inefficient heart action equivalent in effect to heart stoppage.

We can amplify biological potentials and feed them back to control the physiological parameter, which is the source of the potentials as described above. We can, in addition to this, amplify biologi-

cal potentials from one physiological source and use it to modify the biological signals from another physiological source. For example, we can amplify the electrocardiogram and use these signals to provide control of flash lamps in various positions, thus controlling eye movement. We can use biological potentials as control signals to generate audio and video signals which will be presented to the sensory system. Biological signals can be fed into voltage control inputs of any conventional electronic music equipment; but, more sophisticated systems utilize the biological potentials as control signals for pulse height, series-sound synthesis systems, thus providing control of individual pulse heights and individual pulse widths. By doing this, it is possible to generate sound structures of any specified harmonic content. Biological signals can also be used to drive conventional color organs. Again, more sophisticated systems require the possibility of parallel selection of color, form, verbal, graphic, and symbolic information to be displayed on a screen facing the subject. The information is presented both at the conscious level (i.e., intellectually) and subliminally, as the situation requires.

It is essential in any Bio-Music system to design

appropriate limits into each feedback loop. This is done by monitoring vital body functions and the reaction of bodily sensors; and if these physiological parameters rise or fall below specified levels, the feedback loop is clamped within limits until the parameter returns to specified levels.

Feedback loops vary in the amount of influence they exert. A weak feedback loop is easily broken; however, a feedback loop can be so powerful that the individual cannot extricate himself under any condition. The strength of any feedback loop varies from one individual to another, as well as from one time to another with respect to the same individual; and the influence varies dramatically with respect to the amount of time the individual is in the loop. Finally, the strength of the loop system depends upon the kind and the type of feedback loops which are being utilized in the system, as well as on accompanying physiological controls, such as electro-narcosis, etc.

If the only feedback loop in a Bio-Music system is the EEG alpha rhythm being converted into sound, we have a rather weak loop, because the individual can easily ignore the sounds being generated. But, if we have negative EKG direct feedback, the loop is strong, which the subject cannot ignore,

and in a very short time the loop will become so strong that he will be unable to free himself, even by physical means. The subject will lose consciousness and enter the terminal state.

"Latch Up" is a coined term which means that so much feedback has been applied to the input of the amplifier that it can no longer respond normally. This same situation occurs in bio-feedback systems and can be quite dangerous in extreme situations. Under conditions where the physiological parameter is not a vital function, and latch up is not dangerous, it is still a condition which prevents the system from operating dynamically, i.e., no further system reaction. Precautions that employ the fail-safe, limit controls described earlier will prevent latch up. When designing these limiting circuits, the limits are made narrow enough so that the latch up condition cannot be encountered.

T W O

VOLUNTARY CONTROL OF NORMALLY INVOLUNTARY PROCESSES AND VICE VERSA

There are two modes of biological feedback in terms of the relation of the feedback to the organism's normal volitional processes. The first of these, and the one for which there exists presently the most literature, is the use of sensory (usually visual and/or aural) feedback to control a physiological function that is normally involuntary. Considerable experimentation has been done with loops of this type. For example, it is easy to amplify the EKG and feed it to electronic circuitry so that an increase in heart rate above a given level will illuminate one lamp and a decrease in heart rate below a given level will illuminate another lamp. Subjects learn quickly to control their heart rate over a considerable range. We call this the *Voluntary-Involuntary* Feedback Control Mode (using a voluntary function — the senses — to gain control over a normally involuntary process).

Another example of the use of biological feedback to gain control over a normally involuntary process utilizes electrodes inserted into muscle

tissue. After being processed via simple electronic circuitry (which responds only to signals from a single muscle fiber), the signal is fed to a loud-speaker. The subject can learn quickly to play and to control the single muscle fiber, keeping it independent of his control over other fibers in proximity to the one under feedback control. All these loop-types depend upon the will of the subject to gain control of a physiological function that is normally beyond his conscious control.

The second feedback control mode, the *Involuntary-Voluntary* Mode, is the control of physiological parameters (through biological feedback) which are normally under the subject's volitional control. An example of this is a system of electro-narcosis in which the EEG rhythms are used to control the amount of current flowing between the electro-narcosis electrodes. Here, a state over which the subject usually has conscious control is being controlled by another physiological parameter, and in such a fashion that the bio-feedback control overrides the normal volitional control.

Another example of this feedback mode is the utilization of muscle potentials to control the illumination of lamps within the subject's field of vision. Involuntary muscle actions cause the lamps

to flash in such a manner that they control eye movement. The *Involuntary-Voluntary* Mode uses an involuntary function to control a voluntary function.

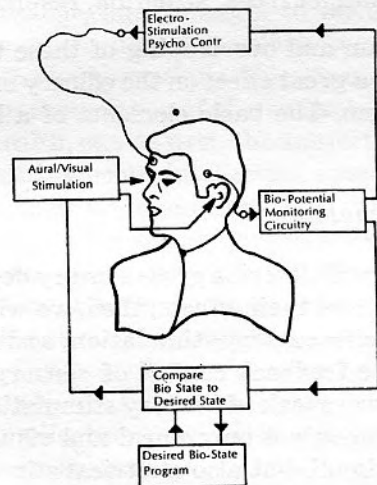
It is quite common in Bio-Music systems to stimulate the subject with a signal, monitor his response, and feed back this response to the Bio-Music equipment in order to adjust the feedback stimulus to more closely approximate the desired reaction.

It is evident that there is a type of biological control that could be called *Voluntary-Voluntary*. This is the type of feedback mode normally used by organisms to develop skills without the aid of non-biological gadgets. Also, there is a mode called the *Involuntary-Involuntary*. This Mode is exemplified in the normal, unconscious workings of the organism in the maintenance of appropriate relationships between various physiological parameters; for example, physical exercise produces a greater need for oxygen, which is taken in by respiration. By involuntary-involuntary feedback, the heart rate increases to distribute the increased amount of oxygen throughout the body. This enables the organism to exert increased effort, which, in turn, requires the feedback processes described.

THREE

THE BASIC ELEMENTS OF A BIO-MUSIC SYSTEM

Bio-Music systems use three principal processes:



- 1) Biological potential monitoring in order to ascertain the effects of stimuli and to ascertain physical states.
- 2) Stimulation of the senses so that external

stimuli can be converted into bio-potentials and carried to the central nervous system for processing.

- 3) Control of physiological parameters to maximize receptiveness to stimulation (consciousness, attention, respiration).

Interaction and overlapping of these three processes have a great effect on the efficacy of any Bio-Music system. The basic elements of a Bio-Music system are:

Sensory Stimulation

First, we will describe gross sensory deprivation, stimulation, and their effects; then, we will proceed to more specific sensory stimulation; and lastly, we will describe feedback control of sensory stimulation. When we speak of sensory stimulation in Bio-Music, we mean not only aural and visual (music and art) stimuli, but also electrical stimulation of muscles and emotional stimulation through photographs, spoken (and written) language, plus emotional sounds indicating states of ecstasy, tension, joy, pain, displeasure, etc.

Sensory Deprivation

An anechoic chamber is a specially-designed room that effectively cancels sound reflections. If an individual remains in such a room, and it is darkened, and he wears gloves, and he moves as little as possible, he will begin to have hallucinations after approximately seventy-two hours. The nature of the hallucinations depends upon the personality characteristics of the subject, his general physical health, etc. At first, the subject can occupy his mind with various intellectual exercises, memories, and conscious imaginings; but, as time passes without outside sensory stimulation for reference, the conscious mind (which is quite dependent on sensory stimulation) becomes increasingly disoriented. Finally, the subconscious, whose activity is usually suppressed by the conscious, becomes dominant. (Note: By subconscious "activity," we mean no implication that it is inactive when an individual is conscious.)

It is extremely interesting to note that virtually all techniques for achieving powerful, generalized psychic states involve the disorientation of the subject's usual resting relationships to the outside environment. This general statement is true of such

diverse states as yogic meditation, sexual ecstasy, hallucinations, and intense concentration on either an intellectual or craft problem. In a very real sense, the activity of life is the achievement of control over psychic states; and the development of any species is based on the ability to achieve new psychic states. Within any culture, certain psychic states are acceptable while others are taboo; and all people are not conversant with these states, even those that are accepted by the society. For example, the Navajo philosophy of psychic harmony with surrounding nature is unknown to the megapolis dweller. Intense concentration on intellectual matters is a commendable ability in present Western society, while the euphoric sensations of love and brotherhood are considered a waste of time by some and politically subversive by others.

Sensory Bombardment

This is the inverse of sensory deprivation. If completely randomized fluctuations of amplitudes, durations, colors, the position of lights and sounds (as well as tactile random stimulation of the palms of the hands) are applied simultaneously to a subject, the subordination of the conscious is accelerat-

ed and most individuals will begin to hallucinate within thirty minutes. Note that this process is much faster than sensory deprivation, at least with respect to the example given: seventy-two hours in an anechoic chamber. This is because the sensory system is bombarded with such a large quantity of random stimuli that the conscious mind cannot cope with it, i.e., the necessary orientation is almost impossible to maintain. The result is that the subconscious comes to the fore and hallucinations ensue.

We should digress for a moment in anticipation of some question or doubt that might arise concerning the last statements. The accomplished hypnotist is an excellent source for practical information about the behavior of the conscious and subconscious minds with respect to their interrelationship. First: The conscious and subconscious entities "seesaw"; that is, either one or the other is dominant, never both nor neither one. It is true that the subconscious may be at the fore while the conscious is "aware," but the subconscious is still dominant. Second: What does "hallucinate" mean? Definitions claim that it means "illusion," which means "delusion," which means "false." Other definitions are more thorough; but, a little more

comment about the functions of the conscious and subconscious may help here, too. (These comments are based upon the findings of practitioners who psychoanalyze while their subjects are under hypnosis.) The theory is that the two minds called the "objective" (conscious) and the "subjective" (subconscious) have different reasoning powers. The objective mind is capable of both inductive and deductive reasoning, while the subjective can only reason deductively. Inductive reasoning "uses" specific information to arrive at a generalization. For example, one says to another, "I have a contraction with a wheel at each corner, a motor in a place at one end, some things that connect the motor to the wheels, and some places for us to sit so that we can be conveyed from here to there. What is it?" "It's an automobile," is the reply. Sherlock himself could not have done better; but, the subconscious can only infer from generalities, and a wheel to the subconscious is what? my boss — square wheel (ha! ha!) — Ezekiel saw the wheel — etc. — is it unreal? — there is no end to the process. Any particular of the subconscious (one name for many things or many names for one thing) is fair game. But still, the subconscious reasons perfectly in the deductive mode; and, with the sub-

conscious to the fore, the idea of viewing one's own remains laid out in a coffin is not at all unreasonable.

The two purposes of hypnosis are: 1) as a therapeutic device, and 2) as an alternate to drug anaesthesia, both implemented by communicating directly with the subconscious through "mesmeric sleep." This cannot be accomplished while the intellect is to the fore. It is also true that in Bio-Music certain desired states cannot be achieved while the intellect is to the fore. It is, in fact, the control by feedback of both deductive and inductive thought that we are seeking for Bio-Music. In so doing, the result is real-time enhancement and coherent organization of that which the composer wishes to express. This should be contrasted with the traditional method of music composition where the composer hopes to communicate through the will of many others, which, at best, dilutes and blurs his meaning.

Sensory bombardment is an electronic technique for achieving hallucinations. However, from the explanation just given about the subconscious, it can be seen that the method used to achieve the desired state does not determine what will be experienced, only the method the subconscious uses

to reason. Sensory bombardment as a method is desirable because other means (LSD and other drugs, for example) require much more knowledge about their effects and even then there is still danger. Another sensible reason for its use is the fact that it is much more elegantly controllable than drugs. So, aside from prudence, the sophistication that we want lies in the electronic approach, not with drugs. The ORCUS AK-4 Sensory Bombardment System is a basic component of a Bio-Music system and through its use these ends are achieved.

Another comment on the difference in the occurrence of hallucinations (between deprivation and bombardment) is that a state of repose is a more natural human state than is total sensory stimulation. Something which may be called natural sensory deprivation has been available to man since the beginning of his awareness. "Close your eyes and be still in a quiet place" is virtually the first suggestion of all treatises on meditation. Primitive man could easily find a quiet, safe place in the forest at any time. These days it is easier to buy a sensory bombardment mechanism that will drown out definite stimuli with a barrage of randomized stimulation, and therein lies the seed of a rhapsodic and philosophic tome on man's pilgrim progress.

It is significant that in traditional music it is assumed that first there was silence and then music began. For those musicians and listeners for whom the music was holy, not only was there an absence of visual and extraneous audio distractions, but there was an absence of internally generated distractions. Any reader who has lived for relatively long periods in both urban and rustic surroundings (active and passive) understands immediately the difference between internal and external distractions within these surroundings. Historically, these distractions have increased to the point where sensory bombardment is a much more practical method than sensory deprivation for achieving "peace of mind." There is a simple significance to the development of electronic rock music instrumentation; it became possible for even the smallest band of musicians to overpower an audience of thousands. Either you listened to the music or you left.

Most present Bio-Music systems use sensory bombardment to cleanse the nervous system before and between presentations of definite visual and aural stimuli. This keeps the attention of the organism during the psycho-state experience; and, just as important, it defines the consciousness field

into which the defined stimuli are injected. This facilitates the evocation of more predictable, and thus more quickly and easily controlled, responses.

Both techniques, deprivation and bombardment, are very useful for cleansing the sensory system, sensory bombardment being more useful because of the time element. Both techniques are implemented without external feedback loops; note, however, that feedback loops within the organism are quite active under either sensory deprivation or bombardment. One of the most interesting uses of sensory bombardment, other than for the production of hallucinations for psychiatric, psychological, or experiential experimentation, is as a device for producing a randomized sensory stimulation field in order to fully engage the senses between Bio-Music presentations. If sensory bombardment is not used, the attention of the individual wanders out of the feedback loop between stimulus presentations. If sensory bombardment is presented before and after each Bio-Music stimulus, it serves to define the sensory environment, thus making it easier to predict response character.

Photic Stimulation

We will now discuss sensory stimulation, using definite stimuli (non-random), and their effects on individuals. We can use photic stimulation by high-amplitude, short-duration flashes of light at repetition rates of 1 to 30 per second. The light can be any color, but frequently blue, white, and red are used. The intensity of the flash may be as high as 56×10^4 foot lamberts (or 42×10^5 foot candles). (Note: Foot lamberts is a measurement of reflected light, foot candles is a measure of incident light.) The following information is offered as a guide to relationships between parameters of photic stimulation and covers techniques and equipment employed.

As the duration of each flash is increased, the maximum frequency of flashes which can be separated out by the eye decreases. At flash durations of 200 milliseconds, for example, flash frequency rates greater than 5 per second are perceived as continuous. At short duration flash rates of 40 microseconds, effects are obtained from flash frequency rates of up to 50-60 per second. However, the perception of distinct flashes depends not only on the duration of the flash, but on the intensity. As in-

tensity is increased, the delay of the retina of the eye in transmitting data to the brain decreases to about 5 milliseconds. (See: Cobb and Morton [1952], "The Human Retinogram in Response To High-Intensity Flashes," *E.E.G. Clin. Neurol.*, 4, 547.) Light flashes of high-intensity and short duration can be produced with a number of devices. Early experimentation was done with a rotating wheel containing slits which acted as a shutter in front of a high-intensity incandescent bulb. However, close control over flash frequency rate cannot be achieved with this method. Flash frequency rate and duration must be controlled electronically. This can be done with Xenon flash lamps, which can produce quite short, high-intensity flashes. These are frequently used by rock bands. Incandescent bulbs are virtually useless, except when used with the slotted wheel. First, the flash cannot be made short enough. Second, at turn-on, they draw approximately 10 times the normal operating current. One of the most useable light sources is fluorescent tubes which can produce short-duration, high-intensity flashes under electronic control. About 450 volts is required to flash the tube; and, to achieve short-duration flashes, it is necessary to dispense with starter capacitors. To

be most effective, photic stimulation should be presented over the entire field of vision. It is for this reason that the AK-4 Sensory Bombardment System uses a plexiglass hemisphere as the presentation screen for visual stimulation. The essentials demand that all stimuli come from the presentation screen, the screen itself providing completely random stimuli.

In 1934 E. D. Adrian and B. H. C. Matthews first demonstrated that responses to repeated flashes of high-intensity light could be detected in the brain (E. D. Adrian and B. H. C. Matthews [1934], "The Berger Rhythm; Potential Changes From The Occipital Lobes Of Man," *Brain* magazine, 57, 335). In 1946 it was discovered that photic stimulation could lead to epileptic type EEG activity and to seizures themselves (W. G. Walter, V. J. Dovey, and H. W. Shipton [1946], "Analysis Of The Electrical Response Of The Human Cortex To Photic Stimulation," *Nature*, 158, 540).

Normal responses to continuous flashes are best monitored at the occipital lobe. The electrical response occurs from about 70 to 90 milliseconds after the flash, depending on the intensity. The amplitude of the principal response is about 40 microvolts. At flash rates of approximately the same

frequency as the alpha rhythm, responses tend to be maximal and increase in amplitude. At flash rates above this amplitude, response begins to fall off. Note here that we are *not* using the alpha rhythm for feedback of flashes.

We will now describe more sophisticated forms of visual stimulation which use patterns, flashes of light, feedback control of stimulus presentation, subliminal visual presentation, etc. First, we must consider the effects of controlling the light-intensity, short-duration flashes with some bio-electrical potential. Experiments have been made that synchronized the flashes with the alpha rhythm. When this is done, the induction of epileptic seizures is much more frequent than when the two are asynchronous. The experimenter must be aware of this phenomenon. This is a potentially very dangerous application of bio-feedback.

It can readily be seen that there are many bio-potentials that can be used to control the flash intensity, duration, color, pattern generation, etc., of light sources. The various effects achieved by these bio-feedback controls are quite numerous. It is possible to control flash rate with heart rate data, eye movements, muscle contraction, etc., or combinations of these bio-electric signals. At the present

state of the art, it is advantageous to deal with maximal stimulations and responses, because these are the most easily detected and controlled. They are also the most potentially dangerous when they are not controlled. For this reason, it is essential that the experimenter/researcher in this field understands the potential hazards and how they are avoided. [Ed. Note: Again, it is recommended that one obtain more specific information than is contained in this book before attempting to experiment with Bio-Music techniques.]

Aural Stimulation

Rhythmic audio stimuli can have the same effect on electrical discharge of the brain as visual (photic) stimulation. Large, evoked potentials are obtainable by presenting high-intensity sounds to the organism when his attention is diverted, or when when he is drowsy. (See: Dennis Hill and Geoffrey Parr, *Electroencephalography* [1963], 2nd Edition, Macmillan Company, N. Y., pp. 244-5, for information on induced epileptic seizures through unexpected sounds and sudden shifts in attention.) Again, the reader is warned that deliberately induced epileptic seizures are dangerous and not to

be considered a state to be induced for Bio-Music purposes. These results are discussed here because they demonstrate the powerful effects which can be unleashed through sensory stimulation.

Just as structural patterns are more engaging in visual stimulation than high-amplitude non-structured flashes of light, sound parameters of frequency, timbre, and spatial organization are more important in eliciting responses than non-structured, high-intensity white noise. Consonance, dissonance, and particularly the switching of sounds from one spatial location to another generate measurable evoked responses. The development of electronic sound generation and control techniques has made it possible to generate and control sound with a precision without which Bio-Music would be impossible. We are not speaking here of electronic music synthesizers that utilize keyboards similar in function to electronic organs; rather, we are referring to electronic sound instrumentation having no mechanical/keyboard inputs. These instruments have direct inputs for control data, derived in real time from biological transducers. It was for these purposes that ORCUS developed the hybrid pulse height series generation system. For further information on electronics and sound gen-

eration techniques as they apply to electronic music, see *Electronic Music, A Handbook of Sound Synthesis and Control* by ORCUS (1969). One of the greatest advantages to accrue through the use of electronic circuitry is that it is possible to generate and control sound parameters with an elegance utterly impossible with archaic contraptions such as keyboards. The attempted control of electronic sound generation with keyboards immediately creates a bottleneck in the effective utilization of the system. The only justification for using keyboards in electronic music is to provide a mechanism for misplaced 19th Century music types.

Emotional Stimulation

Emotional stimulation is a term for non-abstract information which we present to the visual and aural systems. This stimulation may be in the form of visual displays of words, still photographs, slides (or films) of realistic and more-or-less emotionally charged material, and aural presentations of language and emotionally charged human sounds. This type of stimulation is treated here as separate from abstract stimulation forms because, from the standpoint of art production, it stands in a separate

position. Materials of this kind are closely connected with everyday existence; thus, they form a suggestive link between usual terrestrial existence and the more abstract elements of ethereal being. The stimuli and the responses to emotional stimulation tend to be powerful, easily predictable, and serviceable as a foundation context for more abstract stimulation. It is interesting to note that virtually all popular musical expression (in any age or place) is an emotional stimulant closely related to daily life: song lyrics, dance sounds relating to emotions, etc. It is immediately apparent that the use of this material quickly delineates the context, and thus, indirectly, the significance of more abstract visual and aural stimulation which is inset into this context. When the connection between basic emotional stimulation and more abstract sensory stimulation is maintained effectively through monitoring and feedback of altered stimulation, the induced psycho-physical states can be incredibly intense.

The knowledge of the techniques used in presenting emotional and abstract stimuli is known as the language of life. It is the stock and trade of "Everyman." Its effectiveness is not a measure of right or wrong. Consider verbal or written communication

for example. The tools are words extracted from the dictionary whose meaning is defined by a lexicographer. Without guile, this would be enough; but, enter the semanticist, possibly the only individual who would like to see his job eliminated. Adding emotional and visual stimulation, the total effectiveness is still not a measure of right or wrong; but the three together have awesome power. Therefore, Bio-Music, which uses all three, has awesome power, as does television. Because of the application of this potential, commercial media, which often appears at best to be a two-dimensional version of a peddler operating from the tailgate of a wagon, have nothing more lofty to show for their expertise than a following of vicarious existers who are in such a depleted state that their powers of evaluation, cooperation, and the initiative behind the creative process itself have been sublimated. The conscious does this to the more exalted aspects of the mind because of "brain washing." The desire of mankind, however suppressed, is still to communicate on an equal basis, no matter how the surface appearances may seem to contradict this tenet; and if he only communicates with his Creator, that is still a majority, exceeding the autocracy of any broadcast.

Evoked Responses from Sensory Stimulation

In the sensory bombardment techniques described earlier, we did not use feedback control to alter the stimuli in real time; but, in more sophisticated Bio-Music systems, we wish not merely to stimulate the individual with sensory data which will evoke general psychic states, we wish to present specific stimuli, monitor the effects of these stimuli in real time, and use this data to control the generation of subsequent stimulation. To control the nature of the stimuli in real time, it is, of course, necessary to be able to detect responses of the organism to the stimulation. In the ideal system, we would be able to monitor, simultaneously, every parameter of the organism's operation. However, this is quite expensive presently, if not totally impractical. Fortunately, however, it is usually unnecessary to monitor hundreds of points to acquire sufficient data for real-time feedback control. Monitoring the following parameters provides a great deal of information about the state of the individual: heart rate, respiration rate and depth, eye movement, psychogalvanic skin reflex, blood pressure, alpha rhythm (frequency and amplitude), muscle tension, EMG, space/time distribution of potentials at

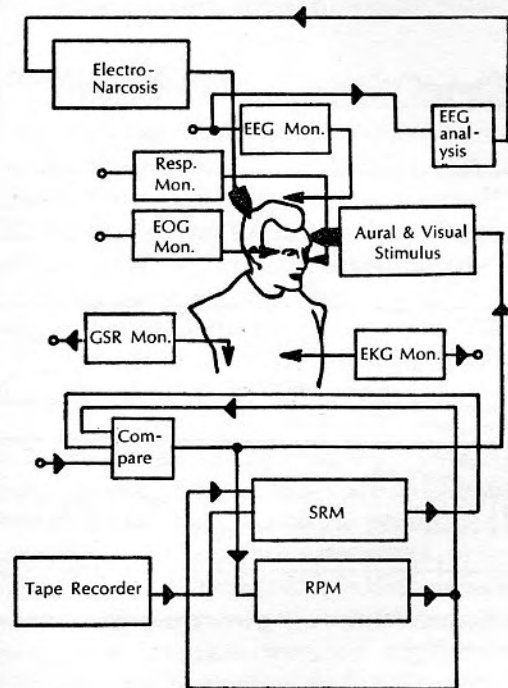
the surface of the skull, and finger pressure curves. More detailed information is available in the general literature and from ORCUS Research.

It is commonly thought that emotional states are vague and imprecise. Quite the contrary! The actual situation is not that the emotional states are imprecise, but that our usual methods of communication are clumsy and inadequate for conveying our feelings accurately. Bio-Music is a method for perfecting these channels of communication. The precision of emotional states can be seen when they are measured through the use of pressure transducers monitoring horizontal and vertical finger pressure. (See: Manfred Clynes and John H. Milsum, *Bio-Medical Engineering Systems* [1970], McGraw-Hill.) The use of standard polygraph equipment should provide sufficient evidence. This precision of response is not restricted to emotionally charged verbal material. Typically, during the performance of a musical composition, either electronically or acoustically generated, the listener finds himself passing through states of varying emotional tension and muscular activity. These states are highly repeatable even over long periods of time and can be monitored through the channels we are describing here.

If a stimulus of short duration (such as a word denoting an emotional state) is presented to an individual, his touch response applied to the horizontal/vertical transducers will produce an output form of quite distinguishable character. Typically, these responses to single emotional stimuli are about two seconds in duration. When a series of these stimuli are repeated, the responses are quite similar from time to time. This is in part a function of the filtering of response that takes place when the monitoring system is simplified to the point described here. If we feed this data into an electronic memory having adaptive capabilities, we can refer to this information and relate it to this particular individual's past response, time since last similar stimulus, etc. This gives us the capability of predicting quite accurately the effects of specific stimuli on this particular individual at a given time and how these reactions compare with normal expected responses.

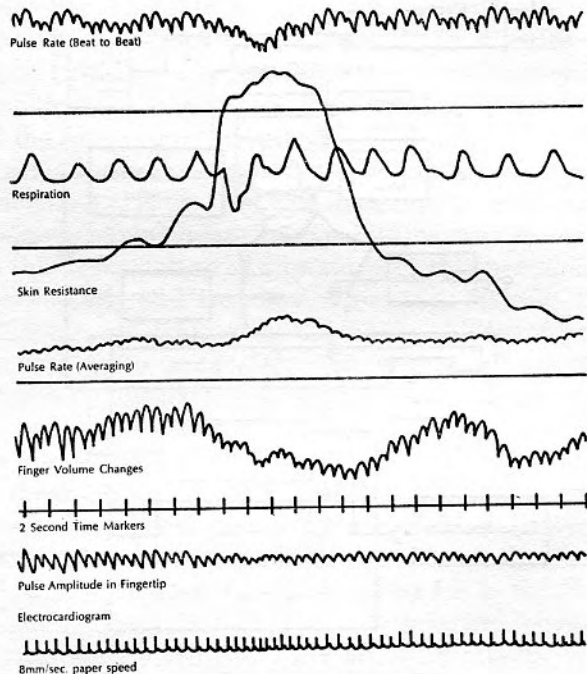
It can be seen from the preceding that it is relatively easy to have access to biological data that can serve as control information for stimulation, and which will achieve the effects called for in the Bio-Music composer's series of psychological/physiological states. We now have all the elements of a

Bio-Music experiential music system. A block diagram of such a system is:



FOUR

HYPOTHETICAL BIO-MUSIC SYSTEM



Notes on a Bio-Music System employing: Consciousness Control, Attention Monitoring, Eye Movement, EEG Sound Conversion, Subliminal Video Feedback, GSR, EKG, Response Monitoring, etc.

At the beginning of the physiological program, all the physiological monitors are compared with the desired state at: $T = 0$. Stimulus instructions are drawn from the Statistical Reaction Memory (SRM) and presented to the subject. (This is after the stimulus of electro-narcosis [electro-anesthesia], etc., indicates appropriate conditions exist.) The physiological monitors (EKG, GSR, EEG, and EM) are compared with the desired output and the program does one of the following:

- 1) It continues monitoring the EKG, GSR, EEG, and EM, if the outputs are at the correct levels and are changing in the prescribed program direction and at prescribed program rates. If the monitors indicate that any of the monitor outputs have gone outside prescribed limits, the program memory applies fresh stimulus in order to amplify the physiological parameter in question.

2) The program presents another stimulus or stimuli to speed up the physiological change if the original stimulus was ineffective.

As the physiological program progresses, the real-time program memory feeds updated information into the SRM to refine the physiological program. If the subject frequently breaks out of the feedback loop, and it is necessary for the control mechanism to pursue him, the programmer for the composition needs to do more homework on how to compose biological music; and/or, the system designer needs to do more work on his Biological Music System design.

The system shown above provides enough engagement of the organism to make it easy to write physiological programs that will keep the subject within the loop limits of the program. The latch-up limits are sufficient to make the system safe for virtually all conceivable physiological programs. The composer of Bio-Music must become familiar with the statistical limits (of average subjects) for speed of eye movement, dangerous levels of anesthesia, etc.

The Physiological Program is contained on a multiple track magnetic tape recorder (8-track mini-

mum) in order to accommodate the following aspects of the program:

- 1) Consciousness
- 2) Respiration
- 3) EKG
- 4) EEG (Alpha, Beta, Theta)
- 5) GSR
- 6) Eye Movement

F I V E

PHILOSOPHY OF MUSIC AND BIO-MUSIC

The modes and methods of communication are many. The most effective and efficient modes are those which are spontaneous. This is because communication takes place in time, and the time spent planning a given communication to maximize its effectiveness produces garbled messages. During the planning time, the transmitter of information cannot be sending information. Thus, the receiver is either without information, or it is receiving information from another source. Also, the transmitter of information cannot be receiving the information that the potential receiver is getting from other sources; it also follows that when the transmitter of information begins to send his preconceived message, the content of his message is without benefit of the information contained in messages exchanged during the planning. As a consequence, the transmitter cannot obtain the desired effect if any information relevant to his planned "contribution" was exchanged while he was occupied with planning. This time, which is consum-

ed by planning (interjected between desire or idea and expression), is a troublesome condition known to every mode of communication. The greater the time lag, the more confusion; and the problem is compounded as the number of transmitters and receivers in the exchange are increased.

This is only one of the causes of faulty communication; another is the relationship between the message handling capability of the communication equipment, such as radio and TV, and the speed of message generation. It is evident that, at present, it is possible to transmit messages faster than messages (with a message) can be composed. We are faced with the spectre of not only large amounts of banal communication, but with a quite dangerous situation wherein the transmitted information becomes less and less related to actual situations; this is because of pressures on those responsible for planning messages to increase their output quantity. The spontaneous content may be increased, but there is a tendency to make the message too restricted in its application (for example, local jokes aired on network TV).

Simultaneous bombardment, instantaneously, with messages written by one person or a small committee, is a broadcast characteristic of the mass

media communication facilities. Their messages are directed to millions of people and scarcely contribute to any rapport, particularly since the only feedback is via door-to-door poll takers whose results cannot be made available quickly enough to be of benefit. This, of course, assumes that the message for which the feedback was intended is still germane, or remembered.

All modes of communication involve some time lag. Historically, in man's development of communication modes that can transmit more complex messages, the importance of the time-lag factor has increased (the spoken word, printing, written music, etc.). Except for the "rag-chews" on the amateur radio bands, the communication media have done very little to facilitate directness, spontaneity, or any other element of multi-directional communication.

The ideal mode of communication is that which reduces or compresses the idea, the formulation, the transmission, and the feedback of this process into a time span that prevents detailed intellectual planning. Our ideal communication system would also enable each individual in the communication "loop" to transmit to and receive from others as an equal, and with equal ease. The best example we

have now, with respect to this kind of technology, is the telephone.

The philosophy of Bio-Music is to make real-time communication on a physiological level possible, to make possible multi-directional communication of these types of messages, to make communication take place on a continuous and spontaneous basis. "Classical music" for the 20th Century psyche is a very weak feedback loop. Many individuals cannot muster enough inner power to stay in the loop. This was not the case with 19th Century man. The 19th Century man had not yet been so decimated by the fragmentation of the spirit, a decimation that is the hallmark of the Industrial Revolution and, now, the Electronics Revolution. Anyone can now look at reviews of god-like (deified by the present) composers such as Beethoven, Wagner, etc., and read about premieres of their works; it is clear that the people who heard the works of these men had definite reactions to them. Nowadays, of course, no one has any definite reaction to these works other than that of nervous coughing and/or an intense desire to go to sleep. Rock/jazz is more powerful; this is not due to sophistication, but through the expression of verbal information that has an emotional impact on its devotees, and

through an extreme volume level that desperately tries to keep its listeners within its purview.

It is unfortunate that the various fields whose activities impinge on Bio-Music have had so little contact with each other in this century. However, there is sign of change, and there must be a change if man is to begin to assume responsibility for his ideas . . . to guide himself toward more humanistic goals. One of the most worrisome of the parts in this mosaic is the field of music itself. Anyone who has had any contact with the university music world realizes how archaic it is, and how unprepared it is to conduct useful research in biological and hallucinogenic music systems; and rock/jazz musicians are rarely in a position to indulge themselves in theoretical speculations, or to indulge in experimentation with new concepts of instrumentation. As a consequence, this research is still being conducted by independent organizations whose output must necessarily be tied to financial considerations, as well as being tied to the responsibility for the effects produced by its products on the market.

Drugs, Music, Society
Altered States of Consciousness

Life is a process of discovering new states of consciousness and learning to control them. The new-born child becomes more and more aware of the world around him. At first, he sleeps or wakes without any control. As he learns to control his consciousness, he becomes able to remain awake at will, and later, to go to sleep by relaxing. As the baby becomes a child, he learns to concentrate his attention (focus his consciousness) on various concrete and abstract aspects of his environment. He goes to school, which is a place where he learns more about altering his consciousness, to concentrate on various problems. Unfortunately, there are no schools that teach one how to relax concentration, or how to forget as opposed to how to remember. (This is one reason for the desperation of the people.) The entire emphasis, the entire pressure on the individual, is to focus his attention (heighten his consciousness) on specific verbal-symbolic problems and to remember them. Such intense training in only one aspect of consciousness surely can cause rebellion, sometimes violent rebellion.

The first effect of forced concentration is the de-

sire for release through what is called entertainment, or diversion. As the pressures become more intense, the diversions must become more powerful; thus, the individual first escapes forced concentration the most natural way, via sleep. As further pressures are added, sleep is not sufficiently effective and progressively stronger diversions become necessary: increased consumption of tobacco, tranquilizers, marijuana, alcohol, and other narcotics, etc., even, perhaps, suicide.

At early stages of development, biological organisms are not able to effectively control the two basic states of consciousness — waking and sleeping — and this has not changed much since the dim past. It is now evident that in present-day society there must be a very rapid development of powers of control if the individual is to cope with and survive this basic requirement (between relaxation and concentration), which is literally imperative for survival. It is not the survival of the onslaught of the elements, but the survival of man in a competitive environment brought about by the formation of artificial group elements (the choosing up of sides). This is surely brought about by the failure of the people to uncover their common goals, or at least to form a climate of rapport and compro-

mise — an easy thing had they communicated with an open heart. The condemnation and subsequent banishment of those who break the law, with respect to drugs and other illegal means for gaining relief from the clamor, appears to be the work of individuals who forget, or who never knew why the prohibitions came into being in the first place — the laws were not written to separate the just from the unjust, the righteous from the unrighteous, the clean from the unclean, but in recognition of the dangers to the user. Therefore, while the enactment of the laws illustrates compassion, ignorance of the original cause and need for such laws — the fact that man cannot withstand continual bombardment, but needs an occasional rest, like his horse or his machine — is not understood. The unkindest cut of all is perpetrated by those individuals who, through the grace of the Creator and because of the state of their evolution (?), and by being thoroughly entrenched sensuously in the realm of the physical, feel compelled to condemn the fallen ones as deviationists from all that is sacred. Those same individuals would be horrified to see the crowds turn on one of their own kind who had fallen while fleeing a fire and finish him off!

We insist that the heightening of consciousness

(forced concentration) to the exclusion of other states of consciousness is subordinating the creative process, the only source for man's liberation. Nor does this imply an opposite emphasis. Man is not wrapped in contemplation of his navel to the exclusion of all else. In order for an altered state of consciousness to be of value, it must, among other things, increase the survival chances of the organism. This cannot be done without an awareness of where the threats to survival lie. Altered states of consciousness, just as ideologies, outlast their usefulness. The emphasis on concentration on concrete and abstract problem solving for material purposes has outlasted its usefulness. It has become, at its present level, absolutely dangerous to the survival of mankind. The development of a similar regimen to produce a constant state of world-wide euphoria would be just as dangerous. Just as a child must learn to regulate sleep, the individuals in the world must learn to utilize new states of consciousness in patterns that are balanced: a mental/physical/creative man who can be prosperous, not just rich.

Music as a Series of Quantifiable Physiological States

In conventional music we speak in terms of frequencies, amplitudes, etc.; and when we speak of sound, we separate it from vision and tactile experience. Inducing physiological states in the listener rarely occurs to the musician; he does not think in these terms. He only knows that different music styles demand varying amounts of cooperation and training on the part of the listener. The player of 18th Century string quartets demands a large amount of aural cooperation and effort from the listener. The contemporary hard rock group is more willing to induce their states with minimal listener cooperation or effort. In Bio-Music, we are concerned with the physiological states induced by sensory and electrical stimuli. Our goal is to be able to say, "These two organisms (the player and the listener) have experienced the same sensory event." To do this, we must talk in terms of experiential events. A Bio-Music composition is a series of experiential events as defined by physiological parameters. The sensory events (visual, auditory, tactile), which are required to induce a defined experiential event, de-

pend on several factors:

- 1) The sensory-perceptual abilities (both physical and educational) of the individual listener.
- 2) The sequence of sensory events and experiential events preceding the sensory event in question.
- 3) The efficacy of the Bio-Music feedback loop system.

Equivalent sensory events are those sensory events which differ in physical structure from each other, but which produce the same experiential events in the subject. Sensory events which are duplications are not always equivalent to each other. Equivalency depends on the factors mentioned above. A sensory event has three major parameters: sound, vision, tactile — and the sub-parameters of the first two are: frequency, duration, etc., for sound; and color, hue, form, symbolic content, etc., for vision. If a listener is outside the feedback loop system, two sensory events may well appear to be the same physically; but to the person within the loop system, the two sensory events may produce

two quite different experiential events. To a listener outside the loop system, the sounds, the visual and tactile stimuli sequences, may well seem to be “unartistic.”

The concept of Bio-Music thinking in terms of experiential events is that of a social-communicative approach to music. We believe it axiomatic that the only reason for going to the trouble of putting sound into the air is to communicate a sound idea from one person to another; and, we also believe it highly desirable that when one person makes a sound that two or more listeners hear the same thing. The desirability of this is obvious until one discusses it with university music pundits. The concept of Bio-Music, and of experiential events, brings the artist-musician face to face with the reality of common experience. That is in itself frightening to many. Here we encounter such words as: human, freedom, imagination, creativity, etc. — and what do these words mean to us and to conventional music?

Bio-Music re-arranges completely the relationships between and our thinking about listeners, composers, music, composition, power of music, sound, etc. All these are changed in meaning (or become meaningless) in the concept of Bio-Music.

Philosophy of Bio-Music

Generally, investigators into biological systems have presented a steady-state stimulus to an organism and then monitored the output for change. Other parameters of the system were held constant or just ignored. Particularly in the case of biological systems which have many interacting channels and which are not amenable to direct control or separation by usual methods, the resulting responses tend to be unpredictable, if not completely mystifying. By using real-time bio-feedback of sensory stimuli, the bio-channel is "driven" by the stimulus to achieve the desired output. Rather than place our emphasis on defined stimuli causing variable effects, we seek to cause defined effects by using variable stimuli. It is more effective, for human development, to learn to manipulate stimuli that achieves definite results than to sort through masses of data seeking some correlation between well-defined stimuli and the wide range of responses evoked.

The reasons for the emphasis on environmental control (rather than interest in the response to the environment) are deeply rooted in the philosophy of science. Until recently, it was not possible to

approach man himself. He is more enigmatic, more complex, and more dangerous than the environment (and, thus, harder to control than the environment.) The environment was considered by science (at least in an earlier age) to be much more amenable to trickery and coercion than man. A realization is dawning:

- 1) That the physical environment of man strikes back quite viciously. The physical rearranging of the environment by man will provide him with no ultimate benefits (even evoking the term "ecology" along with other fad words and unwords).
- 2) That the greatest threat to man's existence exists within himself, because of his unwillingness and/or inability to communicate effectively at the fundamental biological level.

Society must realize that unless it provides itself with artistic medicinal defenses against the hard technology that it has created, that technology will possess him; and then, who will approach its creatures?

I live in an age where the age lives alone,
And lonesome rage
Where the bard may not go.

Bio-Music may be applied in many ways. In the case of TV, we have the situation where many viewers could be controlled to have the same responses to any given work of Bio-Music. This mode of transmission is the only one immediately practical with present network equipment. If it were possible for each listener to transmit responses back to the composer, he could interact with the program and modify its elements, either for himself alone, or as a factor in modifying the signals for everyone listening. However, at present the TV station is essentially a one-way (broadcast) source, except for feedback via letters, polls, etc., which are definitely inferior. Ideally, Bio-Music could be employed in whatever mode now used by conventional forms of communication, but with this extraordinary difference: the real-time feedback loop. In this situation we could have elicited responses rather than only the physical aspects of the stimuli itself, and this is where its great power lies. Bio-Music provides a means for communicating on an

equal basis, without ambiguity, and ensuring message integrity.

Bio-Music could be applied to the preventative and therapeutic treatment of mental/emotional disorders as well as for diagnosis of these conditions. It could be utilized in the treatment of physiological disorders caused by psychological stress. It could also be used by educators to provide sociology students with real-time feedback of psychological/physiological states: and, perhaps most important, Bio-Music provides the possibility for experiential exploration (without the side effects, after effects, and generally gross results of mind drugs).