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The environment, technology, and the music educator

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ABOUT THE AUTHOR:

John Howard is active as a composer, conductor and music educator. His music has been widely commissioned and performed, and his catalogue of over fifty works includes three for the Hong Kong Chinese Orchestra and one for the Taiwan-based p'ip'a virtuoso, Wong Ching-Ping. Music education publications include several articles for Music File (Mary Glasgow Publications) and two books for Cambridge University Press, Learning to Compose (1990) and Performing and Responding (due 1994). He is Associate Professor and Head of Music at the National Institute of Education, Nanyang Technological University, Singapore.

THE TEXT:

INTRODUCTION:

The artist and architect Le Corbusier founded a magazine in 1920 called L'Esprit Nouveau, which united architecture, painting, music, science and poetry and was intended to make the point that

"the arts must be seen together, they cannot be separated without some loss of appreciation of each."¹

The psychologist Arthur Koestler makes a related point when he writes, on the subject of creativity:

The fluidity of the boundaries between Science and Art is evident, whether we consider Architecture, Cooking, Psychotherapy, or the writing of History. The mathematician talks of 'elegant' solutions, the surgeon of a 'beautiful' operation, the literary critic of 'two-dimensional' characters. Science is said to aim at Truth, Art at Beauty; but the criteria of Truth (such as verifiability and refutability) are not as clean and hard as we tend to believe, and the criteria of Beauty are, of course, even less so.²

The view of a prominent music educator of our day, Keith Swanwick, both contrasts with and complements these views. It is said that Swanwick

"is not engaged intellectually by the notion of inter-disciplinarity within the arts, feeling that he can see just as much connection between say, music and engineering".³

So much for the extent of music's potential interdisciplinary connections. But what of its relationship with the wider environment? It is easy to see music as either being very closely connected with the natural environment, or as a completely
artificial art, constructed by human beings. The first attitude would be deduced from the physics of sound, for instance, in which the harmonic series is seen as an ever-present natural element. The second would, for instance, acknowledge that instruments have always used artificial tuning systems, which amend nature to suit the practical and expressive demands of humanity. As Joscelyn Godwin has pointed out,

since we hear some part of (the) harmonic series in every musical tone... many musical theorists have sought in it the main explanation of musical systems, both ancient and modern. 4

Would that things were that simple. If we delve a little more deeply, we discover that Western music has been very selective in its use of certain aspects of the harmonic series and totally ignored others.

In this paper, it is proposed that neither attitude contains the complete picture. Music is neither completely natural, nor absolutely artificial, and we would do well to recognise this in our music education work. In addition, music education must not, cannot, exist in a sealed vacuum: it must demonstrate its relevance to the human condition and to everyday life. It must operate within a broadly-based learning environment, not just safely cocooned within its cosy, subject-based, classroom environment.

Furthermore, in exploiting music's potential in relation to other subject areas within education, we tend to be ignorant of some of the deeper, underlying relationships, so that connections in education between music and other subjects, whilst frequently interesting, have tended to be without real rationale and of a superficial nature. The true source of this problem is often the musician's own ignorance of the underlying nature of his subject, a difficulty that is perpetuated through education (so that, for instance, young musicians often think "theory" means questions about notational practice, as in the ABRSM Theory syllabuses.)

Let us briefly consider some of the problems of the piano tuner. If we use the series of fifths to reach the note E from a starting point of C (i.e. C-G-D-A-E), we discover a pitch which is not the same note as the E arrived at by means of the harmonic series. The former E is equivalent to the eighty-first harmonic, the latter to the fifth harmonic. In order to make a comparison, raise the latter E by four octaves to find it recurring as the eightieth harmonic. The discrepancy is 80:81, known as the syntonic comma. The E derived from the fifths is therefore sharp and completely unusable in harmony. Tuners aim at equal temperament, although some will experiment with other, historical, tunings, and all of them attempt to solve problems expressed, in simple terms, by the difference between the two Es. This "problem" is an effective metaphor for the natural versus artificial situation. So far as music and music education are concerned, this tension can turn out to be a source of creativity, rather than an insurmountable difficulty.

Let us look now at some of these above-mentioned deeper connections between music and other subject areas and assess some of their potential in developing a curriculum which crosses-over between the arts and other subjects.
MUSIC AND NUMBERS:

Joselyn Godwin's article Speculative Music: the numbers behind the notes, starts with the child's question:

Why aren't there black notes between all the white notes on the piano?

This question leads on to the further question as to why, in the alphabetical sequence of notes, is there only a semitone between E and F, and B and C. Godwin adopts a Euclidean approach, as follows:

We can construct a simple scale with a span of an octave from C to C\(^1\) by making G, a fifth above C, D, a fourth below G, A, a fifth above D, and E, a fourth below A. The octave is now filled with the scale:

C D E G A C\(^1\)

(A pentatonic scale, as used in many cultures.)

If we continue the process, progressing by fifths to a sixth term, B and a seventh, F\(\#\), we get:

C D E F\(\#\) G A B C\(^1\)

Although this goes some way to answering the question, it still does not explain the set-up of the keyboard. If we start on F rather than C, we get:

F G A B C D E F\(^1\)

As Godwyn points out,

This is satisfactory, in that it gets rid of the F\(\#\) and gives seven natural or 'white' notes; but it does not answer the reasonable objection that most of our music is based on the scale of intervals from C to C\(^1\), not on that from F to F\(^1\). Here it is necessary to explain that the seven-note scale formed by a sequence of fifths is not a fixed scale with a keynote, but a field characterised by a regularly recurring pattern of intervals:

...F G A B C D E F G A B C D E...

T T T S T T S T T S T T

(T=whole-tone, S=semitone)

This field evidently extends to infinity in both directions, constantly repeating its pattern. Pianos, organs, xylophones, etc., simply present longer or shorter sections of it, adapted to practical use by the human hand or foot.

Finally, Godwin distinguishes between closed fields, as represented by the diatonic and pentatonic scales, closed in the sense that they repeat the same note-names over and over again; and open fields, like the sequence of fifths, in which each new term has to be given a new name. We have here two musical systems, one with
boundaries, limited only by the choice of a number (in these cases five or seven),
the other an infinite system with no boundaries.
I have dwelt upon Godwin's work at some length because it is full of clear
explanation and is a rare sort of approach to music, based on speculation and logic,
rather than the automatic assumption of unspoken concepts. Perhaps the most
important point for us here is that numbers become interchangeable with notes, and
in fact show us much more than just the note-names. Without exploring the details
here, we can establish that Godwin ends up with five limited fields or patterns, each
corresponding to the use of a particular number:

the pentatonic   =5
the diatonic     =7
the chromatic    =12
the enharmonic   =19
the "holistic"   =31  (includes seven natural notes, seven
                      sharps, five double sharps, seven flats,
                      five double flats=31; each note available
                      in any octave)

The wider implications of some of these relationships will become clearer later.
However, an interesting tangential approach to these matters is found in the work of
RJ Stewart⁸, in which he relates pitch to both number and to the Four Elements of
western mystical and astrological thought, in a spiral of octaves:
The Four Elements: Earth, Air, Water, Fire

The Spiral of Octaves

Figure 2
Through this kind of inter-relationship, musical theory can be seen as the key to many things: for instance,

forms of government
historical epochs
the proportions of architecture
the behaviour of subatomic particles etc.

This connects beautifully with Chinese philosophical thinking and its use of five agents (or elements) which I have exploited in both a composition for Chinese orchestra\(^9\) and in a composing project for secondary schools. The following illustration from the periodical Music File\(^10\) gives some idea of this work:
Composer in the classroom 2

This unit consists of one big project. You will compose a piece called Metal, using three ways of making patterns in music.

Detailed instructions for composing your piece are set out on the next three pages, but we shall begin on this page by considering two existing compositions.

First, a piece which is also called ‘Metal’. In 1984 I was asked to compose a piece for the Hong Kong Chinese Orchestra, an ensemble made up largely of Chinese instruments. I wrote a piece with five sections, which I called Five Studies for Chinese Orchestra, and then later made a version for dance of the same music, renaming the piece Hong Kong Perspectives. ‘Metal’ is one of the sections. The dance version was made on a synthesiser, using a computer-based sequencer to store and edit the music.

The inspiration for the piece was the Chinese belief that everything in the world is made out of a combination of five elements:

Earth • Metal • Wood • Fire • Water

Each of these elements has, according to Chinese belief, a corresponding colour, point of the compass, human feeling, and even a musical note:

Earth yellow centre desire
C (1st note of the pentatonic scale)

Metal white west sadness
D (2nd note of the pentatonic scale)

Wood green east anger
E (3rd note of the pentatonic scale)

Fire red south joy
G (4th note of the pentatonic scale)

Water black north fear
A (5th note of the pentatonic scale)

If you put all the notes together, you get the following five-note (pentatonic) scale:

1 2 3 4 5

Earth Metal Wood Fire Water

Now listen to the movement ‘Metal’ from Hong Kong Perspectives (cassette track 1). It uses the following scale, which starts on D, the note for Metal:

When you come to compose your piece, bear in mind the title Metal, and try to make the general character of the music fit by using some or all of the following ideas:

1 Making use of metal instruments, or some made of metal and some not.
2 Making the beginnings of some of the sounds hard and loud.
3 Using the effect of a sound gradually dying away, as when you hit a cymbal or triangle.

Make sure that some of the instruments you use are ones with exactly-pitched notes: you will need them especially for the third section.

Next, listen to an extract from In C by Terry Riley (cassette track 2). This piece uses a set of 53 patterns, each constructed out of the following scale:

In performing this music, there can be as many or as few players as desired, and each player plays each pattern as many times as he or she likes, moving on to the next pattern when ready.

Try performing the following patterns from Riley’s In C:

Everyone starts with pattern No. 1, but each player can choose how many times to repeat it and therefore when to move onto the next pattern.

Before you begin composing, try another improvisation. Use the scale from ‘Metal’ (the one beginning on D), and create a free improvisation, with each player making tunes out of the scale.

Now you can begin composing your piece entitled ‘Metal’. Use the same scale beginning on D – the one I used in my own ‘Metal’, and the one you have been improvising on – as the source of all the notes in your composition.

As you compose each section, record a performance of it so that a picture of the piece is built up to help you. Listen to what you have done so far before moving on to the next section.
MUSIC AND OUTER SPACE/ASTROLOGY & ASTRONOMY:

Godwin also relates music to the principle of cellular growth, in which a one-celled organism grows exponentially by splitting into two. (We will explore later the way in which this principle of exponential growth is related to the Fibonacci number sequence and the Golden Section.) Likewise, the growth number of the octave is also two, (we double the frequency to raise pitch by an octave) and that of a fifth is three. The cycle of fifths is therefore a cycle of powers of three, resulting as it does from a ratio of 3:2. This principle holds good at micro- and macro-levels. As Godwin says,

Two galactic strings, tuned in the ratio of 3:2, would 'sound' a perfect fifth. So would two subatomic particles vibrating in the same ratio.11

The whole universe can be seen as being in a state of vibration. The so-called doctrine of correspondences attempted, before the scientific theory existed to do it justice, to articulate the concept of this continuum of vibration. Music was represented in this doctrine as the 'Harmony of the Spheres', in which the placing and movements of the planets were determined by demonstrating musically significant proportions between them. The astronomer Kepler, a contemporary of Shakespeare, tried to compute the sounds given off by each of the planets according to their rate of velocity and their mass. Here are his musical notations12:
Everyone was anxious to hear these sounds, so we played them on the piano.

Barbara: Is that all that Kepler heard? It's very disappointing.

Schafer: I don't think he actually heard it. He merely computed it mathematically and conjectured that if you could hear the planets they might sound like that.

Barbara: But didn't anyone hear them? Why can't you hear . . .

Jeff: Because there is no air in outer space and sound waves need air in which to travel.

Schafer: What would music sound like on the moon?

It wouldn't.
Our sensations of light and sound depend on this state of vibration. Looked at in this way, our ten-octave range of perception of sound becomes

...something of cosmic significance for us, for in those ten octaves, more-or-less, lies our richest range of sense-perception. The eye is far less well-endowed, for the slowest red vibrations are less than half the frequency of the fastest violet ones. Hence the eye lacks the experience of the octave...There are no harmonies in colour except in an allegorical sense....Hence the kind of painting based exclusively on colour is extremely limited...Music, on the other hand, has plenty to say in its abstract mode, exemplified by wordless or pure instrumental music, since it has no difficulty in creating its own spatio-temporal reality.\textsuperscript{13}

In his interesting article on Peter Maxwell Davies' aptly-named piece, Ave Maris Stella, Stephen Pruslin quotes a listener as saying that, on his first hearing of the work he had been thrown

into a kind of '2001' outer space, while at the second hearing he realised he was listening to an absolutely classical piece of chamber music.\textsuperscript{14}

This sheds interesting light on music's ability to create its own flexible reality in space and time.

In this connection, it may appear strange to remind ourselves that the order of the days of the week, themselves derived from the names of the planets, can itself be seen as determined by musical principles based upon the series of fifths referred to earlier.

Another dimension of this musico-planetary relationship is shown by the picture of the so-called planetary lyre\textsuperscript{15}, in which the sun represents the central harmonic, with the other planets relating to it through a pattern of fundamental notes and harmonics:
The Lunar Solar and Stellar Modes

In meditational or magical music, particularly Elemental Chants, energies are aroused, uttered as musical shapes, and then rotated through various cycles of combination. There is no rigid or fixed rule for such combinations, but all derive from the basic concept of modulation or 'ringing changes'. Similar rotations are found in prayer cycles, mantrams, sacred dance: they all reflect the reiterations and rototations of the Wheel of Life (see Figures 1 and 2), and such spirals and cycles are found through nature in many manifestations.

The examples given here demonstrate a basic reiteration or modal cycle based upon a simple scale of CDEFGABC, which is the basis of all the musical modes in this book. Any other starting mode or set of notes could be used: it is the patterns of reiteration or mirrored changes that are important, and not the actual tones uttered, as these will vary from time to time, place to place, person to person. For practical working, however, it is recommended that one basic set of notes is used throughout, such as the one shown here. Idle experiment and changing of tones usually dissipates energy, and deprives us of the empowering levels of energy that are found by steady repetition and attuning exercises.
MUSIC AND COLOUR:

The relationship between music and colour is often referred to, with colour frequently being used as a metaphor for timbre in music. We speak of 'orchestral colour', for instance. Two twentieth century composers have attempted to exploit the relationship: Arthur Bliss, in his Colour Symphony, and Scriabin in his design for a colour keyboard which would project colours at the same time as music. In a less trivial sense, the following two charts demonstrate a relationship between colour and pitch and demonstrate one possible structure for the whole spectrum of vibrations:
Figure 3

The Planetary Lyre

One of the earliest and most enduring models for the relationship between music, consciousness, and the universal creation, was that of the lyre. This is often taken to be a mythic concept, or an 'allegory', but the use of the lyre was based upon precise attributes and harmonic patterns that are physical rather than allegorical.

Simple lyres are instruments with open (unstopped and unfretted) strings. Although the number of strings varied historically, a seven-stringed lyre was frequently associated with the relationship of the Sun and Planets, as in our illustration. The musical notes allocated in our example are based upon a simple modern scale of C major, but any relative mode or set of notes could be employed, and the relationships would still remain true.

The lyre (and similar instruments in ethnic music to the present day) is not limited to merely plucking of the open strings. Skilled players induce harmonics or overtones by lightly placing the tips of the fingers against a nodal-point on a string or strings, while plucking with the other hand. This technique brings out a very wide range of overtones and complex melodies and harmonies are possible using only seven open strings (or whatever small basic number is built into the instrument).

The diagram shows how a central harmonic, in this case the note F, represents the sun, with the Planets relating to this central utterance through a pattern of fundamental notes and harmonics.
If we accept that the significant numbers of music are 5, 7, 12, 19 and 31, then it becomes relevant to note that the eclipse cycle is a 19 year one, and, of course, that most months have a length of 31 days.

A further extension of this method of relating music to outer space, and to number, is contained in the following chart of lunar and stellar modes\(^{16}\), corresponding to the second and third levels of the spiral shown above:
### Notice

This chart was carefully compiled by the Educational and Research Departments of AMORC College after consulting the most eminent scientific authorities on the subjects of physics and chemistry and comparing their observations and data with those from the Rosicrucian laboratories in foreign countries.

There is a slight disagreement in regard to the rates of vibrations for the various keys of the musical keyboard, due to different standards of pitch in various countries, and these are in some disagreement among scientific authorities in regard to the scale associated with various musical notes. This chart represents not only the consensus of these authorities but also adheres strictly in what the Rosicrucians have been able to demonstrate as truth in their own laboratories and in the experiments of thousands of members in various parts of the world. Regardless, therefore, of any disagreement with authorities outside the organization, this chart is the authentic presentation of the Rosicrucian knowledge.

This chart is to be used by members of the Rosicrucian Order in connection with their studies and experiments and is not to be used for any other purpose or in any other way. Like the lessons themselves, this chart and the facts contained in it are reserved and restricted in use under the rules and regulations of the organization.

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### International Seal of the Supreme Lodge of the Rosicrucian Order

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### The Solar Spectrum

- **Infrared**
- **Deep Red**
- **Orange**
- **Yellow**
- **Green**
- **Blue**
- **Violet**
- **Ultraviolet**

---

### Chart Details

- **Octave**
- **Manifestation**
- **Vibrations per second**
- **Gaps**

---

### Chart Notes

- The phenomena of psychic perception and sound occur beyond the octave considerably beyond that of any known material manifestations. Consequently, they must not be considered as immediately following any manifestations of which we have shown in this chart.
The Musical Keyboard

With Rate of Cosmic Vibrations and Relation to Colors, Chemicals, and Vowel Sounds

<table>
<thead>
<tr>
<th>Key</th>
<th>5th Octave</th>
<th>4th Octave</th>
<th>3rd Octave</th>
<th>2nd Octave</th>
<th>1st Octave</th>
<th>3rd Octave</th>
<th>4th Octave</th>
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<td>Key</td>
<td>1</td>
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<td>6</td>
<td>7</td>
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BASS

Middle C

TREBLE
Much of this is subjective and therefore open to question. As Stewart has pointed out,

The relationship between colours, psychic energies, health, and musical tones...became confused by pseudo-scientific applications and theories, mainly those published by the Theosophical Society and taken up by almost every spiritualist and magical or meditational group from the nineteenth century onwards.....In the twentieth century there has been some significant research into the psychology of colour, and into the relationships between vibratory rates of colour and (octave-related) vibratory rates of music.18

MUSIC AND SOUND (INNER SPACE):

This sub-heading may seem a strange tautology: surely, music is sound. We may think of it that way, but if we think about the broader sonic environment, as the Canadian music educator Murray Schafer calls it, then we see music as a special category of sound. Ever since my days as a fulltime secondary school teacher, I have wondered who takes the responsibility to educate young people in relation to the use or abuse of sound in their environment. Perhaps science teachers would have a role here, but nevertheless, the music teacher has a strong part to play. Sound is our material, and respect for it and an understanding of its power is centrally important to us.

It is interesting also to trace a line of development through sound into the use of the human voice. The forming of shapes in the mouth to modulate the sound produced by the air column ascending from the lungs is a fundamental, even elemental, sound resource. It possesses that very quality of muscually-produced energy (and the control of it) that Schafer finds absent in his concept of schizophonia (see below). The following illustration19 shows how vowel sounds connect with the Four Elements (as above) and with corresponding pitches:
Is Chants and Elements

The vowel sounds E-I-O-A declare and relate to the Four Elements and most complex or active vowel sound is Eee and the least active vowel sound is Aaa. The rising and falling associated with levels of pitch connected to the Elements. Magical utterance or power-tones, these do not require a modern series of musical notes, providing AIR or Eee is and EARTH or Aaa is the lowest.

Magical utterances, the vowel sounds were elided and a sliding or chromatic sequence of pitch, with no clearly stated mode or steps between. Primal chanting of vowels and lowering of pitch connected to Elemental energies is a very ancient practice.

Vowels in connection with the Four Elements is at the heart of consciousness: in many mystical or magical systems are regarded as particularly sacred, for they give the spirit. Words cannot be uttered without vowels, just as the letters of the universe cannot exist without the empowering spiritual Being uttering them.

Elemental Square as Numbers

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<tbody>
<tr>
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<td>WATER</td>
<td>FIRE</td>
<td>EARTH</td>
<td>AIR</td>
</tr>
<tr>
<td>C^1</td>
<td>F^4</td>
<td>D^2</td>
<td>E^3</td>
<td>C^1</td>
</tr>
<tr>
<td>E^3</td>
<td>D^2</td>
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<td>D^2</td>
<td>F^4</td>
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EARTH Eee
FIRE Iii
WATER Ooo
AIR Eee
EARTH Aaa
The composers Stockhausen and Berio have both addressed in their music the basic connections between the workings of the voice and language, and ultimately music. Stockhausen, in the vocal work Stimmung, exploits the ability of the voice to produce harmonics and to alter their relative strength by changing the mouth shape. If the full vowel-spectrum is used, then we hear (once we are attuned to it) an ascent and a descent of the harmonic series. In my book Learning to Compose\textsuperscript{20} and in an article for the periodical Music File\textsuperscript{21}, I have presented material which stimulates students' use of these techniques in their own composing, as the following shows:
VOICE HARMONICS

In Tibet, the Buddhist monks have developed unique ways of using their voices. Instead of concentrating just on a main note (the fundamental) produced by the voice, they have learnt to control the strength of the harmonics as well. At times, it seems that they are chanting several notes at once. It is difficult to explain how this is done, although it is to do with the main note being a very low one, around low C or B, and having a strong upper harmonic.

ASSIGNMENT 53

You can explore the harmonics of your own voice-sound by doing the following:

1. Choose an easily sung note.
2. On that note, pronounce EEOOEE, singing loudly.
3. Move very slowly and deliberately through the individual sounds of the word, changing the shape of your mouth as slowly as possible.
4. Listen very carefully. Part of this trick is learning to hear the harmonics: they are there all the time, but we don’t normally notice them.

If you can use a microphone to help amplify and even record your voice, all the better.

After one or two tries, you will begin to hear the harmonic series changing above the note you are singing. If you do a very slow EE-OO, only gradually opening your mouth, you will hear the descending harmonic series; as you do OO-EE you will hear the ascending series.

An explanation of what is happening is that your mouth is actually moving through the complete series of vowel sounds, and each one of those sounds emphasises a different harmonic in the series.

Stockhausen’s piece, Stimmung, the title of which literally means ‘tuning’, is based on the principle of the vocal control of harmonics. It is built from one chord:

```
\begin{verbatim}
\bigstrut
\end{verbatim}
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with the six singers individually controlling the harmonics sounded above notes of the chord. On the tape you can hear the chord upon which Stimmung is based.
Berio, in his piece entitled O King, makes structural use of the phonetics of the phrase O Martin Luther King, and particularly the vowel sounds. In a project based on Berio's piece for my forthcoming book Performing and Responding, I have included a piece for children which exploits this use of the vowel spectrum (and is itself a response to Berio's piece:}

All this predicates a real relationship between music and language, not just the setting of words, but a more fundamental connection. Murray Schafer's book, *When Words Sing*²³, is an excellent and stimulating exploration of this wider role for the voice and its relationship to sound and language. In Learning to Compose²⁴, I have included material which focuses on this relationship:
Form a group of any number of musicians.

**A** Improvise versions of each of the following types of beginning:

- sudden
- gradually getting going
- start with an accompaniment pattern - add a tune (or tunes) on top
- an introduction, ending with a short hint of the main section

**A** Improvise versions of each of the following types of ending. Obviously, you will have to imagine what goes before in the music - you can then make up the music which comes just before the ending.

- stop abruptly
- the music collapses
- gradually wind down, and slow down
- one instrument settles on a long note, signalling the end
- a fade-out ending
- a special closing section, called a coda

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**USING LANGUAGE TO HELP STRUCTURE MUSIC**

Language can be a splendid source of ideas about the structuring of music. In exploring tunes, we came across the idea of phrases forming sequences of questioning and answering. This in itself is an effective approach to structuring music. We can have:

- musical conversations
- an incomplete musical idea in one instrument/voice completed by another

Words in themselves can be material for a composer. They contain a wealth of implied sounds and can also generate structure, in the sense that one word can contain the structural design for a complete work. As an example, take the word

**REVENGE**

This is a word with two syllables. Of the two, the second one is accented, with the first one leading up to it. We might therefore use this word as a metaphor for a piece in two main sections, in the same relationship to each other as the syllables in the word - that is, section 2 is more important than section 1. (You might like to think about the musical devices which would help to make the relationship clear. For instance, section 1 begins quietly, with a gradual crescendo to the beginning of section 2, which is loud.) With the word 'revenge', we should also think about the end of the word, the 'ge' part of it. What sort of ending would this imply for a piece of music? Perhaps a very abrupt cut-off, rather than a fade-out.
This connection can have a whole variety of implications for curriculum planning, from the use of music to assist the learning of reading skills and language skills through to truly integrated work in music and drama.

**MUSIC AND TECHNOLOGY:**

The impact, ever-changing, of technology in this respect is vitally important. Schafer refers to the radical effect of what he terms 'schizophonia': the splitting of a sound from its source, for instance, the playing of a recording which is split off from the original sounds of the recording session, and the consequent lack of physical connection between amount of sound (amplitude) and muscular effort. To put it simply, it takes no more effort to turn up the hi-fi (low-fi!) volume control as it does to turn it down: there is no direct correlation between energy input and output. Compare this with the singer or the violinist, who must control energy in a very skillful manner.

For music education, this has obvious implications. It would be dangerous if students never experienced live performance; it would also be dangerous if they only played electronic keyboards, where there is very little relationship between sound quality and amplitude and muscular input (despite touch-sensitivity). It is almost equally unsatisfactory if a student only makes music on the piano.

Have we adequately considered the dangers for everyone of increasing levels of noise in the environment and of young people who listen through earphones all the time? If we are not careful, these young people will lose some of their seven to ten octave hearing range, and will also achieve a form of autism in which they are isolated from the world.

Some musicians are becoming deeply critical of some of the ways in which music and technology interface today. For instance, the US composer Lou Harrison:

> Although it has been found that in some species the grassy sound-receptors of the inner ear will grow back after injury or destruction by too-great loudness, it is not yet known whether this is true in humans. Anyway, the musical falsification of the electronic 'enhancement' is not only almost inescapable in USA public halls, but is indeed preferred now, at least by city people. One supposes that urban ears are so used to industrial abuse that concerts for them must be 'turned up' to be heard.

Like any musical instrument, the electronic ones must be seen as neutral, a resource which is neither intrinsically bad nor good, but there for creative and re-creative exploration. What are the benefits of this electronic technology in and for music education?

a) It can enable students to notate using computers and now gives enhanced quality and ease of printed output along with the ability to publish from the desktop.
b) Students can work in both real- and step-time and therefore not be handicapped by a lack of performing skill.
c) The technology can now process a great deal of information very fast
d) Students can create new sounds via new techniques of synthesis
e) Sampling and recording enable students to make use (potentially) of any environmental sound.
f) Technology becomes cheaper in relation to the power it can offer.
g) Technology allows greater and easier storage and therefore choice of materials.
h) Technology can now enable interaction between the user and various media and amongst those media: for instance, the use of digitised sound and picture, and the production of CD-ROM-based packages on pieces of music.27

Nevertheless, there are many dangers as well. Perhaps the most damaging of them are the pre-programming of synthesisers with lots of poor quality pre-set sounds and patterns (by the manufacturers), which purport to imitate acoustic instruments, and the bias which is in-built to most synthesisers in favour of one narrowly-based style of music, loosely and artificially derived from pop. Arguably, a curriculum full of inter-connections will be able to teach students about the design and electronics of these devices, rather than just having them using them in their music lessons in an uncritical manner. We have already noted that Murray Schafer is an enlightened music-environmentalist. He uses his musical abilities to formulate a critique of the sonic environment. The American composer Harry Partch28 did the same in relation to instrument technology: we might call him an enlightened music technologist. Working in the earlier years of this century, before electronic resources were available, he did not blindly accept that existing instrumental designs were a given; he did not adjust his music to fit them. He designed and built the instruments to match his music, conforming to tuning systems such as the division of the octave into 32 steps (micro-tones). It is ironic that advanced electronics might have enabled him to achieve his creative results more quickly and more easily: but only if he could have had a real dialogue with manufacturers. He would be just as critical in his view of many of today's electronic instruments as he was of the acoustic ones available to him.

In a much smaller sense, we can encourage students to relate their music education to ideas from acoustics and technology in a learning environment which is critical and visionary.

MUSIC AND THE SURROUNDING (PHYSICAL) SPACE:

The composer Schoenberg had a vision of the pitch space occupied by music which stemmed from Swedenborg's depiction of heaven as contained in Balzac's novel Seraphita:

In this space, as in Swedenborg's heaven...there is no absolute down, no right or left, no forward or backward. Every musical configuration, every movement of tones has to be comprehended primarily as a mutual relation of sounds, of oscillatory vibrations, appearing at different places and times.29

This is just one amongst a number of ways of looking at music as occupying space. Giovanni Gabrieli, Monteverdi and other 16th century Venetian composers understood very well how to exploit the physical space which music can occupy, by using contrast and echo effects. The design of St.Mark's in Venice was fundamental to this concertato style. 20th century composers have also exploited
physical space in their own way: Varese with his Poème Electronique for 350 loudspeakers in the Brussels world exhibition pavilion of 1958; the British composer Jonathan Harvey, who, in Mortuus Plango, Vivos Voco, electronically simulated the physical and acoustic space of the large bell in Winchester Cathedral. Some years ago, in the midst of composing a spatially orientated piece for brass ensemble, I devised a secondary school project which attempts to explore with pupils this time/pitch/space relationship.
CANZONA

A creative project for secondary school pupils.

John Stuart Howard

1. The teacher should use some of the following as background listening, some for follow-up work.
   a. 16th c. Venetian music (polyphonic): Giovanni Gabrieli and others (motets/instrumental canzonas).
   b. Electronic music using interplay between channels: Stockhausen "Gesang der Jünglinge"
      Varèse "Poème électronique"
   c. Any music which exploits physical space: Ives "The Unanswered Question"
      Stockhausen "Gruppen"
      Britzistle "Verses for Ensembles"

2. Divide the class into five groups and space them around. Use as large a space as possible.
   Give each group instruments as follows:
   Group 1: Drums (various types)
   Group 2: Xylophones / other pitched wooden instruments
   Group 3: Woodblocks, claves, Chinese blocks etc.
   Group 4: Cymbals, gongs, other non-pitched metal instruments
   Group 5: Glockenspiels, chime bars, metallophones etc.
   At least one stop watch is needed, one per group if possible.
The groups should each devise sufficient music to fill the following times:

Group 1: 5 seconds  
2: 8 "  
3: 13 "  
4: 21 "  
5: 34 "

The teacher should, of course, assist as necessary. A more structured approach could be adopted by providing groups with musical ideas written on workcards. See my appendix for some ideas taken from actual canzonas.

(4) Now realise the following formal scheme:

<table>
<thead>
<tr>
<th>SECTION ONE</th>
<th>SECTION TWO</th>
<th>SECTION THREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group: 1 3 4 2 5</td>
<td>4 5 3 1 2</td>
<td>1+2 3+5 4+2+3 1+2+5 ALL</td>
</tr>
<tr>
<td>Dynamics: f pp mf p f -&gt;</td>
<td>pp f f&lt;f mp f</td>
<td>pp ff pp ff mp</td>
</tr>
<tr>
<td>Time: 5&quot; 13&quot; 21&quot; 8&quot; 34&quot;</td>
<td>13&quot; 5&quot; 21&quot; 34&quot; 8&quot;</td>
<td>34&quot; 21&quot; 8&quot; 13&quot; 5&quot;</td>
</tr>
</tbody>
</table>

Notes:
1. The teacher will need to explain that, after Section One, groups have to adjust their music so that it is compressed or expanded to suit different time lengths. I suggest two approaches:
   (a) A group may simply vary their music so that it lasts a different time length.
   (b) " " imitate the music of another group e.g. Group 5, Section 2 could imitate 1.
2. Any kind of music could be used as a source. Ideas for the realisation of the scheme. Canzonas are simply one source. (Why not rock music or folk etc.?)
It is interesting to see how many correlations between scientific ideas to do with space and other related matters and music can be found. For instance, the concept of relativity relates very well to aspects of a great deal of 20th century music (for instance, the symmetrical use of pitch and harmony in Schoenberg's piano piece, Opus 19, No.III); and the Fibonacci number sequence, which expresses in numbers the notion of exponential growth, and relates to so many things in the environment.
The Fibonacci Sequence and the Golden Section

The sequence of numbers

1 1 2 3 5 8 13 21 34 55 89 144 233 377 ...

is such that each term is the sum of the two terms which immediately precede it; thus

\(5 + 8 = 13\) and \(8 + 13 = 21\) and so on. Starting from 1, the next term, 0 + 1, is also 1, the next term, 1 + 1 = 2, and so the whole sequence can be built up very easily by simple addition. The sequence is named after Leonardo Fibonacci of Pisa (born 1175) and has some very interesting applications.

Before discussing some of the less obvious Fibonacci sequences which occur in nature, we can illustrate the sequence by a very simple example. If sums of money amounting to whole numbers of shillings are paid, and the only coins used for payment are shillings and florins, then, if 0 represents a shilling and O represents a florin, the number of ways in which such sums of money may be paid out may be represented schematically as follows:

<table>
<thead>
<tr>
<th>Amount to be paid</th>
<th>Possible arrangements of coins making payment</th>
<th>Number of arrangements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/-</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2/-</td>
<td>00, O</td>
<td>2</td>
</tr>
<tr>
<td>3/-</td>
<td>000, O0, Oo</td>
<td>3</td>
</tr>
<tr>
<td>4/-</td>
<td>0000, O00, O00, OOO</td>
<td>5</td>
</tr>
<tr>
<td>5/-</td>
<td>00000, 0000, O000, OO00, OOOO</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>etc.</td>
<td></td>
</tr>
</tbody>
</table>

The reason why this follows the development of the Fibonacci sequence is clear when we note that 3/- may be regarded as one shilling + 4/- or one florin + 3/-, so that the five shilling arrangements consist of

00000, 0000, 00000, 00000, 00000

obtained by paying one shilling and then one of the ways of paying four shillings, and

0000, O00, O00 . . . .

obtained by paying one florin and then one of the ways of paying three shillings,

so that the number of ways for each amount is the sum of the numbers of ways for the two previous amounts.

Ancestry of a male bee

A male bee, called a drone, has a mother but no father. After a nuptial flight, the fertilized eggs laid by a female bee hatch into females, either workers or queens. Males hatch from unfertilized eggs. If the genealogical tree of a male bee is traced backwards, it will be seen that the number of ancestors in any one generation is a Fibonacci number (Fig. 13.1).

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The Golden Section

Tastes may vary, but many people asked to select one of the shapes shown in Fig. 13.5 for note-paper or for the frame of a picture would choose the third. It is not too square and not too elongated.

![Fig. 13.5](image)

The third rectangle is constructed so that if its height is called $h$ and its width $w$ the
\[ \frac{h}{w} = \frac{h}{w + h}. \]
This proportion, in which the smaller is to the larger as the larger is to the sum of both, is called the Golden Section. Another example is given in the sketch below (Fig. 13.6). The central feature, almost dividing the picture into two parts, is placed so that if $b$ is its distance from the left of the picture and $a$ is its distance from the right of the picture, then
\[ \frac{a}{b} = \frac{b}{a + b}. \]
This again is the Golden Section. The Greek architects, who have left many beautiful examples of their classical art, were aware of this proportion and a number of their buildings illustrate it. It has also been used in many well-known paintings. If both sides of the equation are multiplied by $b$ $(a + b)$ we obtain $a \cdot (a + b) = b^2$ which can be written in the form
\[ a^2 + ab = b^2 \quad \text{or} \quad b^2 - ab - a^2 = 0. \]

![Fig. 13.6](image)

Since we are interested in the ratio $\frac{b}{a}$, the equation may be expressed as a quadratic equation in $\frac{b}{a}$ in the form
\[ \frac{b^2}{a^2} - \frac{b}{a} - 1 = 0. \]
and the two solutions of this equation are

\[
\frac{b}{a} = \frac{1 + \sqrt{5}}{2} \quad \text{and} \quad \frac{b}{a} = \frac{1 - \sqrt{5}}{2}
\]

i.e. \(\frac{b}{a} = 1.618034 \ldots\) and \(\frac{b}{a} = -0.618034 \ldots\)

The first of these solutions gives us the Golden Section.

The reader should verify that

\[1.618034 \times 0.618034 = 1\] and that \[1.618034 \times 1.618034 = 2.618034\]

(both correct to five places of decimals). The ratios

\[
\frac{0.618034}{1}, \quad \frac{1}{1.618034} \quad \text{and} \quad \frac{1.618034}{2.618034}
\]

are all examples of the Golden Section ratio (they are, of course, equal to one another).

Idle Fancy

In text-books mathematicians write seriously, proving things, solving equations and presenting mathematical proofs with elegance and assurance. Because there is little point in going into print, in a mathematics book, if there is nothing businesslike to say, the reader who is not a mathematician is rarely given an opportunity of letting the fancy roam in a mathematical context. This is a pity.

If the thirteen ancestors of the male bee in the sixth generation before him are set out as in the table on page 216, but the females are left white and the males coloured black, they will look like this

\[
\circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ
\]

If the flowers on new shoots in the diagram of the little plant in Fig. 13.2 are coloured black and the flowers on older stems are left white, they will look like this

\[
\circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ \bullet \circ
\]

and both of these look very much like an octave on a pianoforte keyboard, the thirteen elements corresponding to the thirteen semitones of the chromatic scale (Fig. 13.7).

![Fig. 13.7](image)

This resemblance between two naturally occurring examples of thirteen elements in a Fibonacci development and a pianoforte keyboard draws attention to a number of facts about musical scales.

Mankind has a specialized physiological structure in the ear which enables different sounds and combinations of sounds to be heard with remarkable discrimination. Over the two or three thousand years during which man has made musical instruments, various conventions have grown up for the tuning of these instruments and, within the last few centuries, for the writing of musical scores. These conventions have developed in such a way that what we call music gives pleasure when it reaches the brain through
This sequence can itself be expressed as the Golden Section, commonly occurring in art and architecture, but, as discovered by the musicologist Erno Lendvai\(^\text{32}\), used extensively by the composer Bartok to plan many aspects of his music, including both harmony and structure:
by the removal of the mute in the 34th bar, and its use again in the 69th bar. The section leading up to the climax (b. 55) shows a division of 34 + 21, and that from the climax onwards, 13 + 21. Thus, the longer part comes first in the rising section, while in the falling section it is the shorter part that precedes the longer, so the section-points tend towards the climax. Positive and negative sections fit together like the rise and fall of a single wave.*

The proportions follow the Fibonacci series.

It is no accident that the exposition ends with the 21st bar and that the 21 bars concluding the movement are divided into 13 + 8.

The proportions of Movement III of Music for Strings, Percussion and Celesta also reflect the Fibonacci series (if we calculate throughout in 4/4 bars and consider the occasional 3/2 as 1 ½ bars). Its formal and corresponding geometrical structure is shown in Fig. 23.

* The 88 bars of the score must be completed by a whole-bar rest, in accordance with the Bülow analyses of Beethoven.
Incidentally, it is arguably no accident that both tonal harmony and perspective in visual art both began to appear in Europe at about the same time. We have here a complex web of inter-relationships.

CONCLUSION:

In conclusion, in returning to our focus on music education and its environment, I draw attention to three examples of school-based approaches in which music can meaningfully interact with other areas of experience (given the right circumstances):

1. The work of Phil Ellis, in the book, Out of Bounds33:
Dimensions

Aims  To develop further individual research; to explore some of the spatial possibilities in music; to generate musical ideas from the environment and also from abstract ideas and the imagination.

Equipment  Sugar paper, paint, felt tip pens, etc. Tape-recorders, Slide projector(s).

Structure  This course lasts for one-and-a-half terms. It is best started after the half-term break in the Autumn so that groups can be working/researching topics from the homework sheet during this half of the term. After the Christmas holiday groups will thus have a fund of information to draw on, and the longest term of the year in which to attempt up to two quite ambitious pieces. The course is in two parts: an introduction during the second half of the first term; and mixed media work in the following term.

KEY LESSON 1 Horoscopes, Planets, and Space travel (Research)

The first Key lesson deals with the research as detailed on the homework sheet (see page 46).

Research  The homework sheet should be distributed and each of the first three sections explained in some detail, as these forms the subjects for research in the ensuing weeks of the course. There are two ways of working from this sheet: individuals may choose to produce work from one section only, in which case considerable detail is expected; or they may produce less detailed work on each of the first three sections.

Notes on the homework sheet  Horoscopes and Astrology
This is a very popular section, as a large number of people regularly read their horoscope in the daily newspaper, and many magazines and comics read by second-year pupils contain horoscopes. Many pupils will take great delight in decorating their work with zodiac signs and some may even construct very large signs for display. Real interest can come from comparing the characteristics of the personality with those supposed to belong to the various birth signs. When interviewing people on the subject, it is a good
idea to use a tape-recorder so that the more interesting parts can either be written up later or a tape of the best comments assembled. This section thus encourages some historical research and also an investigation of present-day attitudes; many pupils will produce beautifully illustrated ‘chapters’ of work.

**Planets and Astronomy**

This is another very popular area of study with many pupils. The scope of work to be done has deliberately been left open and again is a combination of the historical and the factual. Many school textbooks (and the Physics department) have a considerable amount of information on the factual aspects, and the school library is bound to have several encyclopedias in which the historical information can be found. Often a few pupils will have books on the subject at home, and occasionally a keen amateur astronomer will have his own telescope and will obviously contribute much to discussion on this area of the worksheet.

**Space travel**

This section is in two parts:

a **Modern space research.** Such questions as ‘What is going on?’ ‘What has been accomplished?’ ‘What is going to happen in the next few years?’ will stimulate the class. Again it is likely that some pupils will be quite knowledgeable on the subject, and, as with ‘Planets and Astronomy’, the school should have a considerable amount of information on the subject.

b The list of words are a few suggestions for imaginative writing. Invariably many more suggestions will come from the class. It is possible for pupils to produce quite good ideas—short science fiction type stories—using one of these words (or one of their own) as a title. Some will no doubt read science fiction magazines, and many of the pictures in such publications are very colourful and evocative.

Having explained how these three sections can be worked, pupils should be in a position to pursue their chosen area(s) for homework during the first half term or more of the course. This information will be used in practical work during the second part of the course, which allows pieces to be produced using the above three areas as starting points.

**Movement through Time and Space**

For the first half term of the course practical work is developed from this fourth area on the sheet. Practical work can begin almost immediately, and there are three possible starting points.

**Practical work**

a The instructions on the worksheet can be developed into a **musical score**... for example, the number of cars, lorries, buses, cyclists, pedestrians, etc., passing the school gates (or any suitable location) is noted in 30-second blocks of time over a period of about ten minutes, this information can then be converted into instructions for a piece of music. If only a few vehicles pass during the first ten minutes then the timing begins again and more events recorded until sufficient information has been collected. The results of this—an activity which pupils seem to enjoy—could look like the chart opposite.

**Notes on the chart**
The chart can be converted into a musical score, using large sugar paper. For this particular chart, six instruments would be needed. Lorries could become drums, buses a piano, cars an organ and so on. Just as in the PATTERNS course each instrument can be represented by a different shape and colour. The number recorded for each 30-second block of time can have...
<table>
<thead>
<tr>
<th>Lorrys</th>
<th>Buses</th>
<th>Cars</th>
<th>Motorbikes</th>
<th>Bikes</th>
<th>Cyclists</th>
<th>People</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
2. The following extract from my school project Dream 734 (related to my vocal piece of the same name):
The class is divided into seven groups, as nearly equal as possible. Each group is given one of the following seven texts:

1. God turne us every dreme to gooode. (Chaucer)
2. That which the dream shows is the shadow of such wisdom as exists in man. (Paracelcus)
3. Let us deliver ourselves to the interpretation of dreams. (Synesius of Cyrene)
4. ...the dreamers of the day are dange-ous men, for they may act their dream with open eyes. (T.E. Lawrence)
5. His are the quiet steeps of dreamland, The waters of no-more-pain. (Walter de la Mare)
6. Lullaby, lullaby; Little one to Dreamland, fly. (Phyllis Garlick)
7. A dream-show rode in on a moonbeam white, Go away dreams and let me sleep! (W.B. Yeats)

Pupils' assignment:
Each group to make up a piece of music (possibly combined with action) lasting c. 2 minutes. They must include their text, presented in any way they choose. Reference to the use of the voice in works like Berio's "Visage" may well be useful. Pupils must use the number seven to help them create the music. Choice of instruments should either be freely made by pupils, dictated by the teacher or gradually decided by experiment. The use could be made of everyday objects and instruments played in unconventional ways.
Tom Short Howard, May 1979.

Symphony no. 21
by Mendelssohn

A complete Haydn Symphony (part of each movement to demonstrate the unity)

Zephyr

by Stockhausen

FORM

Groupen
by Stockhausen

Le Matroon sans Masque /Send piece by Boulez

and piece by Xenakis

Gamas in Alma (with metal)

by T巨ll

Density 21.5 for flute

NUMERUS

Evening
by Schuman

Vision of St Augustine

Lent (a conversation)

opera (preliminary to the opening) by Billin

A Midsummer Night's Dream

immediate music by Medtner

DREAMS

Listen to part of the following and discuss:

Follow-up work:
3. The following, from the UK national Curriculum in Music\textsuperscript{35}: 

\textbf{35} \textsuperscript{35}
5.2 Links between music and other statutory subjects

Music has strong links with certain arts subjects - in particular, dance (specified in the Order for physical education) and drama (related to work in languages - English, Welsh and modern foreign languages (MFL)). Examples of links between music and other statutory subjects are summarised in *Box 1*.

| English, Welsh and MFL (as appropriate) | • using words to teach rhythm;  
|                                            | • discussing the meaning of words of a song to stimulate language development;  
|                                            | • talking about music;  
|                                            | • exploring the abstract or sensual sounds of words;  
|                                            | • performing songs to reinforce the acquisition of vocabulary;  
|                                            | • using music to enhance drama.  
| Mathematics | • singing counting songs;  
|             | • exploring shapes and patterns;  
|             | • sorting into sets.  
| Science | • listening to and using sounds from the environment;  
|         | • studying sounds produced in different ways and by different sources, and the effect of changes in variables (e.g. length and tension of a string).  
| Art | • responding to music by drawing a picture;  
|     | • responding to a picture by composing music;  
|     | • exploring common features such as pattern, shape, structure, texture.  
| Physical education | • experiencing rhythm through movement;  
|                   | • using dance as stimulus for composing;  
|                   | • using music as stimulus for dance.  
| Technology | • creating music for a specific purpose (e.g. preparing a precisely timed sound track for a video recording);  
|             | • using a computer to create, alter and arrange sounds;  
|             | • using a computer to store musical material;  
|             | • retrieving and modifying musical material which has been stored in digital form;  
|             | • using IT to present work (e.g. a printed score);  
|             | • designing and making a musical instrument.  
| History | • relating style in music to an historical period;  
|         | • using music to evoke a sense of period.  
| Geography | • exploring the music of particular countries;  
|            | • using music to evoke a sense of place.  
| Religious education | • developing an awareness of the contribution which music can make in religious ceremonies;  
|                      | • participating in acts of worship by singing hymns or other religious songs.  

© Curriculum Council for Wales 1992
It was appropriate that, in his composing of Poeme Electronique, Varese worked with the architect of the Brussels pavilion in which the music was to be presented; it was also appropriate that the architect's assistant was the composer Xenakis; and, to bring us full circle, it is entirely appropriate and indeed significant, that the architect was Le Corbusier, with whose quote this paper begins. Within the learning environment, it is our hope, as educators, that our students will:

A. operate both within boundaries (to enable them to make sense of the world and to acquire meaningful skills and concepts) and across them.

B. recognise for themselves the symbiosis within which the natural and the artificial relate, in music and in so many other areas of human experience.

Above all, I aspire for a learning environment within which music education and all its exciting cross-connections can help to make sense of the world for our students. In a world where we increasingly demand "relevance" for our school subjects, a subject could hardly have a more directly relevant aspiration than that.

REFERENCES:

5. Associated Board of the Royal Schools of Music, London.
15. RJ Stewart, op.cit., Pgs54-55
17. Charts from the Rosicrucian Order
18. RJ Stewart, op.cit., Pg134
19. RJ Stewart, op.cit., Pgs126-7
25. The New Soundscape, R.Murray Schafer, Berandal Music, Toronto 1969, Chapter IX.
27. Some uses of technology in research and composition in relation to traditional musics, a talk to the 1993 ASEAN Composers Forum, 16/4/93, by John Howard.
31. A mathematics text book (other details unknown)

 PIECES OF MUSIC REFERRED TO:

1. John Howard: Five Studies for Chinese Orchestra
2. Peter Maxwell Davies: Ave Maris Stella
3. Arthur Bliss: Colour Symphony
4. Stockhausen: Stimmung
5. Berio: O King
6. Varese: Poeme Electronique
7. Jonathan Harvey: Mortuos Plango, Vivos Voco
8. John Howard: Canzona for Brass
9. John Howard: Dream Seven