2

MUSIC AS COMMUNICATION MEDIUM

Information Theory as a science emerged from studies and research aimed at increasing the efficacy of communication channels. It is primarily concerned with finding answers to what information is, how it can be measured and how communication devices could be designed to transmit information most efficiently. Chapter 2 surveys the research and events that lead to Information Theory becoming an independent study. This chapter mainly deals with music as a communication process and the most important elements involved.

The term 'information' has various connotations and is commonly used as a synonym for facts. In the context of this study, however, the term information refers to the quantifiable parameters of the carrier of a message, or the signal. In other words, it is a measurement of the mode by which information is conveyed rather than its semantic substance.

The measured quantity of information in a message is referred to as Entropy. As the quantity of information in a message increases, its entropy also increases. In a perfect communication system[1] — in which the encoding is optimal—the entropy of the received message will always be the same as the entropy of the message before transmission.

Most systems of communication, however, are not that efficient and do not transmit messages that are free of interference. Such systems tend to increase the entropy of the received message. Due to

[1] A perfect communication system is a system in which the received message is exactly the same as the original message, without interference from an outside source.

imperfections in a system, the effects of noise and interference has a disruptive influence on the resulting message, thereby increasing the entropy.

2.1 Music as communicative process

Music, like other forms of art, is a rather complex communication system by which a composer communicates musical information to the listener by means of a musical performance. The processes involved satisfy the requirements of the classical model of a unidirectional communication process involving a source, channel and a receptor:

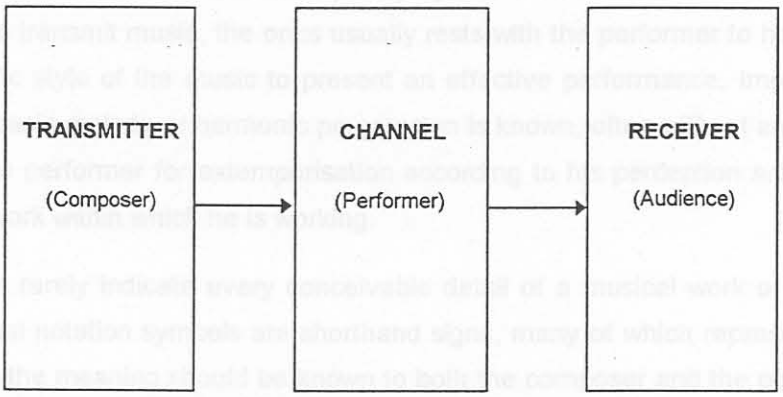

Figure 2-1. Unidirectional communication model

The model above is a simplified representation of music as communication medium. The model does not reflect several interactive factors and restrictions that are inherent in musical performance and that are significant to the effectiveness of the transmission process. The latter ultimately affect the outcome of the musical message by increasing its entropy, or unpredictability. Three of the more important components of a musical performance that may have an important influence on the outcome of a performance are:

1. *Notation*, the customary method by which composers of the Western world communicate or imply their creative intentions. Inherent limitations in the notation system as well as printing and editorial errors may contribute to the masking of the original idea of the composer. In societies where music is transmitted from memory through generations of musicians, the ultimate musical results may be considerably different from the originally conceived musical idea. It would therefore potentially have maximum entropy.
2. *Interpretation*, the contribution of the performer to the creative process in which knowledge of style, experience, mood, and musical ability normally plays an important role.
3. *Acoustical conditions*, which may act as an important element of modification in the musical communication process. The sounds produced in a performance may be significantly changed by the time it reaches the audience.

Below is a discussion of the more salient features of the components listed above, as well as the way they may affect the outcome of a performance.

2.1.1 Notation as musical code

Composers of Western Music normally use the symbols of music notation to represent musical sounds and other directions on paper. There are also musical traditions that have no tradition of notated music and in which music is transferred purely by rote from one individual to another. Whatever the method used to transmit music, the onus usually rests with the performer to have a sound knowledge of the specific style of the music to present an effective performance. Improvised Jazz is an example where a basic melody or harmonic progression is known, often without any notation and that is then used by the performer for extemporisation according to his perception and understanding of the stylistic framework within which he is working.

Music notation can rarely indicate every conceivable detail of a musical work or of the composer's intentions. Individual notation symbols are shorthand signs, many of which represent comprehensive concepts, of which the meaning should be known to both the composer and the performer. An example is the figured bass that is frequently found in music of the Baroque period. To extemporise a figured bass effectively, an extensive knowledge of the harmonic implication as well as other performance principles is required. Merely taking the bass line and melody at face value, without prior knowledge of what the figuration actually means and how it should be interpreted, will inevitably result in a distorted rendition.

2.1.2 The role of the performer

Whereas a composer or editor uses music notation to encode a musical work, a performer has to decode it again to realise the music into actual sounds. The interpreter, which in terms of Communication Science, is an active element in the transmission process, is limited by the completeness of the provided code, the extent of his knowledge and understanding of the period style of the music, as well as the meaning of the codes with which he works.

Frequently, the performer himself is also part of a bi-directional and interpersonal mode of communication involving the audience which may itself also be susceptible to prevailing conditions and influences. Consequently, it is quite likely that during coding and decoding, the resulting product may differ from that which the composer originally had in mind. Because of the interpretative role that the performer has to fulfil, he normally contributes — by virtue of his own understanding of, and interpretative disposition to the music — additional information to the original message. A secondary process

is thus set in motion in which the composer's original intentions may be modified by to the performer's mood, technical ability, and understanding of the style. In terms of the originally notated score the performance of a composition can subject it to interference thereby increasing its entropy and causing the musical message to become unclear or distorted in other words unpredictable in terms of the original score.

2.1.3 Performance interference and its effect on the transmitted message

Several additional factors that may be classified as interference, tend to affect the outcome of a musical performance. These include acoustical conditions, geographical location, instrumentation, also the psychological orientation of both the performer and the audience. What an audience normally hears is a combination of the composer's intention plus the various influences referred to. In Communication Science this is called noise.

Most communication models, especially those referring to electronic media, allow for the effect of noise on the message. As far as music is concerned, factors such as notational and interpretative obfuscation and the effects of acoustic conditions may be regarded as interference factors that could mask the original message as conceived by the composer. These factors are included in the adapted communication model below.

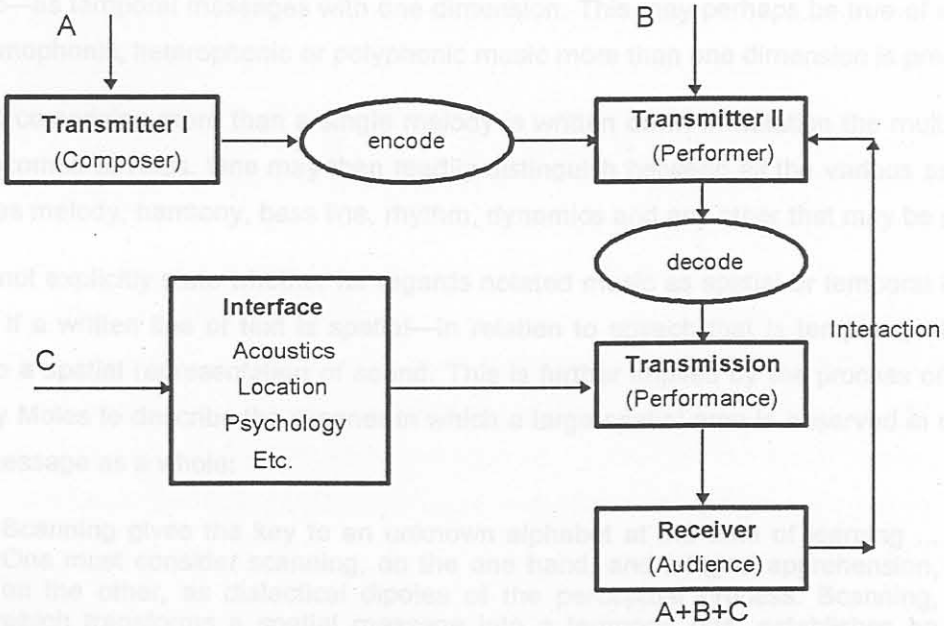

Figure 2-2. Model for music as communication channel

The model illustrated in Figure 2-2, is an expanded version of the original communication model (Figure 2-1) to allow for the dual role of the performer as channel between the composer, as well as

his role as secondary transmitter of information. Also shown are other noise factors (C) over which neither the performer nor the composer has any control.

From the above certain conclusions may be drawn:

a) In music, as with any other transmitted message, the amount of information (entropy) contained therein always tends to increase and become less predictable — it can never become more predictable or contain less information than the composer had intended. It is significant that in this respect music as communication is analogous to the laws of electronic message transmission.[2]

b) More authentic results should be obtained if a message is studied as close to its origin as possible and before many interference factors have had effect. In the case of a musical message this would be the score, preferably before any editing has been effected.

Most analyses by musicologists are therefore based on scores that allow the most authentic details of the musical elements to be readily and visually available.

2.2 Music as temporal art

According to Abraham Moles, music in sound (as opposed to music in score) is a modulation of duration and thus a temporal art as opposed to the spatial messages of the visual arts (Moles: 1966, pp. 8-9). Moles further classifies messages according to dimensions and classifies speech—and by implication music—as temporal messages with one dimension. This may perhaps be true of monodic music but in homophonic, heterophonic or polyphonic music more than one dimension is present.

When music comprising more than a single melody is written down in notation the multidimensional character becomes obvious. One may then readily distinguish between all the various aspects of the music such as melody, harmony, bass line, rhythm, dynamics and any other that may be present.

Moles does not explicitly state whether he regards notated music as spatial or temporal but one may deduce that if a written line of text is spatial—in relation to speech that is temporal,—then notated music is also a spatial representation of sound. This is further implied by the process of scanning, a term used by Moles to describe the manner in which a large spatial area is observed in order to take in a visual message as a whole:

> Scanning gives the key to an unknown alphabet at the time of learning ... One must consider scanning, on the one hand, and integral apprehension, on the other, as dialectical dipoles of the perceptual process. Scanning, which transforms a spatial message into a temporal one, establishes an equivalence between the two types of messages. (Moles: 1966, p. 9)

In other words, Moles implies that a temporal message could be represented spatially but because of the necessity of scanning to learn its contents, it remains temporal, even if in a visual form. Since the

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[2] Chapter 3 contains a more detailed description of these principles.

score has until recently been the most common method by which a composer could permanently store and transmit his work to the performer, it should contain a large number of components of his musical style. As such, a score is a carrier of direct or implied information about the stylistic features of that music.

2.3 Music notation as source of information

In general terms, and as shown earlier in this chapter, a message is transmitted from the sender to the receiver by means of codes, the structure of which should be known to both sender and receiver to make it intelligible. Examples of information codes include hand signals, structured sounds (e.g. language and music), electrical impulses, writing and notation.

The structure of a message is its source of information and is defined by Jagjit Singh as follows:

> It produces messages by successively selecting discrete[3] symbols from a given stock such as letters of an alphabet, words in a dictionary, notes on a musical scale, colons in a spectrum, or even the mere dash-dot twin of telegraphy. In other words, the message actually transmitted is a selection from a set of possible messages formed by a sequence of symbols from its own repertoire. (Singh: 1967, p. 12)

The value of the score as a source for analytical and stylistic study has always been regarded as indispensable by scholars. It is the most convenient and often the most accurate means of representation of music. This is shown by the fact that even in ethnomusicological research continuous attempts are made to modify traditional notation so that music may be graphically presented. Even when traditional notation is totally inadequate, new graphical systems are designed with the principal purpose of producing a visual representation of the music.

A musical score therefore serves as the coded form of the musical message as transmitted by the composer and as such should contain most of the stylistic information as well. However, the score of a composition usually implies more information than that which is immediately available from the notation itself. The date of a Baroque composition, for instance, also implies the kind of ornamentation that should apply, while the country of origin could indicate how *notes inégales* should be performed. Consequently, the conclusion may be drawn that the stylistic information of a composition primarily involves two distinct sources: the information embraced by the notation itself; and historical or circumstantial information that is largely interpretative and often based on erudition or intuitive deduction.

2.4 Semantic and aesthetic information of music

Of the two types of information discussed in the preceding section, the information provided by notation is usually fixed and therefore more reliable for stylistic evaluation than interpretative information

[3] The term 'discrete' means separate or individual.

that may be eccentric and subjective and possibly vary from one performance to another. The many recordings and performances of compositions by different performers, that differ in interpretation without necessarily being incorrect, shows that interpretative information may vary greatly but that the information provided by the notation remains unaffected.

Referring to the two types of information mentioned above, Abraham Moles distinguishes between semantic and aesthetic information and defines the two categories as follows:

> (a) Semantic information, having a universal logic, structured, articulable, translatable into foreign language, serves in the behaviourist conception to prepare actions. (b) Instead of to a universal repertoire, esthetic information, which is untranslatable, refers to the repertoire of knowledge common to the particular transmitter and particular receptor ... One may liken it to the concept of personal information. (Moles: 1966, p. 129)

Those elements in music that are dictated by conventions and that are common to a genre, style period, or specific composer, constitute semantic information because they are translatable into another language (for example, technical terminology), and are normally not subjected to interpretative variations[4]. Semantic information also includes those attributes in a composition that are inherent to the composer's personal style and that distinguishes one composition from another.

Those elements that are subject to influence by personality, mood, acoustical surroundings, quality of instruments and size of ensemble constitutes aesthetic information. A significant portion of aesthetic information, Moles points out, is made available by the limitations of the score and the manner in which music is written down, (Moles: 1966, p. 138), while ...

> Above all, there are the differences or latitudes in interpretation which arise from the instrument (or orchestra) and the performer (or conductor). In the case of the ... orchestra, the latitudes can attain such fantastic values ... that it is impossible to speak of a symphonic work without at least referring to a particular performer, if not a particular performance. (Moles: 1966, p. 139)

Although Moles only mentions the orchestra, the same argument is obviously true of any musical performance.

Two of the more obvious sources of aesthetic information are that of tempo and volume, while elements such as attack, tone colouring and instrumentation are further examples. All these elements are subject to fluctuations not only because of the performer's interpretation but also because of environmental conditions such as the size of a concert hall, acoustical properties, size and type of audience, temperature and geographical location.

The distinction between semantic and aesthetic information has important implications for this study, as semantic information is measurable or, in other words, quantifiable. Aesthetic information usually

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[4] Two keyboard players will probably perform a figured bass differently but stylistically correct, each providing their own instinctive aesthetic information to the performance. However, should the actual chord progressions be changed in the process of extemporisation, perhaps out of character for the period, composer or specific piece, the semantic information is changed.

does not allow translation into quantifiable units and is normally too mutable for accurate measuring.[5] However, the fact that these elements are not quantifiable by virtue of their variability and indeterminacy does not necessarily exclude them from a stylistic study, especially when they specifically have a bearing on, or are an inherent part of the musical style. It is imperative that such elements are included or kept in mind. However, this is predominantly the domain of traditional analysis.

The relationship between semantic and aesthetic information in music is never fixed or constant and may depend on the style period, composer, individual composition and may even differ between sections of the same work. In essence it depends on the ratio between those musical elements that are fixed (for a style period, composer, or composition) and those that are left optional for a specific performance. For instance, the interchangeability of instruments of some Baroque instrumental compositions, increases the aesthetic information of such works because it adds to those elements that are uncertain. In a work written for a specific instrument this knowledge is included with semantic information. Whether semantic or aesthetic, the information provided (or not provided) by the composer tells one something about his intentions, be they dictated by period convention or personal choice.

Generally semantic information is largely dependent on those elements in music that are fixed by convention, the composer, or is present in a specific work. Serial or synthesised music by a twentieth century composer could include more fixed and controlled elements, such as tempo, volume and envelope shape that would result in a greater amount of semantic information than in a composition in which these elements are subject to the many performance influences described above. As such, the ratio between semantic and aesthetic information is an important factor that should be kept in mind in a statistic study of music.

2.4.1 Originality of musical information

The information content of a musical message is directly related to the degree of originality[6] contained in the composition. A composition that contains a greater quantity of original material will also contain more information. The reason for this is that a smaller portion of the information is reduced to basic sets therefore generating a greater number of sets. In works that contain less original information there will be fewer sets of larger dimensions. For example, the harmonic information of a piece of music with a regular and repeated harmonic structure will contain more redundant (repeated) information than a piece of the same length in which harmonic progressions are not repeated. Aleatoric music in which only a limited number of parameters are fixed, for instance, could contain a high degree of aesthetic information with near maximum originality. The semantic elements will be those restrictions that are fixed by the inventor although the results themselves could be totally unpredictable.

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[5] The modern technique of digital recording in which sounds are represented by number sequences may present new possibilities for analysis.

A serial composition, on the other hand, in which almost all the parameters are subjected to serial treatment could have a high originality factor with a high semantic content as well as a low predictability factor.

The model below is an adapted model based on one by Moles (Moles: 1966, p. 141) and shows how the relationship between semantic and aesthetic information and the possible degree of information (entropy) and banality (redundancy) of a composition may be illustrated. The rectangle on the left indicates semantic information content, while the rectangle on the right represents the aesthetic information content. Portions above the horizontal line show the originality factor for both the aesthetic as well as semantic information of a composition:

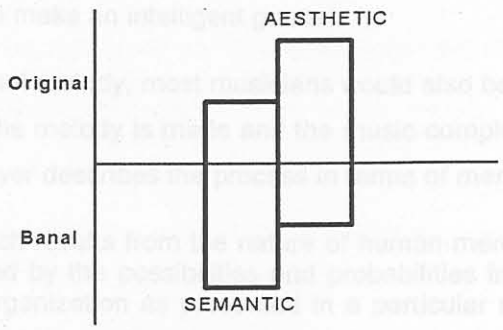

Figure 2-3. Mole's model of semantic and aesthetic Information

The example shows that the ratio between aesthetic and semantic information may change depending on the number of parameters that are fixed. It also shows that the ratio between the predictable or banal elements of each may vary as well.

Of the two aspects of music, aesthetic and semantic, this study is primarily concerned with the measurable part or semantic information of the model above—in effect the ratio between originality and banality of the musical message. Some confusion could arise, however, because of the term 'semantic' and some clarification is required.

2.4.2 Semantic information and meaning in music

Normally the word 'semantic' is a linguistic term that refers to 'meaning' in language. In the context in which the term is used here, there is no attempt to attach any connotation of meaning to music.

In terms of music, 'meaning' remains an elusive and controversial subject. As a form of expression, music nevertheless embodies much information that is normally described and discussed in musical terminology such as, tonality, metre, genre, period, form, monophony, polyphony, and homophony. In respect of these parameters, the information contained in music does have a degree of semantic

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[6] The term 'originality' is here used to describe the degree to which new material is introduced in a composition, and does not refer

meaning but mainly by the inherent processes the terminology describes. These processes imbue a composition with its stylistic characteristics. Music thus contains 'meaning' purely by virtue that it embraces those elements that provide information about the style that characterises it.

2.5 Expectation and information in music

By merely listening to an unknown piece of music it is possible to identify the style period, genre or even the composer; some people are even able to identify the conductor or performer. Through continuous listening and studying, those elements that are stylistically idiomatic to a period, composer or performer are learnt and assimilated. This is made possible by the information that is made available to the listener, thus allowing him to make an intelligent guess.

Having listened to part of an original melody, most musicians would also be able to complete it in the same style. A mental analysis of the melody is made and the music completed according to parameters previously learnt. Leonard Meyer describes the process in terms of mental conditioning:

> ...the expectation which results from the nature of human mental processes are always conditioned by the possibilities and probabilities inherent in the materials and their organization as presented in a particular musical style. (Meyer: 1957, p. 44)

The mental processes involved are beyond the scope of this study but a less obvious implication of the phenomenon of recognition is the probability or predictability element that is often taken for granted. To identify a composition or the style of a melody it is necessary to assume that it would continue in the style that it began. If this were not so, all music would be totally disparate in structure and style and it would be impossible to distinguish genres and forms or even vaguely categorise them. The fact that some entertainment musicians sometimes dress up a trivial tune in a variety of styles such as that of Bach, Liszt, and Jazz, supports the idea that musical style is a source of information that conforms to expectation.

2.6 Elements of musical information

Musical terminology abounds with nomenclature that provides information about music and that implies elements of predictability. An extreme example of predictability in music is the concept of scales that consist of a fixed and predetermined sequence of intervals. It would, for instance, be inconceivable to consider a major scale that does not comprise two identical tetrachords each with two whole tones and a semitone and there is 100% certainty that all major scales will have the same predictability value. Therefore, in some situations (for example the major or minor scale) musical terminology implies maximum redundancy. More often a degree of unpredictability is implied, however. Some musical forms fall in the latter category: a piece in sonata form deviates from the theoretical model

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to the artistic merit of a work.

but is nevertheless classified as a sonata form because there are general similarities to the predetermined model.

Much of what is referred to today as 'general musicianship' is no more than the assimilation and dissemination of musical information. Traditional music analysis — be it harmonic, melodic, or structural — is a process of gathering information about music and frequently demands a measure of interpretation to allow for the limitations of musical terminology.

The nomenclature used in musical analysis serves as carrier of information about a composition and simultaneously is an indicator of the conventions that may apply to the music. John Fiske explains that ...

> We are always checking the accuracy of any message we receive against the probable; and what is probable is determined by our experience of the code, context and type of message, in other words, by our experience of convention and usage. Convention is a major source of redundancy, and thus of easy decoding. (Fiske: 1982, pp. 11-12)

Fiske uses the word 'convention' in reference to information that is already known by previous experience. As such it excludes originality which is a source of new information and thus unpredictability.

Some confusion may arise about the use of the term information. A natural deduction is that the more information that is known about a specific composition, the easier it should be to identify it. However, it is important to realise the difference between information **about** a composition and the information inherently **generated** by a composition. Information about a composition serves to identify a work, while information contained in a piece of music represents the level of tonal, harmonic and rhythmic structural organisation. An increase in structural complexity is directly related to the increase in the level of unpredictability (entropy). For example, a melody that contains only diatonic notes in two regular and symmetrical phrases, both of which are repeated contains less information and is more predictable than a through-composed melody of the same length that contains all twelve notes of the scale and no repeated phrases and therefore contains more information.

The process of reaching a decision based on prior experience may readily be illustrated by the decision-making tree of Figure 2-4 by which the key of a piece of music with, for instance, two sharps may be established.

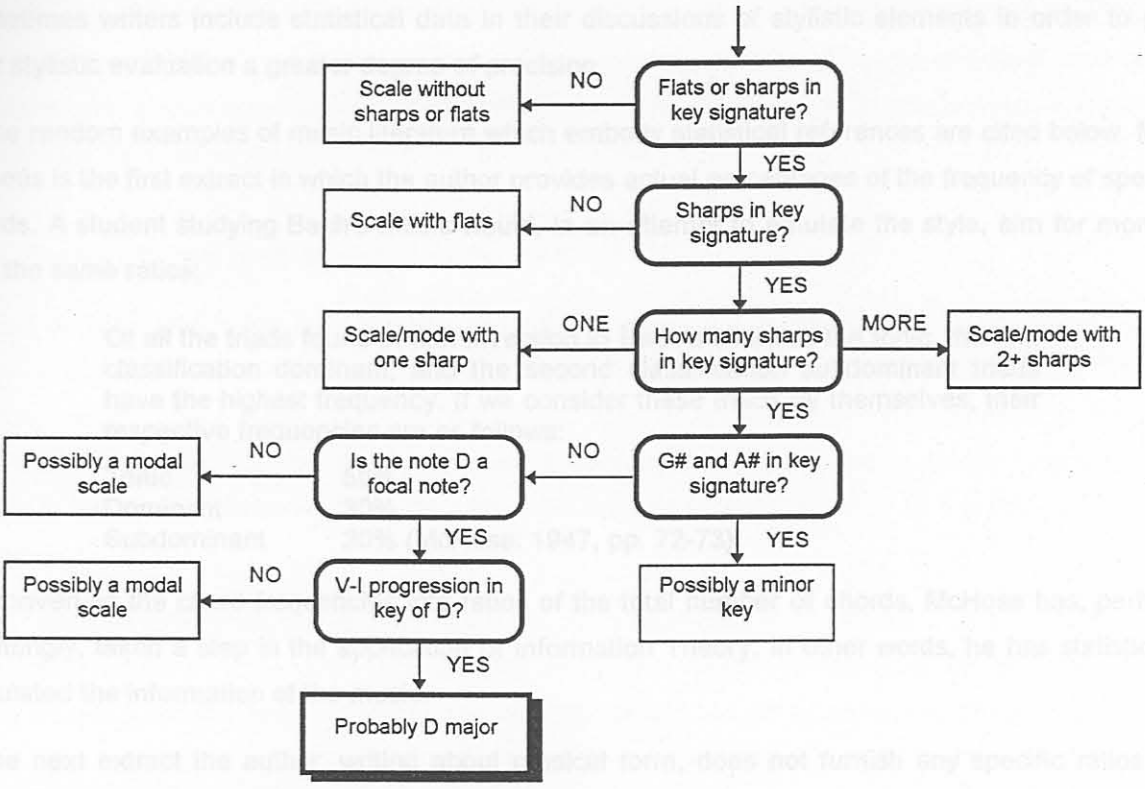

Figure 2-4. Decision-making tree

Many musicians, for whom the recognition of a key has virtually become a matter of intuition the process shown above would clearly seem long-winded and perhaps simplistic. Through continuous use it becomes an unconscious process; one by which various possibilities are systematically eradicated; a consistent narrowing of choices until a final conclusion is arrived at. The fact that a musician has the confidence to state a key is in itself an indication that a certain set of circumstances will always be predictable and generate similar results.

2.7 Music analysis and statistics

Usually, music analysis is more than merely a process of making single decisions and a good deal of intuition and interpretative judgement is often necessary. Many books on musical style present interpretative information in descriptive phrases and classify musical elements in broad terms that often allow for a degree of tolerance within specific limitations. The use of the term sonata form has already been mentioned, and other examples that may be mentioned are: final cadence, ascending or descending melodic curve, and varied repetition, to name but a few.

To make their analysis more relevant and precise some authors endeavour to describe musical elements in more detail. For instance, two forms of perfect cadence are sometimes referred to as 'perfect authentic cadence' and 'imperfect authentic cadence', to distinguish perfect cadences with chords in root position from those containing inverted chords.

Sometimes writers include statistical data in their discussions of stylistic elements in order to give their stylistic evaluation a greater degree of precision.

Some random examples of music literature which embody statistical references are cited below. Most obvious is the first extract in which the author provides actual percentages of the frequency of specific chords. A student studying Bach's music would, in an attempt to emulate the style, aim for more or less the same ratios:

> Of all the triads found in first inversion in Bach's chorales the tonic, the first classification dominant, and the second classification subdominant triads have the highest frequency. If we consider these triads by themselves, their respective frequencies are as follows:
>
> | | |
> |---|---|
> | Tonic | 50% |
> | Dominant | 30% |
> | Subdominant | 20% (McHose: 1947, pp. 72-73) |

By converting the chord frequencies into ratios of the total number of chords, McHose has, perhaps unwittingly, taken a step in the application of Information Theory. In other words, he has statistically calculated the information of the music.

In the next extract the author, writing about musical form, does not furnish any specific ratios but provides a measure of predictability or probability by phrases such as 'often enough', 'occur frequently', 'unlike', and 'unique':[7]

> Other forms occur *often enough* to be grouped into other formal categories. *Frequently*, however, disclosure of the tonal structure and design of a composition results in the discovery that the form is *unlike* that of other known compositions. Such pieces are said to have free, or more aptly, *unique* forms. Our approach will be to consider those forms that occur *frequently* before directing our attention to the *unique* ones. (Green: 1979, p.5)

Analysis of the following lines by Leon Dallin in his book, *Techniques of Twentieth Century Composition* (Dallin: 1975, pp. 6-7), can, with some exceptions, be translated into absolute values:

> Stepwise motion is predominant [51% at least][8] in the melody, and scale-line motion in the opposite direction invariably [100%] follows the descending fifths. There is a balance [about 50%] between the notes above and below the starting pitch. A climactic effect is lacking [0%], because the highest note comes in both the first and third phrases [100% of the two phrases] ... This device occurs in five of the nine measures [55%]. In each instance [100%], besides occurring on different pitches, it is subtly altered ... (Dallin: 1975, pp. 6-7)

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7 Italics by the candidate

8 Figures in brackets were added.

The fact that the information in the three extracts were first gleaned from the music and then in some way or other quantified in order to be represented, either by means of figures or adjectives implying absolute and relative quantities, is an indication that there are elements in music which are naturally suitable for the application of the methods of Information Theory.

2.8 Redundancy and musical style

As will be illustrated in the next chapter, redundancy refers to the predictability in a message and in music refers to the banality or predictability of the stylistic elements. It is inversely related to entropy. In Information Theory, redundancy, is also used to refer to probability or the structure of a message. The same argument may be used in music. A composition which adheres totally to a theoretical model is totally predictable and may be said to have a redundancy of 100% as it provides no new information.

A composition written according to the style of a specific model — for instance by a student in composition — would, by implication show definite similarities. Such a composition will also show certain characteristics peculiar to the composer and stylistic period. As far as style is concerned, the entropy value of a composition would thus give an indication of the individual style compared to an overall model with the fixed elements represented by the redundancy.

One of the nebulous abstractions that is sometimes used in conversations about music is the concept of 'understanding' music, and it would seem that the 'understanding' of music is closely dependent on the amount of information that a composer has vested into a musical work, in other words the relationship between the redundancy and predictability of music. Pop-songs which have clearly defined, repetitive rhythms with a steady tempo, employ a limited repertoire of harmonies, and only have one or two melodic periods which are continuously repeated, clearly have a greater redundancy. Sales charts show that music with these characteristics have a greater general appeal than most contemporary academic music in which variety and originality of musical information is a major factor.

> Redundancy also helps solve problems associated with the audience. If we wish to reach a large, heterogeneous audience we will need to design a message with a high degree of redundancy. A small, specialist homogeneous audience, on the other hand, can be reached with a more entropic message. Thus popular art is more redundant than highbrow art. (Fiske: 1982, p.12)

This may well be the reason why music by composers such as Schoenberg, Hindemith and so many other twentieth century composers has found less general acceptance in contrast to music by composers such as Tchaikovsky. It is probably also the reason why specific works of a particular composer are more popular than others and why it often happens that compositions which are less conventional are often surreptitiously included in concert programmes which predominantly include 'well known' or popular works with a high redundancy.

Traditional methods of music analysis make it possible to obtain a generally detailed and total picture of a musical work. Usually the various aspects and elements of the music are studied and analysed in isolation after which the results may then be viewed as a whole. Complete separation of the various elements is not always possible as there are always interactions at work, for example, a melody and the harmony which underlies it. By first extracting information from the individual elements and then studying the results in relation to each other, a descriptive understanding of the work becomes available. The results are usually loosely worded descriptions referring to form, melodic shape, harmonic complexity, textures, and other musical elements contained in the analysis. A description of this kind is useful in discussing the style of a composition by itself or in comparison with other works, but has major shortcomings when a single model is to be devised which could represent most of the salient as well as the less obvious aspects of the music. By no means does this imply that it would be of any value to attempt to reduce the style of a composition to a single numerical value. This would merely mask the significance of the stylistic qualities of each element which contribute to the uniqueness of the composition. Not only would important stylistic elements be lost, but by combining the various aspects into a single value, those that are peculiar to a specific style would be obscured.

A single element also serves very little purpose in classifying a complete work stylistically. Deryck Cooke provides a number of clear examples in his book, *The Language of Music*, in which he classifies melodies according to their sequential intervals and continues by giving each melodic pattern an emotive value (Cooke: 1959, pp. 113-167). Cooke recognises sixteen different kinds of melodic patterns and it is significant that each pattern represents melodies selected from a repertoire spanning more than five hundred years. One of Cooke's examples is the descending stepwise minor melody starting on the tonic, 8-7-6-5 (minor), for which he lists eighteen examples by composers which include Ockeghem (c 1480) to Benjamin Britten (b 1946). (Cooke: 1959, pp. 163-164) If these melodies were only to be judged by the sequence of the pitches they embrace, it would be virtually impossible to classify them stylistically. However, when the rhythmical and harmonic properties of such selected sections are taken into account, two additional dimensions or stylistic indicators are added to the study, thereby making it possible to obtain a clearer idea of the stylistic properties of the work. As the musical dimensions are increased in an analysis so the identification of the stylistic elements are given greater depth and become more accurate. However, the number of elements that can be taken into account may vary greatly and depend on the style of music in question.

2.9 Conclusion

Music as a form of human communication shares a number of similarities with other forms of communication. Of primary importance in the study of musical style is the fact that composers through the years have imposed certain restrictions and points of reference on their music which makes it recognisable. Most of these structural elements, be they harmonic, melodic, rhythmic or formal, can be measured and expressed in terms of numerical data— usually by way of ratios. For the purpose of the application of Information Theory this is ideal because it can only be applied to quantifiable elements.

As a communication medium, music is more complex than many other forms of communication, especially when a performer contributes to the artistic rendition of the composer's creation by way of aesthetic information. Other factors also have an influence on the final product the listeners hears and which will add or subtract from both aesthetic and semantic information. It is for this reason that the score is the best source for entropy analysis because it presents the semantic information of the music in its purest form.

Before the application of the statistical principles of Information Theory is demonstrated, the next chapters will cover the mathematical concepts and historical background of Information Theory.