

CULTURE SPECIFIC MUSIC INFORMATION PROCESSING: A PERSPECTIVE FROM HINDUSTANI MUSIC

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ABSTRACT

Music can be considered as an art and/or industry. Regardless of this dichotomy, the totality of any music tradition can be studied keeping in view the following ten aspects that are integral to every tradition: compose, perform, receive, perceive, teach, learn, preserve, access, disseminate & share. These areas are interdependent yet mutually influencing. In this paper I outline some issues that have either a direct or indirect bearing on these areas. My observations will be from a perspective of a practitioner and musicologist especially engaged in a project related to computational musicology. I will concentrate mainly on five aspects: listening, intonation, improvisation, instruments and notation. The paper also includes a short discussion of our research project AUTRIM (automated transcription system for Indian music), developed in collaboration with Prof. Wim van der Meer of University of Amsterdam.

1. INTRODUCTION

One of the key features that distinguishes humans from other animals is the fact that we are intrinsically musical. Music is generally associated with the expression of emotions, but it is also common sense that the intellect plays an important role in musical activities.

In a radically important study titled 'How Musical is Man?' John Blacking observes, "There is so much music in the world that it is reasonable to suppose that music, like language and possibly religion, is a species-specific trait of man." Blacking prefers to define music as "humanly organized sound" and a product of the behaviour of human groups, whether formal or informal [1].

Further, as observed by Ranade, "Contrary to oft repeated expectations, musics are found to be more culture specific than imagined. This is so despite the fact that human organism, mechanically speaking, borders on being similar –nearly identical, the world over. It is no exaggeration that there are as many musics as there are cultures" [2].

Although different cultures tend to have different ideas about what they regard as music, all definitions are based on some consensus of opinion about the principles on which sounds of music should be organized. In other words, music means different things to different people.

The creation, performance, significance, and even the definition of music vary according to culture and social context. Therefore it is significant that this project aims at addressing culture specific needs of different music traditions.

To take this discussion further Blacking adds, "Music is a synthesis of cognitive processes present in a culture and therefore confirms what is already present in society and culture." It follows that any assessment or study of a music tradition must take in to account, not only its tonal and rhythmic structures, grammar and aesthetics but also processes and domains that are extra-musical like its history, sociology, psychology, philosophy, economics, physics, technology and such other related aspects that have significant bearings on the deep structures of music in the respective cultures.

It is pertinent to understand what constitutes the "identity" of any artistic tradition. Is it the geographical location of the region with which the tradition is associated? Is it the religious or political belief system or the cultural milieu of the land? Is it the set of specific musical tenets that govern the music? This is indeed a complex issue.

Any attempt to answer this question with respect to Indian music would warrant a thorough examination of various socio-cultural & music related fundamentals that are associated with it, which in many ways are radically different from the other major musical systems in the world today.

2. INDIA & INDIAN MUSIC

2.1 The word 'India' in certain contexts covers regions beyond India's present-day frontiers. Any reference to Indian music would imply the music of Indian subcontinent as a whole, including seven nations - India, Pakistan, Bangla Desh, Afghanistan, Tibet, Nepal & Bhutan.

2.2 The classical or art music of India as we know today, traces its origin to Samveda, comprising the lyrical hymns of Rigveda, the oldest text preserved in any Indo-European language, composed between 1500 - 900 BC. Unlike the music traditions of ancient Greece, Egypt, Sumeria, Israel and rest of the Middle eastern world; which survive only in handful of notated fragments and partially documented theoretical systems, elements of ancient and medieval Indian music are alive in contemporary practice and are adequately documented in the treatises dating back to pre-Christian era.

2.3 Notwithstanding the antiquity associated with Indian music, the contemporary art music should be understood as a confluence resulting from cultural exchanges

operative over centuries within the cultural zone consisting of Greek, Arabic, Iranian and Indian people. Music traditions in all these civilizations had or have the following common features to varying proportion: oral tradition, primacy of vocal music and microtonality. Nonetheless, it is interesting that today each of these cultures have a distinct identity and are the “other” *vis a vis* each other.

2.4 Music in the Indian subcontinent is a reflection of the diverse elements; racial, linguistic and cultural, which make up the heterogeneous population of the area. The extraordinary variety of musical types is probably unparalleled in any other part of the world. Music has a vital role in the religious, social and artistic lives of the people. A great deal of it could be termed functional, as it is an indispensable part of the activities of everyday life ranging from work and agrarian songs, festivities, to the music which accompanies life cycle events such as birth, initiation, marriage and death¹ [3].

2.5 The reality of the broad spectrum of music in India today, is far from a unified and homogeneous entity. For past several centuries six categories of music have flourished side by side: primitive, folk, religious, art, popular and confluence. Even though the present brief is for Hindustani (north Indian) art music, (sometimes inappropriately described as classical music), awareness of the larger perspectives offered by the categorical sextet cannot be ignored.

2.6 The Sanskrit word *Sangit*, an exact cognate of the Latin *concentus* - sung together, conveys the core of the ancient Indian conception of music. The larger implications of *Sangit* include melody and then the organized sound in general. The English word ‘music’ fails to capture the exact sense of *Sangit* just like that of Greek *mousike*. Music covered a somewhat different and wider range of topics than it does today. Its three technical divisions were: melody (*gita*), instrumental music (*vadya*) and movement (*nrta*), the last of which included abstract dance, mime, and acting.

2.7 As a performing art deeply rooted in the socio-cultural milieu, a sound understanding of certain aspects of religion, philosophy, aesthetics, history and culture becomes a necessary prerequisite for the study of Indian music. Furthermore, the Indian philosophy firmly believes in inter-relationship of various arts in general and that of graphic art and the art of music in particular. Ancient scriptures dwell on a strong connection between the art of image-making, painting, dancing, instrumental music and vocal music, thus expanding further the domain of background necessary to undertake a serious study of music.

2.8 There is also a strong sense of spirituality attached to Indian music, the realization of which is essential for its study and practice. The immediate goal of music is

sensory pleasure but its ultimate goal is regarded as the spiritual release.

2.9 Indian music, like the other great traditions of the South Asian classical music, is regarded as pre-eminently vocal; instrumental music of whatever degree of virtuosity is looked upon as tangential, whether regarded as accompaniment to the voice, or as an imitation / extension of the voice, or as a secondary tradition parallel to the vocal tradition.

2.10 Indian music is based on melody and rhythm; harmony and polyphony, as known in the West, have no part in the music. Much of the music is modal in character and is often accompanied by a drone, which establishes a fixed frame of reference and precludes key changes, which are so characteristic of Western music. Indian film music is of course an exception to this norm as it freely uses Western instruments and techniques including harmonization, chords etc.

3. INDIAN ART MUSIC: CHARACTERISTICS

3.1 It is the patently aesthetic intention of the art music that sets it apart from the other categories.

3.2 It is governed by two main elements: *raga* and *tala*. Whilst *raga* is a tonal matrix, *tala* is a rhythmic framework, which unlike in many other traditions is cyclic, and not linear in nature.

3.3 Since the ancient time, in the domain of art music two streams have evolved: performing and scholastic. The latter follows the former, leading to codification of pertinent rules, methods and techniques. The knowledge of the fundamental theoretical precepts is considered essential to a practicing musician.

3.4 It is primarily a tradition of solo performance, affording scope to innovate and interpret, and hence methods and techniques are developed to this end. Consequently, this leads to emergence of various musical ideologies and family traditions (*gharana /bani*).

3.5 There is an abundance of musical forms with specific structures based on patterning of musical elements (notes, rhythms, tempi etc.). Certain forms are regarded more prestigious because of the demands they make on performers in terms of the skill and techniques required. On the other hand, genres in other categories of music are combined results of many active, non-musical factors (for example human life cycles, seasonal changes, associated rites and rituals etc).

3.6 Modes of expression are deliberately cultivated and hence necessitate a highly structured teaching-learning process.

3.7 The audiences are supposed to be educated about the art form and are expected to contribute to music making, expressing their approval/disapproval in accordance with the established norms forming a part of the cultural pattern.

¹ Ranade suggests that the overall religious tolerance of the Indian subcontinent during the successive centuries proved major force in considerable expansion of the Indian performing spectrum.

4. LISTENING

Several individual components go in to the making of any music and consequently, the process of listening to that music involves attention to be paid to every component. This makes for a multi-layered listening, which in case of Hindustani music starts with listening to the drone given by the tanpura (a string instrument with 4 or 6 strings), especially the tonic, which becomes the point of reference for both performer and listener. Unlike Western music, pitch in Indian music is not absolute. It is rather relative (in terms of intervals) to a point of reference given by the tanpura, and hence identification of the tonic becomes crucial.

Typically, a 4-string tanpura is tuned (in the order of strumming) to the fifth (P) or the fourth (m), the tonic (S), again the tonic (S) and an octave below the tonic (S).² The special curvature of the tanpura gives rise to an envelope that is rich in overtones and harmonics.³ Amongst the broad tonal spectrum, the identification of the tonic and then the fourth or fifth as the case may be, is crucial.

Furthermore, identification and understanding the dynamics of the main voice with the accompanying instruments; both melodic and rhythmic, is vital for understanding this music. So far, to identify the main voice, pitch detection algorithms (PDA) have used energy levels as the main parameter. However, for cases where the percussion instrument is louder than the voice /main instrument, this model has limitations. Likewise, the pitch tracking/identifying algorithms that are currently available, are also extremely limited when it comes to pitch detection for instrumental music, especially with the string instruments having multiple strings; main as well as sympathetic strings.⁴

5. INTONATION

In India, great attention has been paid to ‘pitch’ in music. Musicians attach great importance to precise intonation. Although the exact pitch of the notes has never been standardized in frequencies or ratios, it is recognized that the actual position of the semitones excluding the tonic and the fifth can vary slightly. The flat notes can be lowered by approximately 20 cents. Similarly, the sharp fourth can become sharper. As far as steady pitches are concerned, empirical research indicates that intonation is fairly standardized and that no significant deviations can be correlated to specific *ragas*. Scholars starting with Bharata (200 BC – 200 AD) have formulated concepts such as *svara* and *shruti* to describe intonation. Whereas *svara* is a musical note or a scale degree, *shruti* is a more subtle division of the octave. From early times an octave

was supposed to contain twenty-two *shrutis* and the relation between *shruti* and *svara* has been a major source of confusion. It has not been uncommon to refer to *shrutis* as quarter-tones or microtones, but evidently, twenty-two *shrutis* divided over seven *svaras* in an octave presents a mathematical problem.

The crux of the problem lies in the centuries old fallacy of thinking of melody in terms of fixed positions of intonation. Whereas, experimental studies conducted during the twentieth century provide evidence for flexible intonation, ruling out the notion of pitch as fixed points. [4, 5, 6, 7, 8]. Modern scholars have observed intonation as a statistical phenomenon in which the note densities occur, not as exact points but rather as limited ranges within a certain tonal region. The influence of melodic context on the pitch is also clear from these studies. In fact, *raga* specific intonations of specific individual notes do not occur in isolation, and hence, they need to be examined within the respective melodic context.

Intonation in Indian music is characterized not only by the individual pitches, but also by the way they are connected, leading to specific melodic contours or shapes. Theoretically, there exist infinite number of possibilities in which the given two notes can be melodically linked. However, in reality, melodic contours are guided by the grammar of the *raga*, the immediate context and the details of individual ornamentation. Contemporary musicians use the term *shruti* in conjunction with highly specific ornamentations of some notes in particular *ragas*. Thus, they speak of the *shruti* of the flat third (*komal gandhar*) in the *raga* Darbari or Todi, or the *shruti* of the flat second (*komal rishabh*) in the *raga* Bhairav.⁵[9,10] Although most scholars have related the ancient concept of *shruti* to pitch positions or tuning schemes, the contemporary meaning of *shruti* seems more related to ornamentation, or to put it in the words of Nicholas Cook, “music between the notes”. [11]

The presence of microtonality in Indian music is evident to anybody who practices this music or listens to it critically. Empirical research also proves beyond any doubt that the concept is not merely an organological construct of historical relevance.⁶ However, the formulation as it is presently understood, needs a paradigm shift from regarding *shruti* as discrete points to defining it in terms of a melodic shape or melodic contour. To describe intonation in the contemporary *raga* performance, we need a more comprehensive model including acoustic parameters of not only pitch but also volume and timbre in relation to the temporal axis.⁷[12]

⁵ For a detailed acoustical analysis of some examples of intonations in these *ragas*, refer to Rao & Meer (2004 & 2009).

⁶ Given that Bharata explains this theory with the help of two *vinas* (a string instrument) with 22 strings.

⁷ For an exhaustive review on the subject of *shruti*, refer to Rao & Meer (2010).

² S R G m P D N correspond to the notes of the C major scale.

³ The physical structure of the bridge surface leading to this phenomenon is discussed in the section 8 dealing with musical instruments.

⁴ The presence of sympathetic strings is a characteristic unique to Indian instruments. These strings operate on the physical principle of sympathetic / forced vibrations.

7. IMPROVISATION

Improvisation is an essential aspect of music practiced in India. Though the idea of improvisation is conceptually contrasting to ‘pre-composed’ presentation, it does not either imply an impromptu expression or a random arrangement of notes or melodic phrases. It rather accepts creativity within the bounds of *raga* grammar and aesthetic norms of the performance practice.

Generally, a performance of Hindustani music traverses through three tempi - slow, medium and fast, in three registers - low, middle and high octave. In each tempo and register, varied techniques are used for improvisation but essentially they are based on the principle of permutation and combination of notes, use of various ornamentation, and varying emphasis (accent) and volume. In the process of improvisation, both matter and manner or the content and technique play crucial role. Techniques of pattern recognition could be applied to study these melodic contours with respect to a given performance, especially to various ornamentations characterized on the basis of specific melodic movements involved. Since the speed of rendition is one of the important factors determining the resulting melodic shape, the aspect of time is crucial to the study of melodic contours.

Notwithstanding the importance accorded to the aspect of improvisation as an essential component of music practiced in India, a well-structured composition (combining melody, rhythm and lyrics) often referred as *bandish* or *cheez* forms its core⁸. In fact, composition gives the basic framework for improvisation. The dynamics of composition and improvisation is an interesting area that needs to be studied.

Improvisation associated with the composition is called *badhat* or *vistar*, literally pointing to its growth or expansion. Nonetheless, in some genres improvisation can also precede the composition, in which case it is purely an exploration of the *raga* without any rhythmic/poetic framework. The process of improvisation (accompanied with or without composition) is akin to ‘story telling’. Musicians have a strategy (*silsila*) comprising of a chain of events, which occur in a fairly disciplined (but not rigid) order of sequence. There is a subject to be explored, storyline to be followed, grammar, logic and syntax to be adhered to, micro as well as macro structure to be kept in mind to finally create a portrait of the *raga*. Any attempt at studying and modeling this complex process must include, besides the principles of permutation and combination and the story-telling logic, aesthetic principles of the *raga*, genre and the music tradition in general.

Preliminary investigations of intonation and melodic movements in *raga* Yaman suggest that a *raga* performance is a ‘rule based’ and ‘model based’ phenomenon⁹. Outwardly it may seem to be impromptu,

⁸ Compositions meant for instruments may or may not include lyrics. Also, those meant for percussion instruments, san both melody and lyrics.

⁹ This heptatonic *raga* has all natural notes, except the fourth, which is augmented.

but in reality, any *raga* exposition is essentially governed by certain rules comprising its grammar and also the model preconceived in the mind of a performer which results from his/her training, experience, imagination and skill. The similitude of the tonal configuration makes it possible to correlate it with the unique character of the *raga* (*ragabhava*) and consequently to the aesthetic emotion elicited in the mind of a sympathetic listener, often referred to as *rasa*¹⁰ [13].

8. INSTRUMENTS

Despite primacy accorded to human voice as the God-made instrument, Indian subcontinent abounds in a variety of man-made musical instruments. While the human body itself is regarded as an instrument (*shariri vinalgatra vina*), instruments are expected to have ‘vocal’ quality¹¹. A considerable degree of specialisation is displayed in instrumental usage, both in the north and the south Indian art music. Instruments present music solo, provide melodic or rhythmic accompaniment, or produce drones.

It was in India that the concept of classification of instruments first emerged. Bharata’s *Natyashastra* (c. 200 BC – 200 AD), which is a magnum opus on the subject of dramaturgy, also covers a detailed discussion on various instruments, wherein the author has proposed a four-fold classification of instruments — *tat* (strings), *ghan* (solid), *sushir* (winds) and *avanaddh* (membrane-covered). This seems to be the first ever attempt at classifying instruments on the basis of type of sound producing agent – strings, solid body, air column and stretched membrane, which are made to vibrate using different techniques like plucking, blowing, bowing and striking. The contemporary musical practice is fairly well explained by this classification. Nearly 2000 years later, in the West, we find a similar model proposed by Sachs-Hornbostel (1914) to classify instruments practiced in the contemporary Western tradition [14].

In the 1920s, Sir C. V. Raman, the Nobel laureate Indian physicist attracted attention of the world to the unique acoustic properties of Indian string and percussion instruments. On the basis of scientific enquiry, he proved that the materials and techniques used in making of, and performing on, these instruments result in tonal and timbre properties that are unique, and not found in similar instruments elsewhere. The special curvature of the bridge (supporting the strings) and the loaded membrane (in percussion instruments) are indeed significant contributions of India to the world of musical instruments [15].

There are several aspects in the area of instrument-making and maintenance that can be assisted by technology (mechanical & electronics). These are:

- Spectral analysis, identification and synthesis of

¹⁰ The concept of *rasa* is unique to Indian poetics and dramaturgy. There is no exact equivalent in other cultures but ideas denoted in terms like *ethos*, *empathy*, *eurfulung*, *gestalt* and *duende* are somewhat similar.

¹¹ Instruments are called *vadya*, which literally means “that which speaks”, from the Sanskrit root word *vad*, meaning to speak,

sound of specific instruments.

- Study of the bridge surface, especially for string instruments like tanpura & sitar, with a view to have automated process for its manufacture and maintenance.
- Manufacture of standardized instruments.
- Study of the wear & tear behaviour of a string on a given surface so as to identify alternate material for the bridge surface.
- Development of electro-acoustic and electronic instruments.

9. NOTATION

Notation is a way of manipulating visual designs to communicate one's individual impressions of music to other people.

9.1 Role of Notation in India

In India, music is first and foremost an oral tradition, which is also true for disciplines such as Ayurveda, philosophy, yoga, linguistics and grammar. Many features concerning education, performance, appreciation and propagation of music are directly and deeply rooted in the oral tradition. Although systems of music notations have existed in India at least since the early centuries AD, the relationship of notation to performance in the Indian tradition is very different from that in the West. As observed by Widdess, Indian musical notations are oral in origin, and mnemonic in function; in both respects they contrast with Western staff-notation, which is graphic in origin and prescriptive in function [16].

The Indian notation system uses mnemonic syllables (*sargam*), which basically means that sounds are given names by which they are referred, essentially to help talk about, think, discuss as well as transmit both melodic and rhythmic music. The mnemonics can include note names and strokes of stringed instruments or drums. They can be recited and remembered with specific inflections that symbolize ornamentation and/or dynamics of volume and timbre. It is to be noted that independence of Indian art music from written notation allows, or is a function of, a high degree of variation, embellishment and improvisation practiced in performance.

9.2 Notation: Advantages

For musicians, there is a direct connection between sounds and mnemonics, and hence they resort to *sargam/bol* for musical thinking- teaching and composing. The sketchy *sargam* notations are an aide-memoir especially to keep record of traditional compositions. From the late 19th century onwards, compositions were printed & published with notation for the purpose of instruction, dissemination and preservation of traditional repertoire, which has so far come to us mainly through oral tradition.

9.3 Notation: Limitations

Although the 'oral notations' may be committed to writing in whatever syllabic script prevalent locally, both in intention and actuality, notation is expected to be

skeletal. It is neither graphical in the way the Western system is, nor is intended to precede or replace oral instructions but only to reinforce it. Although there is a direct connection between sounds and mnemonics, the ways in which the mnemonics of Indian music can be interpreted are far more diverse than words in the domain of language. Nonetheless, during the process of writing music, the 'extra' information in terms of various inflections is never written; rendering the system inadequate for the visual representation of music. Although such sketchy notations are an aide-memoire, in general, the practitioners rightly maintain that 'written' music doesn't represent the musical events as they are transmitted through oral-aural mode adopted in the traditional method of instruction.

9.4 From Notation to Transcription

The difference between notation and transcription is mainly in their function. Although related, there is a basic difference between the two. The former is 'prescriptive' while the latter is 'descriptive'.

The development of transcription in the late 20th century seems to be towards cognitive or conceptual transcription that seeks to portray musical sound as an embodiment of musical concepts held by the members of a culture. It provides a graphic interpretation of the essential concepts and logical principles of a musical system.

9.5 Human Transcription – Limitations

The invention of sound-recording has lent new meaning to the process of transcribing. Ethnomusicologists have used a most rigorous method for objectifying, essentializing and sometimes even appropriating music of the 'other', first by recording and then by transcribing the recording. The resulting transcription is used as analytical description. The fundamental problem with the transformation of sound into transcription is that the coder is a black box, the inscrutable brain of either a musician or (ethno)musicologist. If we would know the functioning of this black box, we can make the decoder at the other end to work. Moreover it is not unlikely for our own black box to fail when we have to decode the data. The human transcription also tends to rely heavily on hypothetical conditions such as "a reliable ear" and "unfailing instincts", not to mention the general tendency of the 'coder' to reduce and distort the music so as to adapt it to Western categories of musical thought.

9.6 Computer-aided Transcription

On the other hand, computer generated transcriptions can create graphs that are free from these limitations. At least, if the computer program is correctly documented the coder-decoder system is totally transparent. The average musicologist may not fully grasp the workings of the computer 'codec' but it is wide open and it always works in the same way (provided the parameters of the program remain unchanged). In this respect it is reliable, objective and consistent.

10. AUTRIM: ‘Music in Motion’

Sound and sight constitute one of the major synesthetic pairs of senses. The validity of this project, which is essentially based on computer-aided graphic transcription, rests on this premise. The auditory perception of sound combined with a simultaneous image of melodic shapes can be far more effective because the graphic transcription can help to “see” notes as well as their intricate movements. Graphic contours are useful in understanding the “sound” of music, which is otherwise assimilated only by repeated learning and practice. It reveals what we do not “hear”, what we change in the process of “hearing” or what we take for granted. It can also provide an insight in to extremely subtle elements of music that we cannot readily distinguish aurally, but which might nevertheless influence our perception of the music on a subconscious plane [17]. The microscopic viewing ability afforded by the graphic transcription is also invaluable in music analysis. Various subtle aspects such as intonation, melodic and rhythmic features, lyrics etc. can be reliably studied with the help of computer-aided transcription.

The idea of deploying such transcription seems apt for the visual representation of Indian music, as it allows to overcome the limitations of the traditional notation system and supplement the conventional method of teaching and learning, which is mainly based on oral-aural techniques. It seeks to depict graphically the essential concepts and logical principles of the musical system. Although it presumes prior knowledge of essential features of performance, it allows freedom to make strategic choices appropriate to the music.

Computer programs like PRAAT developed by Boersma and Weenink are now very sophisticated and can produce more “beautiful” images of melodic music. In the ongoing research project jointly undertaken by the National Centre for the Performing Arts and the University of Amsterdam (Prof. Wim van der Meer), we have developed an automated transcription system to notate Indian music (AUTRIM). We have evolved a process of developing PRAAT into a full-fledged music analysis program for Indian music, and have processed a large volume of music. The final output is a video (720 p HD) showing melodic graphs corresponding to a mini *raga* performance of 10-12 min duration; superimposed on a tonal grid and supplemented with the rhythmic and poetic information, displayed simultaneously with the corresponding audio. A vertical cursor corroborates the visual and audio information. At present we have a data comprising of 110 compositions in 85 *ragas*. Out of these, videos corresponding to 25 *ragas* are already available with the full details of the *raga*, the composition, the performer and analysis of the performance¹².

¹² <http://autrimncpa.wordpress.com/>

11. CONCLUSION

As discussed herein, several components of art music can be considered as rule-based and model based phenomena. Hence, it seems that technology could play an important role in understanding, analysing, documenting and development of these facets. Not surprising therefore, today the technologists and technocrats are becoming increasingly curious about music as an art, science and industry. It is also interesting that so far most research related to aspects such as recording, reproduction, broadcasting, artificial intelligence etc. has been by the researchers working outside the domain of music per say. However, it is crucial that musicians & musicologists as the major stakeholders and custodians of the necessary artistic/theoretical knowledge base to be actively involved in the process of conceptualising such interdisciplinary projects. Only such joint ventures can hope to lead to aesthetically meaningful and culturally viable endeavours.

Sound as we know, is fundamentally an abstract entity. On one hand, music as organized sounds is an intentional and rule based activity. On the other hand, it is also governed by culture specific philosophical tenets rather than universally standard quantifiable parameters. Anyone who desires to seek the beauty and the truth in the art of music cannot afford to overlook this enigmatic reality.

It is said that music sounds the way emotions feel! Nevertheless, it is conceivable that in not too distant future we may be able to meet the formidable challenge of finding computational analogs to represent human intelligence and emotion. While we are on the road to developing such “software” to meet the “mindware”, let us be cautioned by the thesis given by the eminent mathematician John Myhill, “Trying to characterize all the musical cognition in terms of computations alone, is a bit like trying to paint all the landscapes without using green.” [18]

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