Social and Perceptual Dynamics in Ecologically-Based Composition

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Abstract

The ecological approach has provided fruitful applications in sound synthesis and composition. Nevertheless, the implications of this approach in the understanding of music theory have not been sufficiently explored. This paper explores the theoretical aspects behind the development of ecologically-based compositional work. Following closely Shepherd's (1992) essay, I discuss whether ecologically-based music can be studied with linguistic tools. The concepts of potentiality and actuality are situated within the perspective of individual-environment interactions. A process that describes the relationship between an individual and his specific social context is proposed: the personal environment. Consistency is discussed in the context of environmental sound listening processes and ecological modeling work. The paper concludes by suggesting that form-creation is dynamically determined by a process of mutual adaptation between the listener and the environment.

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http://www.sfu.ca/sonic-studio/EcoModelsComposition/SoundExamples.html

1. Introduction

Ecologically-based compositional processes make use of familiar sound classes and temporal grouping mechanisms to provide cues that reference the listener's everyday sonic experience. Social references provide pointers to the cultural context where the piece belongs. These compositional strategies do not fit within the context of traditional theoretical categories. Concepts that stem from pitch-based and tonal music can hardly be applied to dynamical processes that are context-dependent and listener specific. Abstract, universal laws lose meaning when music organization relies on specific social contexts. Thus, a theoretical approach that works from the level of sonic configuration up to the level of socio-cultural relationships is needed in order to develop ecologically-based sound works.

Although issues such as performance, improvisation, documentation in its several forms, aesthetics, or neural processing are intimately related and relevant to my study, I will concentrated only on one conceptual axis: social context as related to music composition with ecologically-based sound models. The first two sections of the paper address two aspects of the music theoretical framework: (1) temporal levels of the compositional and analytical work, (2) socio-cultural context and its relationship to sound structure. The third section discusses the problem using broad generalizations in music theory. Personal environment as a specific dynamic process is proposed. The fourth and fifth sections deal with two key concepts in ecologically-based work: (1) structural coupling as a way to establish potential and actual meanings between individual and environment, and (2) consistency as a means of defining sound model constraints. The last sections outlines the salient characteristics of ecological models and the paper concludes with a summary of the main theoretical items presented.

Shepherd (1992) differentiates between two perspectives in musicological and theoretical music research by their choice of the object of study: (1) cultural context, the social circumstances surrounding the creation and appreciation of music; and (2) cultural text, the sounds of music as carriers of social and cultural messages. The focus of the next section will be the cultural text, specifically, the theoretical shortcomings of syntax-based or linguistically oriented musical analysis.

2. Music as cultural . . . text?

By introducing the actual sounds as a valid object of research, Shepherd's work departs from traditional musicological methods that deal with everything but the actual music (cf. Leppert & McClary, 1987). Nevertheless, his use of the word "text" to identify musical phenomena is highly problematic. It carries the implication that music is in some way equivalent to language and thus can be analyzed with the same tools, namely linguistic, semiological, or syntactical (Lerdahl & Jackendoff, 1983). Syntax-based analysis suggests that music is shaped by abstract relationships which are not dependent on the dynamics of sonic processes. Thus, compositional strategies that use spectro-temporal configurations as their basic material can hardly be analyzed with these tools. Although Shepherd acknowledges the existence of musical sounds that do not lend to syntax-based analysis, he keeps an explicit differentiation between sound structure and meaning in music.

According to Shepherd (1992, 136), meaning is conveyed by musical syntax, "the abstract relationships between sonic events." Similarly to Boulez (1992) and other music theorists, he asserts that these relationships have existence "primarily through the parameter of pitch, and to a lesser extent, through the parameter of duration (. . .)." As we have discussed and demonstrated experimentally, musical parameters interact (Tróccoli & Keller, 1996). The listener's musical experience is not defined by orthogonal, out-of-time variables, such as pitch represented on a staff, but by the interaction of concurrent processes that unfold in time during actual listening (Melara & Marks, 1990). These processes do not solely occur at the level of syntactical events (musical notes), they also take place at the micro (timbre) and at the macro level (musical morphology). In other words, analyzing music syntax using out-of-time notation creates an object of study that does not correspond to any actual musical experience.

Further support of the idea that music listening processes are not syntactically based comes from studies in sound identification and linguistic labeling. The experimental hypothesis goes along the following lines. If sounds are organized using linguistic mechanisms, a two-stage process is necessary. Before cognitive relationships among the stimuli are established, linguistic labels need to be assigned to each of them. Therefore, experiments have to test whether identification processes, such as labeling, take place in music listening. A complementary test should point out the difference between identification and recognition mechanisms.

Handel (1995) brings up a paradoxical study by Eustache, Lechevalier, Viader, and Lambert where a subject with a "left temporoparietal lesion was unable to identify common tunes but was able to discriminate whether two tunes were the same in terms of one false note, rhythm, or tempo. (. . .) [In contrast], another subject with a right frontal lesion could identify environmental sounds and familiar tunes, but was unable to say whether two sounds or tunes were the same." These results indicate that identification, which involves labeling and speech-based cognitive mechanisms, should be clearly differentiated from discrimination tasks.

Handel (1995, 456) states that "there is rather strong evidence that the processing of speech and music is done in different parts of the cortex." He points to examples in the literature which show that individuals suffering from auditory agnosia can neither recognize nor identify a sound, although they can perceive changes in its acoustical properties, i.e., frequency, intensity, amplitude. Other subjects are able to understand complex verbal material but fail to identify environmental events. Furthermore, some patients are unable to discriminate voices but recognize environmental sounds (Handel, 1995, 457, and references therein).

To study whether labeling mechanisms were used in organizing acoustic stimuli, Warren (1993, 40) employed the task of ordering acoustic sequences. He reports that in several experiments the threshold for identifying the order of looped (he says recycled) sounds was found to be between 100 and 200 ms. On the other hand, when subjects were asked to discriminate between different orders of sounds, thresholds dropped to 5 to 10 ms. Warren argues that at fast rates, subjects rely on holistic strategies to order the sounds. His article outlines two possible mechanisms for the recognition of acoustic sequences: (1) holistic pattern recognition, where 'temporal compounds' are not resolved into an ordered sequence of elements, and (2) identification of components, which involves the application of linguistic skills in labeling the items. These results suggest that micro-temporal sound structures, – within the range of a few milliseconds - which characterize environmental sounds, are usually processed by pre-linguistic mechanisms. Warren (1993, 62) also summarizes several studies which show that other mammals also use holistic mechanisms to group sounds. He hypothesizes that our "use of speech and production and enjoyment of music might be based upon an elaboration of global organizational skills possessed by our pre-linguistic ancestors." In other words, music listening is probably based on spectro-temporal cues and does not necessarily rely on linguistic constructs.

Even though Shepherd (1992) supports the view that compositional processes should make use of extra-musical referential elements, his concepts are not quite consistent with an environment-based approach. "[U]nlike the sounds of language, sounds in music never refer directly to people, events and objects in the external world. They either copy or evoke symbolically the sonic manifestations of those people, events and objects. Secondly, sounds in music seem not to function in a fundamentally arbitrary fashion. They function in a structural fashion that allows them to evoke, directly and powerfully, the logics and structures of the socially mediated inner life." (Shepherd, 1992, 142). Shepherd is referring to syntactical structure and not to the spectro-temporal dynamics of sound. The distinction between direct reference, as given by environmental sounds, and indirect reference, provided by what he calls musical sounds, is particularly illuminating. It clearly reflects the view held by most music and cultural theorists regarding what sound elements are 'musical.' The next section will discuss the interactions between social context and musical structure in order to place the processes of form-creation within the realm of social and perceptual dynamics.

3. Social context and music: structural interactions

Regarding music's cultural context, Shepherd (1992) identifies three main analytical perspectives: (1) autonomy, (2) structural homology, and (3) relative autonomy. The focus of each of these approaches can easily be represented in terms of how social structure influences musical structure and vice-versa (see figure 1).

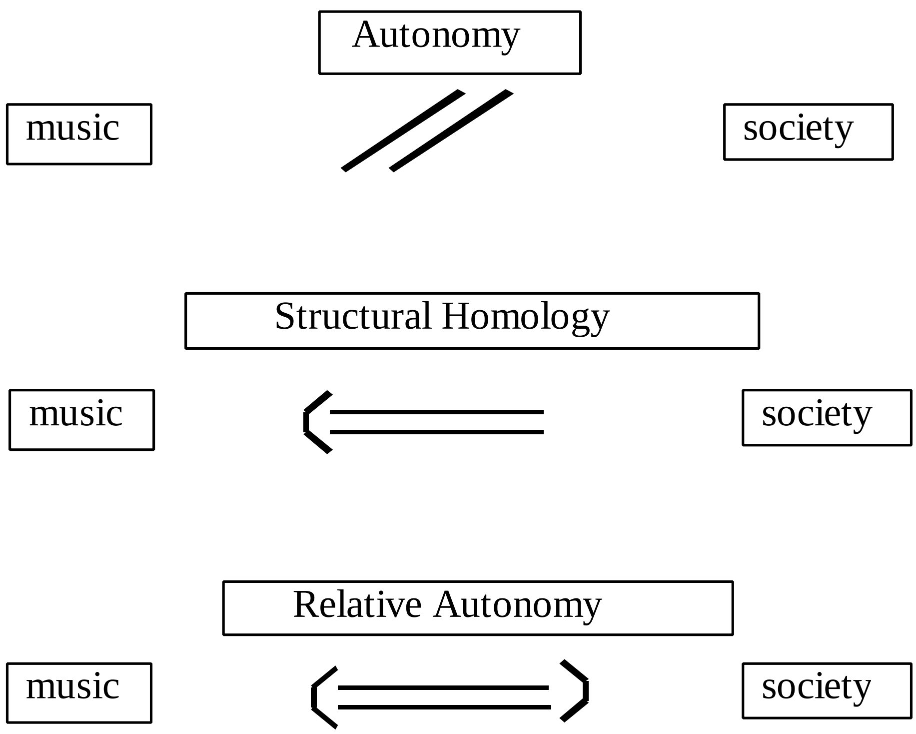

Figure 1. Interactions between social and musical structures.

Most European and North American (ENA) music theorists believe that musical structure and meaning bear no direct connection to the social context in which music is created. When analyzing stylistic features of a specific musical period, i.e., sonata form in Classicism, changes in compositional techniques are usually explained by purely structural criteria and are seldom assigned to extra-musical causes (Bent, 1987; Boulez, 1992). This attitude is not confined to music theory but also permeates other music research areas. Within the field of music psychology, McAdams (1987, 13) sustains that music is an autonomous phenomenon. "Music creates a non-referential (or perhaps self-referential) world. (. . .) It does so through psychological dimensions that are unique to music. (. . .) Despite its lack of specific reference it can have deep emotional significance," he states.

On the other end of the conceptual spectrum, structural homology provides an alternative to analytical practices that lack grounding on social content. Arnold Hauser (1951) maintains that the notion of autonomous art is inextricably linked to capitalist socio-economic structures. The conception of an independent artist, as opposed to a craftsperson, depends on the dissolution of the direct bond between artist and patron. This bond is replaced by a dependency on dealers, critics, art institutions, etc., which act as mediators between art producers and the consumer market (Leppert & McClary, 1987). In other words, music reproduces the structure of the society in which it is being produced. Therefore, musical meaning is directly related to the social structure that supports it.

Shepherd's (1992, 137) concept of relative autonomy establishes a compromise between autonomy and structural homology. His approach strikes a balance between social determinism and musical independence from social dynamics. "(. . .) The significance of musical sociality does not necessarily originate outside 'musical processes.' However, musical sociality would be of little significance if its internal logics and structures were of no relevance to the logics and structures of other, non-musical social processes (. . .). No artistic or cultural forms need depend on non-artistic or non-cultural social processes for their significance. (. . .) An 'autonomous' musical sociality (that is, 'autonomous' musical processes as social processes) may be thought of as resonating, either harmoniously or dissonantly, with other areas of non-musical sociality." In other words, music gives life to the conflicts taking place in society, but does not literally follow the dynamics of social interactions.

Although I do not agree with Shepherd's use of relative autonomy in support of the mythic 'expression' (Stambaugh, 1989, 143), 'creativity' and 'individuality' of the composer, I believe that his position raises interesting theoretical implications. Since "[music] offers up *potentials* and *possibilities* for the construction and investment of meaning on the part of people" [italics his], these possibilities can only be realized in the act of listening. And, listening implies enacting the social and cultural processes ingrained in the piece of music and in the listener's sonic experience.

Ecological psychology researchers such as Michaels and Carello (1981, 44) have drawn a border between the cultural and the 'natural' environment. Nevertheless, if we abide by the idea that the musical environment is listener specific, then a single concept can encompass the multiplicity of contexts that are brought into play at the moment of music listening: namely, a 'personal environment.' This environment places the work within the listener's cultural context and re-enacts his previous sonic experiences. Thus, instead of forcing sound and its organization into abstract 'universal' molds, we can use the listener's specific background to interpret the work from a specific cultural and natural context.

Under this light, there is no culturally neutral listening experience. Every music carries the cultural baggage of its social origin and every listener places the music within his personal environment. The clash between these two contexts informs the creation of musical meanings and simultaneously reshapes the personal environment. Thus, an ever-changing history of meanings is established.

4. Universals?

ENA music theory usually treats the musical work as an object separated from an actual performance, a specific acoustic space, a reproduction mechanism (human or mechanical), and a social context (cf. Bent, 1987; Boulez, 1992; Dempster & Brown, 1990). This methodological approach has been also applied in music psychology (cf. Parncutt, 1989; Sloboda, 1985).

Two illustrative examples of the 'universality fallacy' can be taken from the music psychology literature (Krumhansl, 1990; McAdams, 1987). When presenting the conclusions of her work "Cognitive Foundations of Musical Pitch," Krumhansl (1990, 281) states that "the investigations focused on pitch structure, and tonality in particular. This focus on tonality was chosen for several reasons. First, it plays a central role in theoretical treatments in Western tonal-harmonic music. Second, *most music cross-culturally and historically* can be described as tonal in a general sense that pitch materials are centered around one or a few significant tones." [italics mine]. This definition of music implies a clear hierarchy where pitch and tonality occupy the center of the theoretical (and therefore methodological) preoccupations leaving aside key parameters such as temporal organization, timbre configuration, and referential elements.

A second example of the use of universal concepts in music research is found in McAdams (1987), though in this case there is no acknowledgement to traditional ENA music theory. Following Sloboda (1985), McAdams (1987, 12) calls attention to some of the assumptions made in current music psychology paradigms. I list the ones that tinge present day research (cf. Aiello, 1994; Bregman, 1990; Krumhansl, 1990): "(1) The internal representation of music has a hierarchical component; (2) scales, meter, and rhythm are psychologically real organizing principles and instantiations of music universals which may be found in almost any musical culture" I suspect that McAdams is being faithful to Sloboda, since throughout his text he maintains that musical representations are culturally specific but simultaneously he states that these representations are just instances of abstract universals.

McAdams (1987, 13) subscribes to the traditionally accepted view of autonomous music. That is, music creates its meaning without establishing links with the social or natural environment where it takes place. He says that "music creates a non-referential (or perhaps a self-referential) world." Furthermore, he criticizes the use of referential elements in music because they hinder the structural coherence. "One of the problems with *musique concrète* is that the sound elements (. . .) have such strong references to everyday life that they are made to cohere with an overriding structure only with great difficulty. (. . .) In a sense, the material is not only too identifiable but is also too discontinuous or categorized to be assimilable into a form that is foreign to its already strong semantic function." (McAdams, 1987, 55). Although his assessment of concrete music may be correct, by now it is clear that its structural weaknesses are not caused by the elements themselves but by the transformations (or lack thereof) imposed onto the material (cf. Schaeffer, 1993; Palombini, 199). The compositional gap to be filled lies in the development of transformational techniques that do not destroy the referential elements of the recorded sound material. Furthermore, this technical insufficiency points to a conceptual shift from sound organizations established by formal processes to sound organizations framed by environmental constraints. This is precisely the niche of ecologically-based composition.

5. Structural coupling

Shepherd's division between potential meanings offered by the sound structure and the actual meanings realized through the act of listening finds an interesting parallel in the concept of 'evolution by drift' put forth by Varela et al. (1989). The well-known theoretical biologist Francisco Varela suggests that animal and environment are mutually determined. Evolution and cognition are shaped by actual interactions between individual and environment. Contrasting with the cognitive approach, "cognition is no longer seen as problem solving on the basis of representations; instead, cognition in its most encompassing sense consists in the enactment or bringing forth of a world by a viable history of structural coupling." (Varela et al., 1989, 205). As the Spanish poet Antonio Machado said, "se hace camino al andar."

The key idea differentiating Varela's (1989, 196) approach from neo-Darwinian adaptationism is the shift from optimal adaptation to 'satisficing' fitness. Varela (1989, 194) states that "[t]he constraints of survival and reproduction are far too weak to provide an account of how structures develop and change. Accordingly, no optimal fitness scheme apparently suffices to explain evolutionary processes." Patterns of animal communication exemplify a case of varied solutions to the same problem. The use of selective frequency ranges, distinctive time-patterns, or even fast-varying timbral changes are alternative approaches to sound-streaming in a noisy environment. A particularly problematic issue is the distinctiveness of signals among bird species that compete for the same niche within a common sound environment. Time-sharing between and within species is one of the strategies employed to reduce the temporal overlap among signal emissions (Nelson & Marler, 1990). Another example of selective adaptation to environmental characteristics is "the high-pitched, narrow-band, whistled alarm calls used by animals in extreme danger (. . .). Due to attenuation, the high frequency signal is limited to a small surrounding space. This signal might be audible to companions close by, but will probably not be heard by the predator." (Nelson & Marler, 1990, 444).

A complementary aspect of evolution by drift is the mutual determination between the individual and its environment, also called structural coupling. "[L]iving beings and their environments stand in relation to each other through mutual specification or codetermination. (. . .) Environmental regularities are not external features that have been internalized, as representationism and adaptationism both assume. Environmental regularities are the result of a cojoint history, a congruence that unfolds from a long history of codetermination. (. . .) The organism is both the subject and the object of evolution." (Varela et al., 1989, 198). Again, a specific example of transmission of information in ambient acoustics, is provided by Nelson and Marler (1990, 445): "Far from being a random phenomenon, the background against which animal signals must be detected and discriminated is often highly structured. It may even interact with the behavior of the signaler. (. . .) Thus the sound environment in which an animal species has evolved has a strong influence in shaping the acoustic signals employed for purposes of social communication."

The separation between environment and individual in the formation of cognitive structures is arguably one of the main limitations of cognitive approaches. "[P]erception consists in perceptually guided action and cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided. (. . .) Cognition is not representation but embodied action. (. . .) The world that we cognize is not pre-given but enacted through our history of structural coupling." (Varela et al., 1989, 200). Thus, it is not a mental representation that determines the formation of perceptual processes but the bodily interaction between the environment and the individual. A good example in the musical realm is Smalley's (1993) assertion that instrumental gesture is a refinement of our daily interaction with objects in the environment. He states that the passage from object experimentation to the creation of a musical instrument involves the increasing refinement of hitting, scraping, or blowing. Interestingly, sounds highly significant for survival - such as breaking, spilling, or producing avalanches - have been left out of instrumental practices!

The next logical step that the enactive perspective brings forth is to "recast selective pressures as broad constraints to be satisfied" (Varela et al., 1989, 198), thus allowing for the occurrence of patterns that are not necessarily determined by selection. A metaphor for this conception is "evolution as bricolage, the putting together of parts and items in complicated arrays, not because they fulfil some ideal design but simply because they are possible." (Varela et al., 1989, 196). More specifically, "form emerges in successive interaction. Far from being imposed on matter by some agent, it is a function of the reactivity of matter at many hierarchical levels, and of the responsiveness of those interactions to each other. (. . .) [The] extraorganismal environment is made internal by psychological or biochemical assimilation. [An] internal state is externalized through products and behaviors that select and organize the surrounding world." (Oyama, 1985, cited in Varela et al., 1989, 199). The hierarchy principle cannot be applied to the organization of sound. Nevertheless, this thesis is consistent with an ecologically-based theoretical framework in relation to the idea that musical structures provide potential meanings which are realized through a mutual determination process between individual and environment.

Figure 2. Structural coupling between the individual and the environment generates a process of pattern-formation.

6. Consistency: relaxing optimality

As we have seen in the previous section, current evolutionary theories view natural selection as the realization of possible outcomes rather than as a result of necessity. In other words, we "recast selective pressures as broad constraints to be satisfied" (Varela et al., 1989, 198). This perspective allows for the occurrence of patterns that are not necessarily determined by selection. In contrast, the usual Artificial Intelligence approach is to come up with a single, optimal solution within a predefined parameter space.

Cooke (1993, 55) pointed out that "the questions of optimality and search are not often raised in experimental studies of auditory grouping. Instead descriptions of strategies are more common. (. . .) [T]his work is based on heuristics which express the belief that it is possible to discover similar groupings from large numbers of different starting points."

The adaptability of perceptual processes places two requirements on implementation mechanisms: (1) the same mechanisms may be used for different stimuli in different contexts, and (2) several perceptual states can be obtained from a single stimulus. The first requirement can be deduced from the precedence effect: regardless of the source sound, the perceptual system separates the source from the ambience reflections. The second requirement can be exemplified by the repeating stimuli used by Warren (1993). These stimuli are perceived as changing even when no physical change occurs.

Ellis (1996, 54) proposes more flexible criteria for a best match between model and data in auditory processing. A data-driven model, such as Cooke's, constructs successive levels of abstraction founded on the identifiable features of the data. On the other hand, "in the prediction-driven framework, the model itself is obtained by drawing predictions from the existing components, and the 'connection' is limited to ensuring that the model falls somewhere in the space of uncertainty. Depending on how model and stimulus uncertainty are represented, there may be a wide range of possible matches, with a continuum of resulting confidence or quality metrics, rather than a single, brittle yes / no comparison."

Thus, the work done in computational auditory modeling converges with the theoretical approach proposed in evolutionary biology: perceptual mechanisms are constrained by environmental requirements but no single optimal solution exists for a given state in the process of individual-environment interaction.

Translating these principles to the compositional domain means to implement sonic models that provide environmentally consistent sonic cues. A key characteristic of everyday sounds is the impossibility of repeating exactly a single event. Other constraints are established by the affordances of the exciting and resonant objects used. These constraints ensure that the output of the model remains within the given sound class and avoid a one-to-one correspondence between the model and the sounds obtained. As long as the sound model is kept within ecological constraints, each instance of the model will belong to the given sound class but no two instances will be the same.

7. Ecological models

So, what do evolution and signal communication in animals have to do with musical composition? There is no direct connection between these topics as there is no straightforward link between perception and aesthetics. Thus, the only test for the assertions put forward in this paper can be empirical. The difficulty with this procedure is to define clear-cut variables that provide qualitative and quantitative results to the problems posed. This is probably too optimistic, so an alternative method should be proposed. Instead of testing direct hypotheses, we can design models that provide simplified representations of the problems at hand.

I take this approach in the production of ecologically-based sounds (Keller, 1999). Variables are directly related to environmental processes such as excitation of resonant bodies, time patterns, etc. The range of possible values that these variables can take is restricted to ecologically feasible ranges. Thus, a ball cannot bounce forever and a surface cannot be perfectly regular. As should be expected from the previous discussion, these sounds provide cues of feasible events in the environment. So they render stimuli that are coherent with pattern-formation processes. If mutual-determination is a reasonable model, we should expect to find perceptual mechanisms that are fine-tuned to process frequently occurring environmental sounds.

8. Summary

The discussion presented in this paper suggests that ecologically-based musical approaches need to be grounded on the specific social environment where the musical work is placed, taking into account the dynamics of sound structures and the listening processes. The universal concepts proposed by ENA music theory and cultural studies theory, i.e., 'neutral cross-culturalism' or 'Western culture,' are not capable of dealing with the problems posed by specific social and perceptual processes. Therefore, they overlook important aspects of musical organization, such as referential elements and listener-environment mutual adaptation processes.

Because ecologically-based sounds are characterized by highly varying micro and meso temporal structures (Keller & Truax, 1998; Keller 1999), syntax-based analysis fails to deal effectively with their underlying organizational processes. Linguistic approaches are also rendered useless for the study of these sounds: most perceptually relevant processes take place at a pre-linguistic level.

A separation between musical sound and environmental sound can only be made in relation to a specific artwork within a given cultural context. It makes no sense as a general or 'a priori' statement. Truax (1996) has argued that it is the ability of making direct references that makes environmental sounds ideal raw material for music composition. These sounds provide a way to create meaningful symbolic systems by arousing associations with the listener's sonic environment. A new layer of meanings is thus established where the listener's cultural context interacts with the dynamics of sonic structures.

To fully embrace the model of mutual determination means to accept the idea that music comes into existence at the moment of listening. This perspective places the concepts of potentiality and actuality in musical meaning within the broader context of mutual determination between the individual and the environment. In this context, the interaction between the individual's specific sonic experiences and the music's structural processes establish a form-creation process that brings forth an ever-changing history of meanings.

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