

LISTENING TO INTERACTIONS: THE RELATIONSHIP BETWEEN *STREAMS* IN MIXED ELECTROACOUSTIC MUSIC

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ABSTRACT

This paper analyses interaction in mixed electroacoustic music through the perception of streams in the listening experience. The interaction between acoustical instruments and electroacoustic resources is observed in a wider theoretical scope: the interaction between streams perceived in listening. The study investigates issues related to the characterization of streams, how we perceive their interaction, and how we can describe this interaction for analytical or compositional ends. For this, two central concepts are revised: Dennis Smalley's *behavior* metaphor and Trevor Wishart's *counterpoint* idea. We present a brief analysis of selected electroacoustic mixed works by Karlheinz Stockhausen, Cort Lippe, and Tristan Murail to better illustrate listening aspects of interaction in this repertoire.

1. INTRODUCTION

The relationship between instrument and electroacoustic is the main feature of mixed electroacoustic music and is frequently called *interaction*. The term often refers to human-computer interaction (HCI) also. However, in this paper, it is not important whether the electroacoustic is fixed in support, live-electronics or interactive computer music system, but the focus is on the listening perception of interaction. This focus dislocates the interaction from an issue of technology or instrumentation to a wider scope of sound morphology. Studies [1, 2, 3] have investigated the theme with this focus by several perspectives. Menezes [1] approaches the spectral fusion and contrast between instrument and electroacoustic. Bachratá [2] explores the interaction by a multi-perspective study on musical gesture and catalogs gesture interaction in mixed music. Souza [3] presents several aspects to be considered in the study and composition of mixed works, also using several theoretical perspectives. However, these studies are little concerned with issues related to the concept of *streams*, present in Dennis Smalley's [4] and

Trevor Wishart's [5] theories. This paper intends to demonstrate the analytical and creative potential in approach the interaction between instrument and electroacoustic from a perspective of interaction between *streams*. For this, the research presents (1) an investigation on the characterization of streams, (2) an explanation about the perception of streams interaction, and (3) a utilization of Dennis Smalley's [4] *behavior* metaphor and Trevor Wishart's [5] *counterpoint* idea to describe this interaction. Mixed pieces by Karlheinz Stockhausen, Cort Lippe, and Tristan Murail are briefly analyzed through these two theoretical tools (behavior and counterpoint) in order to demonstrate their applicability.

2. THE STREAMS

Stream is understood as a conceptual tool that explains textures composed of clearly distinct 'bands' of sonic activities that are part of the overall spectrum [6]. Likewise, stream is used here in the sense of *layer*, equivalent to voice in traditional theories, and refers to the grouping of successive and related sound events. A stream can be identified by differentiation in relation to another. The differentiation can be perceived in pitch, timbre, gestural configuration, space or another parameter, and can be complete or partial. As musical instruments are historically designed to maintain timbre stable and to enable the pitch to vary, often, the different fixed-timbre instruments constitute different streams [5]. In such configuration, the streams are structured in discrete values; they are in instrument x or y and are one or two, or three, etc., there is no gradation between these possibilities.

However, the discrete organization has been challenged by composers. An earlier example can be found in Schoenberg's *Klangfarbenmelodie* idea – Five Orchestral Pieces op.16, no.3 (1909) entitled *Farben* is an example. The conception of timbre (or tone-color) as a structural parameter allowed timbral transformations of a single line (stream), which is shared among instruments [7]. In this case, it is not instrument x or instrument y streams, but it is only one stream that is developed through a gradual timbre modification (almost a continuum) among instruments.

If in this case of instrumental music it is difficult to analyze streams by instruments, in discrete values, it is even more in the case of the mixed electroacoustic music. At a first glance, there is a special "instrumental" distinction: the acoustic instrument produces sound by mechanical vi-

brations as the electronic sounds are produced through electronic circuits, analog or digital, that are heard through loudspeakers. However, from the listening perspective, such distinction is not useful, whereas electronic sounds can project a recorded sound of instruments, and instruments can produce unconventional sounds that can be confused with electronic ones [3]. Therefore, although it seems to be easy to reduce mixed music in two streams (instrumental and electroacoustic), it is evident that it is not that simple. On the one hand both instrumental (even in a single instrument) and electroacoustic sounds can present multiple streams, and, on the other hand, one single stream can be shared between instruments and electroacoustic.

Menezes's study [1] on the issue can be helpful to attempt the distinction of streams in mixed music. According to the author, the interaction between instrument and electroacoustic happens between two poles: *fusion* and *contrast*. Fusion is the absolute similarity, characterized by spectral transferences from one side to the other, as the contrast is the absolute distinction, characterized by the absence of these transferences. Between these two poles, there are transitional stages of relative similarities and dissimilarities. In *fusion* the listeners are in a *doubt condition*, they do not know if the sound comes from the instrument or is/was processed electronically. Applying this *morphology of interaction* to distinguish streams we have that, in *fusion*, instrument and electroacoustic share the same stream. and in *contrast*, they present different streams. Besides, between these two possibilities, there are transitional stages, a gradation, between one stream and another. It is possible that a single stream splits in separated streams which could be individually developed and converged again into one. In this case, it is not one or other stream but one that engenders the other, or two (or more) that merge in one, occupying dubious regions between independence and parallelism. In his notes about the *Music for Flute and ISPW* (1994), Cort Lippe writes about a continuum between an extended-solo and a duo configuration:

Musically, the computer part is sometimes not separate from the flute part, but serves rather to amplify the flute in multiple dimensions and directions; while at the other extreme of the continuum, the computer part has its own independent musical voice [8].

Karlheinz Stockhausen's *Kontakte* (1958-1960), for piano, percussion, and tape, is another example of the possibility of one stream split into others. At approximately 22 minutes of tape, it happens in the tape part. The score illustrates that (see Figure 1).

In the case of *Kontakte*, the idea is that the original sound is constituted by components. Stockhausen explains the excerpt: "The original sound is literally taken apart into its six components, and each component in turn is decomposing before our ears, into its individual rhythm of pulses" [9, p.97]. In this case, after separate, each component is developed concurrently in its own stream.

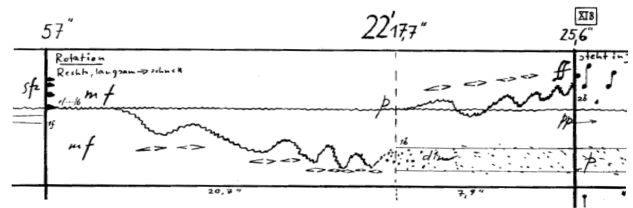


Figure 1. Splitting of one stream into two others in Stockhausen's *Kontakte*.¹

Therefore, in mixed music, streams can be distributed in several forms among the instruments and electroacoustic including a continuum between them. In addition, there is a continuum between one stream and two independent streams. From this viewpoint, the subsequent question is how the streams interact. In the next section, the perception of this interaction is explained through the concept of *extrinsic behavioral references* [4], and the interaction between streams is analytically approached through the *behavior* metaphor [4] and the *counterpoint* idea [5].

3. THE BEHAVIOR OF THE STREAMS

3.1 Extrinsic Behavioral References

The placing of distinct sounds in a context ensures that some kind of relation must to exist between them. Smalley [4] uses the term *behavior* to conceive the relations among spectromorphologies² acting into a musical context. Although the author emphasizes that *behavior* may be applied at a variety of levels, here, the metaphor is used to consider the relation between streams.

The behavioral references are extrinsic, that is, they are not references to the music itself (intrinsic) but are related to a range of experiences external to the context of the music.³ In acousmatic music⁴, the possibilities in content and movement of spectromorphologies create a great and variable collection of extrinsic references [4]. This means that, in the listening experience, we associate the relationship perceived between the sounds with other lived experiences. A common example is when we listen to two instruments that intersperse their play with similar fragments and we compare this fact to a conversation. Charles Ives's *The Unanswered Question* (1908) present the extrinsic reference to "question" and "answer" explicit in the title, for example.

In acousmatic music, the behavioral relationships are perceived through the spectromorphologies alone. However, in mixed works, they are perceived with a strong in-

¹Extracted from K. Stockhausen (composer). *Kontakte*. London: Universal Edition, 1966, p.25.

²Spectromorphology refers to the development of the sound spectra through the time. The term applies to musical structures of any size and level [4].

³Smalley approach is based on Nattiez's intrinsic and extrinsic distinction [10, pp.118-126].

⁴We consider here that acousmatic music is prerecorded and played through loudspeaker, there is no performer at stage [11]

fluence of the relationship between visual and gesture-bearing performer with the acousmatic part [4]. However important this issue is, this paper will not approach performer's visual and gestural references due to the focus on structural aspects of streams. Nevertheless, the issue could be included in future studies.

Therefore, the analysis of behavioral relationships is based on extrinsic references. From this perspective, we could speculate if it would be possible to think in other behavioral relationships based on other extrinsic references. This issue is resumed forward.

3.2 Behavior

The behavior metaphor includes any behavioral relationship. The developments of such concept are presented by Smalley in general and in specific terms. In the general terms, *behavior* is dependent on two semantic oppositions: *dominance/subordination* and *conflict/coexistence*. These oppositions represent the basis for a collection of *relationship modes*: *equality-inequality*; *reaction-interaction-reciprocity*; *activity-passivity*; *activity-inactivity*; *stability-instability*. These relationship modes are articulated in two interactive temporal dimensions. In the *horizontal* dimension, the streams pass from a context to another, it is concerned with *motion passage*. This can happen in a *voluntary* or in a *pressured* way. A key concept here is *causality*: when one event appears to be the cause of the next or the cause of a modification in a concurrent event. In the *vertical* dimension, the streams present, or not, vertical synchronization, it is concerned with *motion coordination*. That happens on a continuum between *loose* and *tight* coordination freedom [4] (See Figure 2).

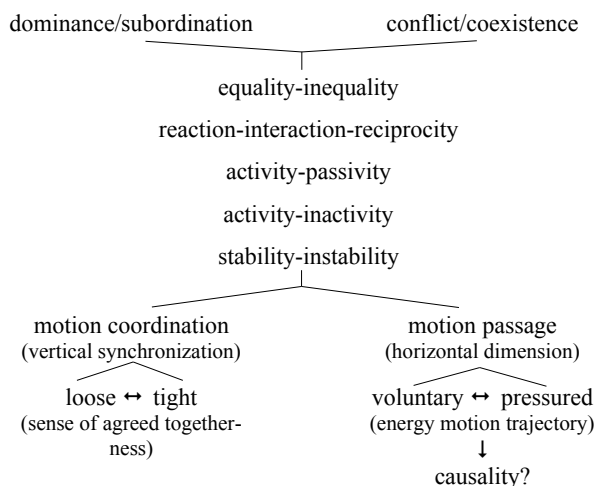


Figure 2. Behavior by Smalley.⁵

The Cort Lippe's mentioned *Music for Flute and ISPW* (1994) serves as an example. In the first section, there are two streams intercalated in the flute, one is more continuous and has the *piano* dynamic; the other consists in *forte* attacks. The *forte* stream is synchronized with the computer part, in fact, together they form a single stream. *Pi-*

⁵Extracted from [4, p.119].

ano and *forte* streams are *tight* coordinated in the vertical dimension and they alternate suddenly, in a *pressured* way. It is possible to perceive that the *forte* stream establishes an *instability* upon the more stable *piano* stream (*relationship mode*). In addition, the relationship between the two is *conflicting* and, as the music develops, we perceive that the *forte* stream *dominates* the subordinated *piano* stream.

In this case, the theory proved to be suitable to indicate the behavioral relationship between streams.

3.3 Counterpoint

Another approach on the relationship between streams is Wishart's counterpoint idea. In the *Gesture and Counterpoint* chapter of his book [5], Wishart is concerned with a contrapuntal structure in *continuum-based music*. According to the author's perspective, music has historically been developed in a tridimensional *lattice* with discrete values for pitch, duration, and timbre. In such lattice-based music, pitches are organized in semitones; durations, in divisible values; and timbre, in different fixed-timbre instruments. Nevertheless, there is a continuum between a semitone and a tone (evident in the glissando, for example); there are infinite duration values between an eighth and a quarter note; and, as demonstrated before, there is a gradation in timbre. The continuum is even more apparent when we consider sounds that are not made with conventional instruments, very common in electroacoustic music. If the lattice provided a structure to evolve a tonal counterpoint, thence the question is how to establish a contrapuntal structure to work in the continuum.

Wishart distinguishes two independent principles to achieve a contrapuntal structure: (1) An *architectural principle*, which offers reference points in the global progression of music material. In tonal music, it corresponds to the key structure (the return to the tonic tonality is often an important point, for example). In the continuum, this architectural principle will be 'the concept of transformation from one timbral and sound-morphologic area to another' [5, p.117]. And (2) a *dynamic principle*, which determines the nature of motion. In tonal counterpoint, it is related to the ebb and flow of rhythm coordination and harmonic consonance-dissonance, that is, it refers to the manner that the notes of one voice are placed in relation to the notes of other voices. In the continuum, instead of this, the dynamic principle will be the "gestural evolution and the interaction between the separate streams" [5, p.117].

The *gestural evolution* is related to the horizontal features of the dynamic principle: the type of gesture⁶ used, the sequence of individual gestures and the average rate of gestural activity in a stream. In this context, it is important to consider especially the features of the gestures.

⁶The term *gesture* is used here according to Wishart's concept, as an "articulation of the continuum" [5, p.17]. On the basis of this concept relies the idea that the intellectual-physiological gesture can be translated in sound-morphology and, inversely, the sound-morphology evidences the intellectual-physiological gesture [5].

The *interaction between the streams* is related to the vertical features of the dynamic principle. Wishart offers a solid theoretical development in this ambit. It is possible to consider: (a) the number of gestures that occur in all streams in an observed period; (b) the homogeneity of the gestures among the different streams (homogeneous or heterogeneous); and (c) if the gestures of one stream seem to interact with that of the other streams or if they seem to behave independently. From these relations the author establishes six archetypes of gesture organization (see Figure 2): (1) *parallel*: akin to *tutti*, the gestures have the same characteristics in all streams (it is not about spectral characteristics but about gesture structure); (2) *semi-parallel*: the parts follow the same logic but not synchronously; (3) *homogeneous independence*: the parts seem to behave independently; (4) *heterogeneous independence*: the gestures are independent and different; (5) *interactive*: especially related to causal and imitative connexions between events in different parts; and (6) *triggering*: the gesture of one part is the onset of a gesture in another part or it causes a modification in another part quite clearly, it is the *causality*, to use the Smalley's term.

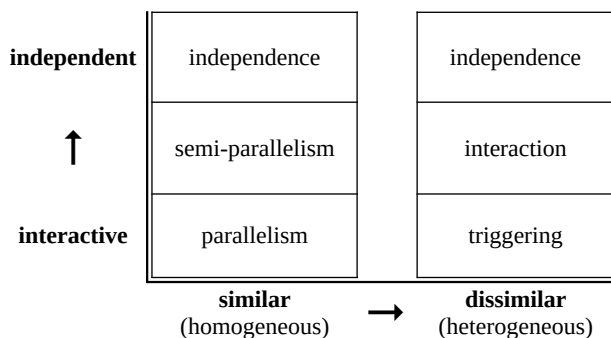


Figure 3. Six archetypes of vertical gesture organization (dynamic principle)⁷

Wishart describes a compositional strategy from these ideas:

I found this approach to be a powerful heuristic tool for composing with this kind of material. It was possible to lay out the structure of the overall density of events on the score, then compose the gestural structure of a section using elementary symbols [...] and then, working from the overall plan of timbral and articulatory development, score in the details of the individual sound-events in each voice. [5, p.123]

Tritan Murail's *Desintegrations* (1982), for computer-synthesized tape and 17 instruments, can be an example to elucidate Wishart's theory⁸. The piece is based on spectral analysis of instrumental sounds (piano, brass and cello sounds). Therefore, tape and instruments share the same origin, according to Murail's previous notes, "their relationship being one of complementarity" [12]. The tape part frequently "exaggerates the character of the instruments, diffracts or disintegrates their timbre, or ampli-

fies the orchestral effects" [12]. That the relationship is one of complementarity it does not mean that we will perceive just one shared stream. In fact, like in Stockhausen's *Kontakte*, Murail works with the disintegration of sound in different streams that are shared among instruments and tape.

Murail explains that there are eleven moments, eleven distinct "stages" in the piece, and the change of stage happens by "transition-transformation or by the unleashing of a 'threshold effect'" [12]. This transition evidences the *architectural principle*, the transformation of one sound-morphologic area to another. The composer explains the transformation process:

Each moment emphasizes a different kind of spectrum treatment, each stage makes it evolve from the harmonic to the inharmonic or vice versa. This creates movements of shade and light, accompanied by movements of increasing or decreasing agitation, of rhythmic ordering or disordering. [12]

Therefore, in architectural principle, it is possible to observe the transformation of a harmonic sound-morphologic area to an inharmonic one or vice versa.

During the third stage of the piece, the *architectural principle* is characterized by a transition from harmonic to inharmonic spectra and from a high range to wide one. Figure 4 shows part of the beginning of this stage.

Figure 4. Triggering relation between gestures in different streams in Murail's *Desintegrations*.⁹

In this stage, piano, crotales, glockenspiel, and tape share a stream. The gestures in that stream are composed of short and resonant high notes that are rhythmically active at the beginning of the gesture and present just the resonance in its termination. In a first moment, the *gestural evolution* happens by a temporal expansion of the rhythmically active part of the gesture. At the same time, the resonant part of the gesture engenders gradually a second stream, first only in tape, after in the instruments. In relation to the *interaction between the streams*, we listen as if the high notes gesture in the first stream is initiating

⁷Extracted from [5, p.122].

⁸In his book, the author demonstrates the theory in his own compositional experience in *Vox-I* (1982), for 4 amplified voices and tape.

⁹Extracted from [12, p.30] and analyzed.

the resonant gesture in the second stream (*triggering*) that become each time more *independent*. Figure 4 shows the representation of the two gestures in the tape part analyzed.

Finally, it is important to underline Wishart's attention and imperativeness to the importance of the listening experience in compositional practice. 'No notational logos can in itself justify a musical procedure' [5, pp.123-125] According to the author the listening experience is unmediated, unprejudiced, and must to be the responsible for the ultimate validation of any musical procedure.

4. DISCUSSION

The objective of this study was to demonstrate the analytical and creative potential in approach the interaction between instrument and electroacoustic from a perspective of interaction between streams.

Both approached theories are pretty similar. The largest difference is that specifically Smalley's *behavior* concept does not consider the aspect of development in time of the behavioral relationships as does Wishart through the *architectural principle*. This could be easily changed if we considered other aspects of the *Spectromorphology* such as motion and growth process, structural functions, and others. It is possible to perceive that Smalley's *behavior* intends to describe a state, a character rather than a process, while Wishart's approach creates a space in which the streams can change from one state of interaction to another, going through the concepts of Figure 2.

In addition, the two theories exposed and applied in concise analyses demonstrate pertinence and achieve categories of analysis that others do not considerate.

Menezes's article [1] discusses the issue of fusion and contrast between instrument and electroacoustic, however, do not relate this morphology with the disposition of streams. Nevertheless, as demonstrated, the Menezes's study is a useful tool to observe the splitting and converging of one stream. The fusion-contrast continuum present direct relation to the similar-dissimilar, homogeneous-heterogeneous axis in Wishart's table (see Figure 3).

Bachratá's [2] study presents the interaction by a multi-perspective on musical gesture. The study presents a catalog of several and very specific gestural interactions between instrument and electroacoustic. It concentrates on what we can consider specificities of the general terms of both Smalley's and Wishart's theories. And, because of that, maintain a local rather than a global perspective, with exceptions. Her research can be used in order to specify how are the *relationship modes* [4], or how the *six archetypes of gesture organization* [5] are in punctual descriptions.

Souza [7] approaches the interaction between instrumental and electronic sounds by several perspectives. By a semiotic perspective, he distinguishes the *marked sounds* which we are habituated to attribute to the instruments (e.g. piano sounds) from the *not-marked sounds*,

sounds to which the relationship with the source is not recognized (e.g. some granular sounds). This perspective call our attention to the fact that the stream can be articulated through this two types of sounds but it does not mean that marked-sounds were produced on the instrument and the not-marked sounds in electronics. This fact also directs us to think an alternative category to that of simple sound production distinction between instrument and electroacoustic. By the viewpoint of this article, the stream concept is an interesting one, as demonstrated.

Although this three mentioned studies configure a limited referential to outline trends, it is possible to perceive that the authors tend to introduce new concepts or a multi-perspective approach in order to demonstrate different aspects, in different levels of the same interaction. It is important to point out the need to concatenate these approaches in order to build a shared and complementary knowledge about the issue. In this sense, it is especially necessary to consider the previous approaches to mixed and electroacoustic music such as the Smalley's and Wishart's ones. We could go beyond and question if there are no other theoretical approaches to instrumental music that think the interaction, likewise the mentioned *Klangfarbenmelodie*.

In addition to this centripetal force, we could think in a centrifugal one that lead us to investigate aspects that are not covered in this studies. For example, based on the extrinsic behavioral references [4], was possible to explain how we perceive this relationships. Nevertheless, we need to ask if there is no other references that explain better certain behavior in question. Or, in the case of composition, we could ask what other extrinsic references, present in other lived experiences, can be projected in the relationship between streams.

Further studies can also focus on the influence of technology on the configuration of streams and their interactions. It could be investigated how does the relationship between two types of interaction: on the one hand, interaction between streams and, on the other hand, the interaction between performer and machine (HCI) in performance.

5. CONCLUSION

The interaction between instrument and electroacoustic can be approached by a perspective of interaction between streams perceived in listening. This perspective proved pertinence in analysis and possibly in composition of mixed music. Future studies are needed to, on the one hand, combine the already done studies in this area and, on the other hand, to expand the issue with questions related to the influence of technology and the use of other extrinsic references to interpret interaction.

Acknowledgments

The research for this paper was financially supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível

Superior (Capes). I also thank to Felipe de Almeida Ribeiro, my supervisor, who contribute with helpful input in developing the ideas presented here.

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