Towards a semiotic model of mixed music analysis*

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In this paper I try to outline a model that can bring out the meaningful relationships between 'the instrumental' and 'the electronics' in mixed music. The model is based on the semiotic square which is considered in semiotics as a powerful conceptual framework to examine the relationships between two terms (S1/S2) and their negative (non-S1/non-S2), terms which can be characters, situations, actions, concepts, etc. Two paradigmatic axes represent the relations between the actors of mixed music: the sources (instrumental and electronic) on the one hand, and the manipulations (real-time processing and sound projection) on the other. According to the semiotic square, the relations inside the environment are defined in terms of contrariety, contradiction and complementarity. This model allows us to start out with a purely technological description of the 'mixed music' genre and of individual pieces, with the advantage of a pre-operative analysis of the system. It describes the immanent structure of the environments and releases the potential interactions between the instrumental and the electronics of mixed music. These interactions are examined, from a paradigmatic point of view, with numerous representative pieces of mixed music from the twentieth century.

1. INTRODUCTION

The first examples of the confrontation of live music with magnetic tape within performance date back to the beginning of the 1950s. They were meant to merge the infinite variety of concrete and electronic sounds with the contemporary instrumental pallet and, secondarily, to bring in a visual dimension that was absent at loudspeaker concerts. However, the composers quickly realised that this new means of expression involved many aesthetic and formal problems. The confrontation of the instrumental and the electroacoustic universes revealed traps inherent in the nature of these media. The instrumental is 'played', and thus visible, flexible and malleable, however limited by its timbric and spatial potential, while the electroacoustic is 'projected', and thus invisible, rich in unprecedented resources, however rigid in its timing. Soon after these two domains were brought together, it turned out that defining their relationship was a real challenge; it may be grasped by the concepts of fusion/opposition, similarity/difference, balance/imbalance, simultaneity/succession, etc. Although Varèse decided to intercalate pre-recorded interpolations between the instrumental sections of *Déserts* (1954), as is also the case in the first version of *Musica su due dimensioni* (1952) by Maderna and *Analogique A et B* (1959) by Xenakis, Stockhausen's *Kontakte* (1959–1960) was the first piece to establish a true 'contact' between these two universes. Starting from the postulate that 'the meeting of the familiar, the named, in the areas of the unknown and the unnamed, confers the earlier growing mystery and fascination. And conversely, the well-known, even the banal, the old, to which we hardly pay any attention, gets fresh and alive again in the new environment of the unknown', Stockhausen (1988: 109) set the basis for mixed music. Consequently, the desire to explore the interactions between these two worlds gave rise to a full musical genre that still develops and evolves.

We have to notice that the evolution of new musical technologies in the twentieth century involved continuous bidirectional passages from the studio to the instrument and *vice versa*, symptomatic of the simultaneous need to process the sound in-depth and to keep it live at a concert. Thus Battier (1992: 66) analysed it as follows: 'In the twentieth century musical technology is subject to a strange cycle. In the first half of the century it appears as a full instrument. After the birth of the support-based music in the 1950s, it takes on the form of a network of the laboratory equipment with limited functions. In the recent years it took up the keyboards and recovered the appearance of instruments and electronic processing boxes; step by step the computer slips to the centre. At that time, a concept of a silent instrument simply controlling an external device of sound production emerged. That's why keyboards and wind instruments lost their own voice and gesture or oral interfaces, etc.'. This trend can also be observed in the evolution of mixed music practices, which can be divided into seven main stages.

Since the 1920s, instrumental pieces with at least one electronic instrument have been composed (Honegger, *Rose de metal* with Dynaphone, 1928; Schillinger, *First Airphonic Suite for Theremin and Orchestra*, 1929; Milhaud, *Suite pour Ondes Martenot et piano*, 1933;

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Varèse, *Ecuatorial*, with 2 Ondes Martenot or 2 Theremins, 1934). Soon after the first works with the use of a tape were put forward (Schaeffer, *Orphéo 51*, 1951; Badings, *Capriccio for violin and two sound tracks*, 1952; Maderna, *Musica su due dimensioni*, 1952), pieces transforming the sounds of the acoustic instruments by means of *live electronics* appeared (Kagel, *Transicion II*, 1958–1959; Stockhausen, *Mixtur*, 1964). They were logically followed by the coexistence of magnetic tape music and live electronics within the same piece in the 1970s and the 1980s (Ferneyhough, *Time and Motion Study II*, 1973–1976; Manoury, *Zeitlauf*, 1982). In the 1980s, MIDI keyboards controlling the sounds stored in a sampler or on a computer's hard disk restored the flexibility of synchronisation (Mâche, *Iter memor*, 1985; *Aliunde*, 1988). At the same time, computers were dealing with the real-time processing, the diffusion of sounds stored on a hard disk, and even the synchronisation between the performer and the electronics (Boulez, *Repons*, 1981; *…Explosante-fixe…*, 1993; Manoury, *Jupiter*, 1982, rev. 1992). These six stages should be supplemented by works using gesture interfaces, which are the subject of abundant current research (Cage, *Variations V*, 1964; Machover, *Begin Again Again*, 1991).

The technological development and the composers' creative imagination multiplied the possibilities of interaction between the instrumental and the electronics. Such potentialities have been realised in various environments as a choice of an instrument and its function and a device used in sound production, processing and diffusion. The environment is not only a heterogeneous sample of equipment and software, it is a reflection of the creative will. Thus, sometimes the choice of the environment could close the aesthetic gaps, as pointed out by Durieux (1992: 95): 'The composers attached to the post-serial tradition eagerly practise instrumental transformations of the figures directly resulting from the score, and they spatialise them by means of the loudspeakers. On the other hand, those representing the spectral school conceive electronic parts as a global realisation of non-tempered frequencies, calculated beforehand, on which the instrumental parts are grafted'. Before writing a single note or working out a single sound, part of the relations between 'the instrumental' and 'the electronics' would depend on the choice of an environment.[1]

Thus, what environment should be chosen is not trivial: it is a consequence of both the precise technological needs and an aesthetic wish. How do we consider the creative possibilities that these environments give? Which conceptual framework is capable of clarifying the relationships between the instrumental on one hand, and the electronics on the other, in mixed music? In this paper we try to outline a model that can bring out the meaningful relationships between the instrumental and the electronics, starting from the poles defined by the environment. The model is based on the semiotic square already employed in the analysis of various semantic micro-universes (novels, comics, advertising, visual arts, music, etc). According to Greimas (1970), the semiotic square fits into the Generative Course on the level of the underlying structures, i.e. the immanent structures, which can be actualised in the surface structures (semio-narrative and discursive structures). Two paradigmatic axes represent the relations between the actors of mixed music: the sources (instrumental and electronic) on the one hand, and the manipulations (real-time processing and sound projection) on the other. The relations inside the environment are defined in terms of contrariety, contradiction and complementarity. This model allows us to start out with a purely technological description of the 'mixed music' genre and of individual pieces, with the advantage of a pre-operative analysis of the system. But before we describe these relations in more detail, it is necessary to specify what perspective we take in employing the concepts 'instrumental' and 'electronic'.

2. INSTRUMENTAL GESTURE VS ELECTRONIC GESTURE

To characterise the instrumental and the electronics is not an easy task. Referring to the difference of timbre does not seem valid in this day and age. Soon after the rise of electronic music their timbres were easily differentiable, today they aren't anymore. The progress of sound synthesis makes the acoustic differences between instrumental and electronic timbres less and less noticeable unless the perceiver has access to the visual aids of the source. The possibility of recording and sampling instrumental sounds has also contributed to reducing the gap. As soon as this technology became available, composers took advantage of such an ambiguity by mixing instrumental pre-recorded parts and instrumental live parts (Höller, *Arcus* 1978; Reynolds, *Archipelago*, 1983). According to Levinas (1998: 301), the 'instrumental' implies a relation with the human body (gesture and breathing): 'I call the instrumental all the sounds produced in real time as a result of an intervention of a human body. The sound immediately prolongs the movement of the body. In such a prolongation it immediately appeals to the imaginary possibilities which are answered naturally by the body of a musician-composer'. This definition widens the field of the instrumental to encompass the human voice and the electronic instruments that people can play (except for the machine-like sequencer). But if so, where is the border between the instrumental and the

[1]We will use the terms 'the instrumental' and 'the electronics' as concepts referring to more general categories than music played with instruments on the one hand, and played with electronic devices on the other. This includes such categories as writing and gesture.

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electronics? Such a broad definition poses problems in qualification of such works as *Tempora* (1989) for three samplers and a sequencer by Mâche, which includes instrumental sounds and bird songs. However, some fundamental differences exist between the instrumental gestures performed on an acoustic instrument and on an electronic device.

Cadoz (1999: 62) proposes a general definition of the instrumental gesture (musical or not): 'It is a set of gesture behaviours applied to the instrument whose part will produce the energy necessary to the finality of the task'. With regard to music, the instrumental chain consists of at least three components: aerial environment, a vibrating structure, and an exciter (an object capable of putting this structure into vibration). At least two types of gestures should be distinguished: the excitation gesture, putting the structure into an instantaneous, maintained or continuous vibration, and the modification gesture, changing the properties of the instrumental chain (and thus the sound itself). Both types of gestures expend energy; however, the principal difference between them refers to the fact that, in the modification gesture, this energy can be very weak and there is no direct bond between the expenditure and the result. On the contrary, still according to Cadoz (1999: 63): 'A gesture is not instrumental when a human is not a source of energy consumed intrinsically by the resulting phenomenon'. In the non-instrumental chain, another circuit whose source is external, distinct from the human circuit, is necessary. The appearance of such a circuit results in an arbitrary relation between the movement and the variation of the energy produced.

Another fundamental difference between the instrumental gesture and the non-instrumental gesture refers to the relation between the performer and the machine on the sound production level: 'This relation is defined precisely by the fact that it is sensorimotor and multisensory' (Cadoz 1999: 43); sensorimotor – because, as for an acoustic instrument, the gesture action and the object's reaction (of the sound source) are simultaneous, and multisensory – because in addition to the auditory perception, visual and tactilo-kinesthetic perception intervene. The instrumental gestures are bilateral, but the majority of the electronic instruments, the synthesizers, the MIDI keyboards or the hyper-instruments do not take into account the bidirectionality of the instrumental gesture. They are sensors, but not effectors; they do not comprise the reaction effort or the tactile reaction. As long as the bidirectionality is not taken into account in the context of the electronic instrument, a gesture cannot be called instrumental.

In the case of the electronic instrument, these two fundamental differences involve dissociation of the cause and the effect on several levels. The gesture of the electronic instrument does not comprise a univocal relation between the gesture and the sound, while there is a direct relationship between the energy of the gesture implied in the production of a sound with an acoustic instrument and the intensity of the sound (a string played with force produces a stronger sound) or the type of excitation (an instantaneous excitation produces a short sound). As regards the electronics, this relation can be ambiguous: one can produce sound deflagration by only lightly pressing the key of an electronic keyboard or a continuous sound with a single instantaneous pressure. While the instrumental sound production implies limitations inherent in the gesture and breathing (e.g. of velocity and duration of emission), the electronics is limited *a priori* only by the properties of a machine/device. The electronics also involves a very unstable relation between a performer and an instrument. Action is entirely dissociated from perception. Such a dissociation may be supplemented by two others – spatial and temporal dissociations. The instrumental sound radiates from itself while the electronic sound is projected. The localisation of the sound produced by an acoustic instrument is related mainly to its position in space which is fixed unless the performer moves while playing. The localisation of an electronic sound is not in a univocal relation with its source. The sound is projected through one or more loudspeakers, which are very often localised away from the performer. The onset and the duration of an instrumental sound are related to a gesture. The onset cannot be delayed compared to the gesture. As regards the electronic sound, the temporal localisation of the cause and the effect can be disentangled. This is particularly true with the support-based sound, the production of which is totally dissociated from sound diffusion.

The gestural dissociation, as well as spatial and temporal dissociation characteristics of the electronics, influences the reception of works. The importance of gestural causality on perception is undeniable. The gestures, the posture, the movements, even the facial expression of the performer contribute to the nature of the perceived musical discourse. In the case of the instrumental gesture, there is a correspondence between the gesture and the sound, between what the listener sees and hears (cf Shove and Repp 1995; Clarke and Davidson 1998). This function of the gesture is significant for the anticipation of the discourse as well as for the perception of the expressive intention and for the separation of the auditory streams. Similarly, the localisation of the sound plays a perceptive role insofar as it creates the context of a coherent and foreseeable auditory scene (cf Bregman 1990). In the case of electronic sources, the causal predictability is reduced; a listener perceives the effect, not determining its cause.

However, from a composer's point of view, this property of the electronic sounds and gestures is not always disadvantageous. Composers use them to create ambiguities or contrasts in various expressive contexts. Moreover, even if the electronic gesture is not an instrumental gesture in the narrow sense of the term, the

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instrumentality of the electronics appears at a virtual level. Today, the sound behaviour of machines more and more closely resembles the acoustic instruments and integrates the possibilities of control and interaction. The physical cause disappears in favour of the moving causality. It is up to the composer to play with this virtual causality. Now, what we have to do is to examine how these instrumental and electronic sources, these real and virtual gestures, are articulated in the context of mixed music environments.

3. AN AXIOLOGY OF MIXED MUSIC

The origin of the semiotic square dates back to Aristotle's *Organon*. This model was taken up again by the semioticians (Greimas 1966; Courtès 1976) in order to analyse the structure of micro-semantic universes. The semiotic square is intended to map the logical conjunctions and disjunctions of concrete or abstract notions. From a formal viewpoint, the semiotic square is made up from two oppositions: an opposition of two principal notions (called S1/S2), distinct but connected, and an opposition of two secondary notions (called non-S1/non-S2) which are their negations. The concepts in opposition form a hierarchically higher semantic axis whose function is to establish a relation of *contrariety* on the basis of common subjacent identity (e.g. life/death). The secondary notions are in a relation of *contradiction* with the principal notions, i.e. they can not coexist (life/non-life, death/non-death; non-life being comparable with dead-alive and non-death with eternity). Lastly, by implication, S1 and non-S2 on the one hand, and S2 and non-S1 on the other are in a relation of *complementarity* (eternity implies an infinite life, and dead-alive implies an unfinished death). Now there is a challenge to transfer this model to the environments of mixed music in order to give rise to a relational network. It should allow us to clarify the bonds that weave the instrumental and the electronics together.

The model is based on the founding opposition of mixed music: duality between a real source (the instrumental or vocal sound played live in a concert setting) and a virtual source (support-based sound, electronic instrument). A source is considered real when the auditory image (cf McAdams 1984) coincides with the gesture that produces it, and virtual when the auditory image does not derive directly from the gesture that produces it. This relation of *contrariety* (S1/S2) constitutes the hierarchically higher primary axis unified by the concept (in semiotics referred to as *classème*) of 'source'. The secondary axis is constituted by two non-sources: the real-time processing and the sound projection, unified by the concept of 'transformation' (handling). The real source (S1) forms a relation of *contradiction* with the sound projection (non-S1) whereas the virtual source (S2) forms a relation of *contradiction* with the real-time processing (non-S2). Lastly, a relation of *complementarity* exists between the real-time processing and the real source on the one hand, and between the sound projection and the virtual source on the other. The figure shows a visualisation of the semiotic square applied to mixed music. The relation of *contrariety* characteristic of the main axis (S1/S2) can be defined in terms of human/machine, master/slave, model/imitation, homogeneity/heterogeneity of timbre, or known/unknown relationships. Let us analyse these relations in detail.

The human/machine relation concerns the rate of control one can have over a source. As the sources become more and more developed, production of electronic sound involves gestural, spatial and temporal dissociations between the cause and the effect. This relation is graduated according to the type of source. It's not a dichotic opposition, but a continuum from the instrument to the support-based sound. Some acoustic instruments can be subject to a high level of control (e.g. the bowed string instruments), while others cannot (e.g. the church organ or some percussion instruments such as the sanza or wood-block). Some electronic instruments can be programmed in order to show a quasi-instrumental behaviour, whereas the possibilities of control of a support-based sound are very restricted. It results from the fact that the instrumental sound, being subject to multiple variations of interpretation (temporal, dynamic, microphone-intervallic, timbric, etc.), is

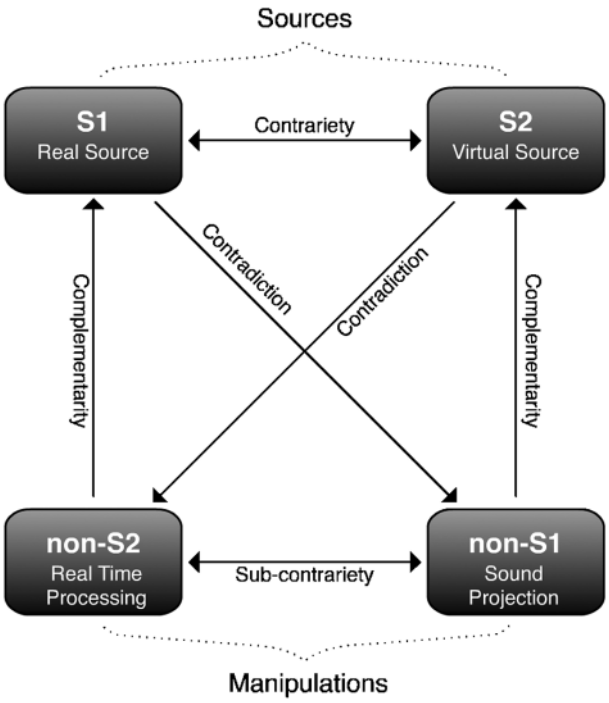

Figure 1. Representation of the relationships between the instrumental and the electronics in mixed music by means of the semiotic square.

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generally strongly opposed to the fixity of the support-based sound identical at each performance. Composers have taken advantage of this relationship in many ways. In *Different Trains* by Reich, the human/machine relation is of major importance. The rhythmic patterns and whistles of the train and human voice testimonies constitute the compositional material. On a symbolic level, the string quartet, under the influence of the machine represented by its three recorded duplications, escapes this vice thanks to the humanity of the voice (some patterns of the string quartet derive from vocal intonations). In works by Reynolds this relationship comes into play in a very different way. In several mixed parts (*Archipelago*, 1983; *Transfigured Wind*, 1985) the composer develops the concept of the interpretive variation: the instrumental parts are pre-recorded, processed and mixed to constitute the contents of the magnetic tape. The composer can then exploit the ambiguity between the instrumental and the electronics, between the real gesture and the virtual gesture, in order to emphasise certain characteristics of the performance.

The master/slave relation refers to the problem of synchronisation between the instrumental and the electronics. From the very beginnings of mixed music, composers were confronted with the problem of the temporal rigidity of the support-based sound, especially when the score requires precise synchronisation between the two media. Technological developments (click-track, MIDI keyboard, Disklavier, score following, motion captor) have provided a partial solution to the problems of synchronisation between the performer and the machine. Sometimes, synchronisation is not necessary, as in *Sinfonia for 12 Instruments and magnetic tape* (1958–1960) by Mumma where the band runs independently of the instruments until it submerges them. Sometimes it is essential, as in the *Synchronisms*' series by Davidovsky where the close temporal relationship between the instrument and the tape emphasises some accordance of colours, phrasings, attacks, resonances, etc. Thanks to the technique of score-following, the master/slave relation changes in favour of the performer. In several pieces by Manoury, the electronic parts are initiated and react in response to some data emanating from the playing of a performer (*Jupiter*, 1987; *Pluton*, 1988; *Neptune*, 1991) or a singer (*En écho*, 1993–1994). The use of a master keyboard connected to a computer or a sampler played by a performer restores the freedom of tempo in instrumental music. Thus, in *Manuel de résurrection* (1998) by Mâche, two master keyboards, triggering a spoken voice and percussion sounds, dialogue freely with the soprano soloist. In *Advaya* (1994), Harvey developed all the forms of synchronisation between a cello, a keyboard-sampler, and the sounds stored on a hard disk.

In the implementation of the model/imitation relation there are two opposing tendencies: certain composers decide to compose the instrumental parts modelling them on the electronic parts, while others prefer to force electronic materials onto the instrumental parts. In the 1970s, Nono composed bands of mixed music starting from improvisations played by a performer (Pollini in … *sofferte onde serene* …, 1974–1976; Kremer in *La lontananza nostalgica utopica futura*, 1988–1989). In *Kuzwellen* (1968) and *Spiral* (1968), Stockhausen follows a reverse procedure, as the performers improvise starting with the sounds of a shortwave receiver. In the former case, the transformations of the instrumental sounds on tape are such that the model is not really recognisable anymore. In the latter, the code which directs the instrumental improvisations dilutes their relation with the model. In Mâche's pieces, on the contrary, the relation is built by the explicit confrontation with the model (*Korwar*, 1972; *Kassandra*, 1977). In several composers' works (e.g. Saariaho's *Verblendungen*, 1982–1984 or Harvey's *Tombeau de Messiaen*, 1994), the model comes from the instrument: one or more sounds analysed in their spectral components are used as a model for the tape and the instrumental parts.

The relation of *contrariety* also appears in the degree of timbre homogeneity/heterogeneity between the instrumental and the electronics. Choosing homogeneity or heterogeneity has aesthetical consequences. If homogeneity is not sufficient, fusion cannot be exerted, and it results in the impression of two independent paired universes which do not communicate or are confronted with one another. Thus, Malec often seeks a contrasted relation (*Cantate pour elle*, 1966). The choice of the homogeneity allows other composers to take advantage of the ambiguity between the sources. At the end of *Passages* (1982), Risset requires the flautist to sing in his instrument in order to make the acoustic sound identity waver, whereas an anonymous electronic sound, granted a vocal identity, becomes animated as a result of a modulation. In *Advaya* (1993), Harvey pushes this search for ambiguity between instrumental and electronic timbre very far by moving back the borders of the instrumental timbre (by means of a special way of playing) to the borders of electronics. Some composers use the tape pre-recorded instrumental parts to support the ambiguity. Examples of such a solution include Höller's *Arcus* (1978), Mâche's *Aulodie* (1983), Reynolds' almost all mixed pieces since *Archipelago* (1983), Risset's *Voilements* (1987), Nono's *La lontananza nostalgica utopica futura* (1988), etc.

Finally, the *contrariety* relates to the known/unknown relation. From a perceptual perspective, the real sources benefit from a representation in long-term memory (e.g. the timbre of the flute is well known and easily recognised), unlike the virtual sources (except for the case of sampled instrumental sounds). It is due to a greater variety of timbre of the electronic sounds compared to the instrumental sounds, a lesser categorisation of class timbre and the absence of semantic

labels. It implies a higher cognitive cost of perception of the virtual sources as the sound must go through all the stages of the analysis of the micro and macro spectro-temporal properties. Thus, in theory, electronic sounds are difficult to identify, which, however, does not mean that they are unrecognisable. Composing with the known/unknown relation, inaugurated by Stockhausen's *Kontakte* (1958–1960), can be exploited on timbre or thematic dimensions, and many others. Thus, the sound sources (diphonic songs, Tibetan trumpet, Mongolian viola, etc.) used by Murail in *L'esprit des dunes* (1994), unfamiliar to many Western listeners, are confronted with the European instrumental sonorities. Viñao arranged a meeting of the known and the unknown in *Chant d'Ailleurs* (1991), which is a set of three song-like chants. The composer merged the imagined ritualistic monodies (inspired by Mongolian tunes) sung by a live soprano with a computer part, which seeks to extend the phrasing and timbre of the voice beyond its natural acoustic means. In *The Angel of Death* by Reynolds, the thematic material presented either by the piano soloist or by the orchestra in the first half of the work, returns in a more or less distant form both in the instrumental and the electronic parts in the second half of the work. The electronic part constitutes a kind of memory from which more or less deformed materials are recalled.

The sound production of these two sources is transformed (handled) by two 'non-sources' – real-time processing and sound projection (spatialisation). Each non-source will establish a relation of *contradiction* with one of the two sources. The immateriality and a-causality of sound projection deny the corporeity of the real instrumental source. The work beyond-time (*hors-temps*) which is intended to compose the virtual source, denies the real time processing.

The *contradiction* relationship between the instrumental sound and the sound projection (S1/non-S1) concerns the way the sounds are diffused in space. The instrumental sound is localised according to the self-qualities of *radiation* of the instrument and the place of the performer in the diffusion space. On the contrary, the electronic part is localised according to the *projection* of the sound through the loudspeakers distributed in space.[2] Sound projection by means of loudspeakers metaphorically changes the distance between the sound and the listener. The sound amplification seems to bring the listeners closer to the source. Thus, in *Black Angels* (1970) by Crumb the amplification of the string quartet is used to create surrealistic effects in which the amplified *pianissimo* instrumental sounds seem to be played nearby to the listener's ears. The same type of effect is used in Saariaho's *Lonh* (1996) to amplify the spoken passages murmured by the singer. With the loudspeaker diffusion, the sound is not localised at a fixed point of auditory space any more, but can change its location according to the location of the loudspeakers. The sound is no longer focused at one point but can be projected on to several points at the same time, and the projected sound can be moved and can follow trajectories. In the case of an acoustic instrument controlled by the processes of spatialisation, a disjunction will appear between the sound produced by the performer and his localisation. Such a disjunction will lead to a kind of disembodied reality of the instrument. The spatialisation thus seems a negation of the corporeity of the instrument, but gives it the possibility to move in space. In *Spirali* (1987–1988, rev. 2002) by Stroppa, each instrument is projected through its own loudspeaker, but the depth (distance) and the space image (width) of each instrument are also composed and change as the piece unfolds. Spatialisation deploys the material, without any movement of spatialisation, using various focal distances, forming an image more or less precisely. In *Watershed IV* (1995) by Reynolds, the spatialisation was used to suck the audience into the world of the percussionist in order to blur the border between the listeners and the performer. Spatialisation widens and projects the percussionist's gestures in the outside direction so as to include the public.

The relation between the support-based sound source and the real-time processing (S2/non-S2) also has a character of *contradiction*. This opposition is in line with the question of the technological choice between the differed time and the real time. The transformation of a source in real time is defined as the negation of the support-based sound. Although the support-based sound can be subject to the same electronic processing, its fixed sound image removes the possibility of the interaction and the unpredictability. The transformation of a source in real time can be more or less programmed, but it is nevertheless dependent on the source and it interacts with it. From another point of view, the support-based sound allows the studio work to be much more developed and controlled. Although the difference tends to grow more and more blurred, some processing requires a large amount of computing power and is only feasible in the studio. Now it's time to examine the relations of *complementarity*.

Complementarity applies to the various types of interactions which can exist between a live instrumental source and its transformations in real time (non-S2/S1). This type of relation can be regarded as a *glose* of an utterance, an enunciation/commentary relationship. The transformed sound can constitute a prolongation, e.g. in the case of an infinite reverberation or a delay, as in *Echoes* (1968) by Chadabe or in *Ricercare una melodia* (1984) by Harvey. It can be a reduction of texture or an enrichment of harmony or timbre by using ring modulation as in *Mantra* (1970) by Stockhausen, or a harmoniser as in *One Evening*

[2]Spatialisation can also be simulated by processing the signal (filtering, reverberation) with software.

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(1993–1994) or *Soleil Noir* (1994–1995) by Harvey. It can be a form of sound analysis by filtering as in *Mikrophonie I* (1964) by Stockhausen. In pieces using real-time transformations, the electronic part is often metaphorically compared with a shade following its master more or less faithfully. In *Duo pour un pianiste* (1989), Risset sought an interaction between the interpreter and the computer, not in the field of the sound processing, but in that of the composition. The computer analyses the playing of a pianist on a Disklavier (MIDI acoustic piano) online and produces the responses playing the same piano.

Complementarity appears in the relation between the electronic source and spatialisation (non-S1/S2). It corresponds to the types of relations which one finds in electroacoustic music (concrete music, tape music, computer music, acousmatic music, etc.). Spatialisation constitutes a 'natural' prolongation with the editing carried out in the studio. It brings movement and life into the electronic world. It provides spatial compensation for the absence of the visibility of the sources by differentiating the streams and the rigidity of the support-based sound by means of a dynamic mix. Spatialisation is a quasi-body of the support-based sound. Paradoxically, the invisibility of the source reinforces the sensorial presence of the sound (it is what Bayle [2003] called an i-sound, a sound image). In *The Palace* (1978–1980) by Reynolds, a singer soloist, alternating the countertenor and the dramatic baritone registers, sings with the accompaniment of his own pre-recorded spoken voice. The movements of the sound, in a kind of a spatial choreography, underline the contrast of the speech and the song, action and reflection, the visible and the invisible. In a certain way, spatialisation reinstates the instrumental gesture. In *Dialogue de l'ombre double* (1985) by Boulez, a solo clarinet is confronted with its 'electronic shadow' (a pre-recorded clarinet). The pre-recorded clarinet is diffused by six loudspeakers in the passages called 'Transitions'. Various types of writing employed in the score are articulated by means of several techniques of spatialisation: variation of the number of loudspeakers to particularise a motive, variation of the intensity to differentiate plans, and circular or diagonal motions.

4. CONCLUSION

We decided to examine the environments of mixed music as a network of relations between the instrumental and the electronics. The model outlined in this article transfers the relations defined within the semiotic square in terms of *contrariety*, *contradiction* and *complementarity* to the field of mixed music. It describes the immanent structure of the environments, organises the coherence of a conceptual universe, and releases the potential interactions between the actors of mixed music. The model is built on the basis of two paradigmatic axes whose terms are opposed in a relation of *contrariety*, between real and virtual sources (main axis, S1/S2) on the one hand, and between transformations in real time and sound projection (secondary axis, non-S3/non-S1) on the other. Each term of the principal axis separately contracts a privative relationship to a term of the secondary axis. Sound projection is defined as the negation of the real source (contradiction non-S1/S1) and the real time processing – as the negation of the virtual source (contradiction non-S2/S2). Each term of the secondary axis separately contracts an operation of implication with one of the terms of the principal axis: the real-time processing implies *complementarity* with the real source and the sound projection implies *complementarity* with the virtual source. The semiotic square of mixed music whose poles are thus defined is subdivided into two triangles corresponding to two 'historical' environments. The first triangle, including the principal axis (S1/S2), *contradiction* (non-S1/S2) and *complementarity* (non-S1/S2), was brought up to date with the music with the instrumental and the support-based sound (mixed music, strictly speaking). The second triangle, containing the secondary axis (non-S2/non-S1), *contradiction* and *complementarity* (non-S2/S1), appeared in the music with an instrument and transformation in real time (live electronics). The model of analysis of mixed music outlined in this article opens up several possibilities. Mixed works can thus be analysed, using the model suggested, from the paradigmatic point of view. A mixed piece can be examined, and compared with others, in the choice of the environment and the potential relations resulting from it. However, syntagmatic reading is also possible. The deployment of a particular work fits in a 'narrative course'. One can emphasise one or another type of relation at each moment of the piece. These issues deserve more consistent developments, which go beyond the scope of this paper.

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