Traditional and digital music instruments : a relationship based on a interactive model

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Abstract – **In the present work some aspects of the influence of the digital music instruments on composition methods are observed. Some consequences of the relationship between traditional instruments and digital music instruments result on a triangular interactive process. As an analytical approach to understand this relationship and the association process between traditional instruments and digital music instruments, a typology of interaction for the musical performance based on this instrumental configuration is proposed. The deduced classes are based upon the observation and systematization of my work as a composer. The proposed model aims to contribute towards an unifying terminology and systematization of some of the major questions that arise from the coexistence between two different paradigms (traditional and digital music instruments) in the universe of live electronic music.**

I. BUILDING A SYSTEMATIZATION METHOD

My activity as composer implies a constant research, in the field of sound materials, namely timbre. Although this research activity does not always occur as a systematic strategy, I am very focused on understanding and developing some interaction models on the relationship between composition and interpretation. These models, adapted to precise situations, make it possible to establish, *a priori*, a kind of memory catalogue in order to reflect a global paradigm, within a strictly musical point of view, where composer, composition, musicians and instruments interact in a macro scale [1]. In order to explain the connection modes and communication models, within the exchange and cooperative relations among traditional musical instruments and digital music instruments we propose a paradigm based on a typology form. Traditional music instruments and digital music instruments are able to influence and interact mutually through the actions of performers. Consequently, in my work, the interaction classification in the form of a typology results from the need to systematize some categories and hierarchical relations in this universe. A global approach to these problems leads to two main questions:

- the systematization categories derived from the relations between musicians and instruments;
- the adaptation and understanding of the musical resources and techniques to the technological contexts - better technological choices or improved technical solutions - in order to realize a musical work.

II. STUDY CASE

Through the interpretation of a live electronic music work, the relations established between all instruments able to operate and play in real time (digital music instruments and traditional music instruments) - shows us different characteristics and qualities [6]. These differences can change according to the technological devices or the technological infrastructure associated to the realization of the work [3], such as:

- traditional instrument and music on support (CD or tape);
- traditional instrument and digital music instrument with limited access (digital MIDI sampler, digital MIDI synthesizer, effects processor, etc.);
- traditional instrument and digital music instrument based on the computer (open programming access).

Therefore, the technological device category enables the definition of the kind of interactions limits between the musicians and the instruments as well as the interpretable musical parameters. For example, in a work for traditional instruments and music fixed on support (Tape or CD), it is very difficult to interpret the time, because time and durations associated to the recorded musical contents on support are unchangeable [7]. On the other hand, in a work for traditional instruments and digital music instruments (able to operate in real time) as well as in a work for traditional instruments, the interpretation of time has a very large space of variation, operated with much more flexibility. Thus, we perceive that the characteristics and qualities of the relations between traditional instruments and digital music instruments can be classified according to interaction categories. In the last few years, we have developed specific strategies based on our experiments to conceive the right communication approach between traditional instruments and digital instruments. In this framework we have introduced typological descriptors aiming to characterize the interactive processes employed in our works. It is our belief that the typology of an interactive process is delimited by two principal categories: *kind* and *directionality* (see Fig. 1). As far as *kind* is concerned, we divide it into two subcategories:

- discrete;
- continuous.

Regarding *directionality*, we also divide it into two subcategories:

- one-way;
- two-ways.

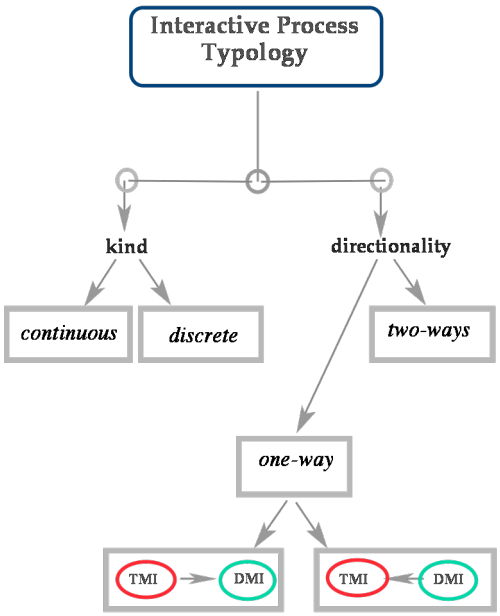

Fig. 1. Typology of interactive processes.

Regarding *directionality*, in the case of a one-way process, it can be further divided into two subcategories:

- when the traditional music instrument is able to influence the musical results of the digital music instrument (TMI---> DMI);
- when the digital music instrument is able to influence the musical results of the traditional music instruments; (TMI < --- DMI).

In the Table 1 we can see clearly the different regions produced by the division categories.

TABLE I.
INTERACTION CATEGORIES TYPOLOGIES INTERSECTION

		DIRECTIONALITY		
		One-way		**Two-ways**
		T>D	D>T	-
KIND	**Discrete**	TDD1	DTD1	TWDI
	Continuous	TDC1	DTC1	TWCI

III. THE CATEGORIES DESCRIPTION

3.1. The Kind Category : Discrete Interaction

We begin this chapter whit an example of a discrete interactive process : when a traditional music instrument controls the sound produced by a digital music instrument through procedures controlled with impulses. It can be the situation where a note, a frequency or one dynamic peak from the traditional musical instrument signals starts: categories

- a sound or a whole collection of pre-recorded sounds;
- a global effect (reverberation, delay, etc...).

The principal characteristic of a discrete interactive process, being it one-way or bidirectional, can be reduced to an impression of *globality*. In this case, the notion of *globality*, even if able to express different meanings, is circumscribed by us to the aspects that refer to a real time transformation of the sound matter [10]. *The globality*, as the main characteristic of this process, is a consequence of the control mode. In fact all that is related to the handling and the sound processing is operated from a single event, where data control continuity does not exist. In this network, each point represents a place of intersection where a value, a data or a single impulse, determine the beginning or the end of an event, a treatment or a musical transformation. In this type of structure, the communication between man and instruments, is realized, in a general way, through very distant coordinates (space and temporality):

- where the events cannot establish, successively or alternatively, a relation between them;
- where an event cannot be transformed in a continuous mode (from the starting point up to the end point);
- where the existence of an transitional space, between the temporal occurrence of each point cannot establish a kind of relational memory between the performance and the musical results of the electronic part.

Even if this structuring method appears very effective, from the point of view of system stability like the control of the multiple digital music instruments, it limits the continuity of musical gesture [2]. This aspect reduces drastically the interpretation potentialities of the electronic part in a musical work.

3.2. The Kind Category: Continuous Interaction

The most important characteristic of a continuous interaction process consists on the distribution of interventions in which each intervention usually relates to a specific process [11]. These interventions are more

commonly materialized in the form of sound processing or of musical material generation. This means that: the increase of a continuous interaction process between the musicians and the digital music instruments imposes specific procedures to each situation [9]. This principle presupposes one permanent continuous data exchange during the realization of live electronic music work and implies that all the parameters, controls and adjustments are carried out in real time, both in the level of musical generation and of sound processing. One example of such a continuous interactive process: when a traditional music instrument controls the digital musical instrument sound results through a continuous data exchange. In this method an additional level is required in order to accomplish the acquisition and the data representation extracted from the controller instrument (in this case a traditional music instrument). Generally, the real time sound processing or a sound generating control method depends from the data tracking method catches, during the musical performance. A continuous interactive process requires a continuous data tracking method in order to represent a continuous flow of numerical values. The assembly of these data generally entails two successive steps:

- the step related to data acquisition;
- the step related to the previous gathered data representation.

The step concerning data acquisition can be carried out in three forms:

- data acquisition, based on the audio signal analysis coming from the traditional instrument;
- data acquisition, based on movements, mechanical actions of pressure of displacement tracking through various sensor types;
- data acquisition, based on the combination of the above.

The main purpose of the representation step is to adapt and transcribe the data provided by the analysis from the signal, the sensors or both. The greatest difficulties regarding data transcription lie on the adaptations of common variables to a model tailored to a specific concretization [12]. In this type of structuring, the communication between the man and the instruments allows that:

- various events can successively or alternatively establish a relation between them;
- an event can be transformed in a continuous mode (from the starting point up to the end point);
- a transitional space, between the temporal occurrence of each point establishes a kind of relational memory between the performance and the musical results of the electronic part.

3.3. The Directionality Category : One-way interaction

As was mentioned in the introduction (see also Fig. 1 and Table 1) the directions in which an interactive process progress can be taken in different ways. The advantage of identifying the direction among which the process progresses, is that it is possible to quantify the influence between the entities involved on the process. On the other hand, understanding the direction among which an interactive process progresses also makes it possible to deduce three aspects simultaneously:

- the number of entities engaged in the process and their principal qualities;
- the hierarchical placement of each entity;
- the entities which act and those which are affected by the actions.

Taking the literal significance of the interaction concept in the context of a communication process, one of the first meanings, and the most spontaneous one, establishes a significance link to a kind of reciprocal game between two or several entities [8]. This concept of exchange and reciprocal influence in an interactive process characterizes the different entities related to the process as human beings. However, according to Jensen [5], one can deduce that the medias also have some singular qualities and characteristics, which are able to influence the behaviours and actions of human beings:

> *"... the concept of interaction is a concept directly correlated with the communication, which implies among the process of exchange a permeability to the medias characteristics ...." [5].*

The one-way interaction typology, such as we discuss it in the musical context, represents the particular case of the interaction because the communication channel works in one way only. In this case, the process evolution vectors are spread in only one direction. This situation implies that the entity affected by these vectors is not able to reply because the communication structure does not contain a return channel. In the case where the interaction process is carried out in a one-way direction, we state two distinct situations:

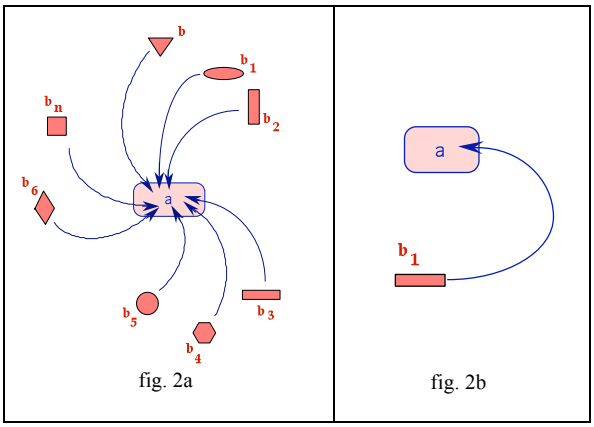

fig. 2a fig. 2b

- one or more performers influence, through their instruments or through external controllers (see fig. 2a and 2b) the musical results of the digital music instruments;

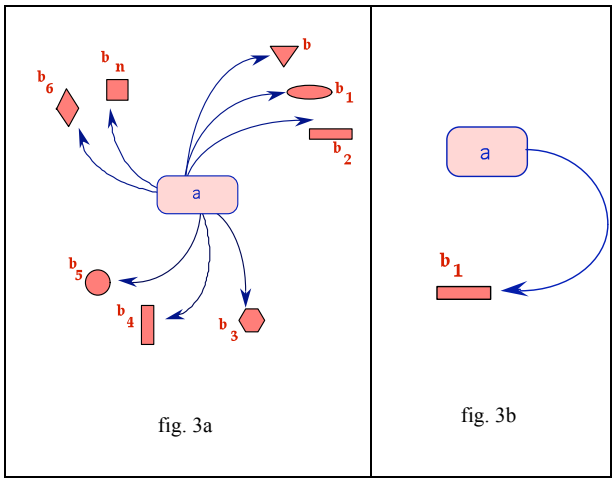

fig. 3a

fig. 3b

- one or more digital music instruments interact and influence the musical results of one or several interpreters (see fig. 3a and fig. 3b).

3.4. The Directionality Category : Two-way interaction

In the cases where interactive typologies are based on a two-way communication method, the principles of this typology can be considered as a duplication of the communication chain between the entities related to the process, but in opposite directions. In this way, we can conceive a general category of bidirectional interaction, where it is possible to include at least two typologies of interaction. The first typology: we can observe a similar preponderance of influence between each instrument. In this typology, it is possible to observe a process in which the traditional music instrument controls the musical results of the digital music instrument and at the same time the processes of the control - in the form of transformations into real time - that the digital music instrument operates on the achievements of the traditional musical instrument. We can illustrate this typology through the following example: data extracted from the dynamics analysis of a traditional music instrument make it possible to start the sound or music sequences previously sampled and stored on hard disk. In tandem with this, the digital music instrument transforms the sound of the traditional music instrument in the form of global effects: reverberations effect, harmonizer effect, etc... In this example, we mentioned the effects operated on the traditional music instrument as global features, however the transformations operated by the digital music instrument could have been more complex. It only depends on the choice of typological kind (continuous or discrete) and consequently in the mapping complexity of control parameters between the physical action of a human (TMI) and a programmed environment within the computer (DMI) [4].

IV. Conclusion

The background upon which we characterize the interactive process between a traditional music instrument and a digital music instrument is based upon a typology based on two main categories: *kind* and *directionality*. This means that, on any interactive process, there is one stratification related to *kind* and another one related to *directionality*.

Hence, *kind* reveals the internal type of interaction process articulation (discrete, continuous), and *directionality* dictates which entities (traditional or digital music instruments) will be the object of the process assignments.

In the situations where it is intended that the digital music instrument achieves highly complex musical results and a “humanized” performance, we notice that what results from sound processing only denotes the desired complexity if the process of articulation between the traditional and digital music instruments is accomplished by a kind of continuous communication. Within this framework we also remark that the quality of a “humanized” performance implies that the traditional musical instrument assumes a non-common category: the interface controller of the digital music instrument.

In cases where the main accomplishment intended for the interaction is a global sound processing effect (reverberation, harmonizer, chorus) applied to the traditional musical instrument through the digital music instrument, we observe two major problems:

- first, the computer cannot determine beforehand what the musician will carry out in the performance due to the fact that the computer is used simply as a transformer entity and the communication chain had only a one-way channel;

- second, the magnitude of the sound resolution scales and the sound fragmentation dimensions do not allow a micro local manipulation and micro temporal isolation of the different layers from the sound spectrum. This type of constraint implies that the sound manipulation and the spectral transformations can only be operated on undifferentiated and global sound mass.

The second typology is based on situations where it becomes possible to establish two channels of communication, a two-way interaction, the traditional musical instrument can have a dual function: as transformed and as transformer. In this kind of situation, it is possible simultaneously:

- through a channel, to configure an interaction process, favouring digital musical instrument operations on the traditional instrument ;
- through the second communication channel, it is possible that the traditional music instrument makes the assignment to the transformations settings itself, that will be produced on its own sound.

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VI. References

[1] Ferreira-Lopes, P.; *Étude de modèles interactifs et d'interfaces de contrôle en temps réel pour la composition musicale.* Thèse de Doctorat ; Paris ; Université de Saint Denis - Paris VIII - Dép. de Sciences et Technologies des Arts, 2004

[2] Ferreira-Lopes, P., Coimbra D. and Sousa Dias, A.: "Music and Interaction: Consequences, Mutations and Metaphors of the Digital Music Instrument" *in ACTAS do 2º Workshop Luso-Galaico de Artes Digitais* ; Vila Nova Cerveira / Portugal ; 2005.

[3] Garnett, G. E.*;* The Aesthetics of Computer Music in *Computer Music Journal vol 25 nr. 1*; Massachusetts: éd. The MIT Press, 2001.

[4] Goebel, J.; "The Art of Interfacing: Senses, Sense and the Discipline of Playing Interfaces" *in The Sciences of the interfaces* (p. 306-314); Tuebingen: éd. Genista VERLAG, 1999.

[5] Jensen, J.*;* Interactivity; Tracking a new concept in media and communication Studies in *Computer Media and Communicatio* ; Oxford : Oxford University Press , 1999.

[6] Lèvy, F. ; Texte de présentation du CD-Rom "Le temps réel en musique" - *A l'occasion de l'exposition "Le temps, vite" présentée au Centre Georges Pompidou,* Paris : éd. IRCAM, 2000.

[7] Manoury, P.; "De l'incidence des systèmes en temps réels sur la création musicale" *in Actes de la Conférence ARTE E TECNOLOGIA*; Lisbonne : éd. Fondation Calouste Gulbenkian;1987.

[8] Rafaeli, S.:Interactivity : From New Media to Communication *in Sage Annual Review of Communication Research* ; Beverley Hills - Newbury Park : éd. Sage; 1988. (pp110-134)

[9] Risset, J. C.; Evolution des outils de création sonore *in Interfaces homme-machine et création musicale* ; Paris : éd. Hermes; 1999.

[10] Vaggione , H. : "L'espace composable sur quelques catégories opératoires dans la musique électroacoustique" *in M. Solomos et J-M Chouvel (Ed.): Espace : musique, philosophie.* ; Paris, L'Harmatan; 1998.

[11] Weibel, P.; "The Art of Interface Technology" *in The Sciences of the interfaces* (p. 272-281); Tuebingen : éd. Genista VERLAG ; 1999 ;

[12] Winograd, T.: Interaction Spaces for 21st Century Computing, in John Carroll (ed.), *Human-Computer Interaction in the New Millennium*, Addison-Wesley, 2001.