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"Music and Systems Thinking: Xenakis, Di Scipio and a Systemic Model of Symbolic Music "

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Music and Systems Thinking:
Xenakis, Di Scipio and a Systemic Model of Symbolic Music

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Abstract

'Systems thinking' includes a number of interdisciplinary theories based on organizational approach to problems, in other words considering everything as systems. The paper discusses the connection of Iannis Xenakis and Agostino Di Scipio with 'systems thinking' and proposes an experimental compositional model related to this line of thinking.

Xenakis, in order to formulate and explain what he called 'Stochastic Music' he used the methodology of 'cybernetics', one of the most important theories of 'systems thinking'. Also, based on the same approach, he formulated the hypothesis of 'second order sonorities'. After this historical point Di Scipio comes to add his objection to Xenakis's approach. Di Scipio doubts that the stochastic laws are capable of determining the emergence of 'second order sonorities'. Resulting from this problematics on Xenakis, his criticism of the conventional model of interactive music and the application of notions found in 'systems thinking', Di Scipio is suggesting a 'self-organized' interactive model. According to this model, the sound system is able to observe itself and regulate its own processes. It can be considered as a self-organized system, an organism, placed in his environment, the space of the concert hall.

Based on this line of music evolution connected with 'systems thinking', we have attempted to develop a systemic model of symbolic music, an experimental compositional model mainly used for instrumental writing. The term 'symbolic' refers to the focus on the information's flow through symbolic means, i.e. through music notation. In addition, the approach treats 'systemically' the compositional work, applying notions found in 'systems thinking' through the cognitive sciences. We have abstracted the 'live interactive music model' used in live electronics, from a systemic viewpoint, using it as the basis of what we call the *Creative System of Symbolic Music*. Using simple examples, the structural design and the functional performance of the model will be presented.

Introduction

'Systems Thinking' includes a number of interdisciplinary theories, mainly Cybernetics, General Systems Theory and the more recent Complexity Science, treating organized entities. In other words, through the prism of 'Systems Thinking', everything is considering as a system. In this paper I discuss the connection of Iannis Xenakis and Agostino Di Scipio with 'Systems Thinking' and I propose an experimental compositional model related to this line of thought. [1]

Xenakis and Markovian Stochastic Music

Xenakis, in his polemics against serial music, he announces the fall of music's linearity resulting from the ever growing complexity (Xenakis, 1956). As a solution to that, Xenakis introduces the notion of probability in music. Consequently, he formulates what he calls 'Markovian Stochastic Music' attempting to 'generalize the study of musical composition with the aid of stochastics' (Xenakis, 1963). He describes his theory using Ashby's methodology found in his *An introduction to Cybernetics* (Ashby, 1956). He formulates a basic hypothesis where he claims that '[a]ll sound is an integration of grains, of elementary sonic particles, of sonic quanta' (Xenakis, 1963). According to Xenakis' hypothesis, we can analyse and reconstruct whatever existing sound. Furthermore, it is possible to create non pre-existing sounds as a combination of countless grains. His so called 'granular hypothesis' is connected with the production of timbres, where *second order sonorities* emerge from clouds of sonic grains. Xenakis first applied his hypothesis into works *Analogique A* for string ensemble and *Analogique B* for tape which he later combined them into one piece *Analogique A & B*.

Di Scipio on Xenakis

According to Di Scipio, Xenakis' use of stochastic laws in the application of his hypothesis are unable to determine the emergence of second order sonorities: '*Just as the pizzicatos of Analogique A could not but remain string pizzicatos, however dense their articulation, the electronic grains in Analogique B remain just grains and do not build up into more global auditory image*' (Di Scipio, 2001). Furthermore, Di Scipio states that Xenakis' mechanism although it is sensitive to initial conditions it is unable to be influenced by the events of his own function. Instead, only the

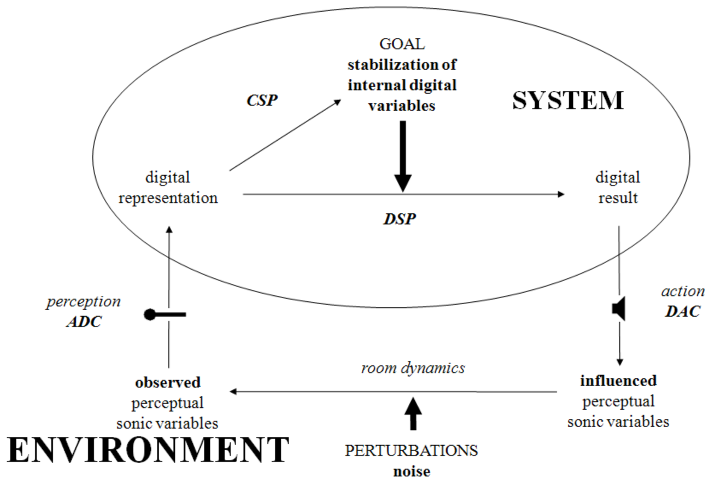

Fig. 1 *– Audible Eco-Systemic Interface according to the model of second-order cybernetics*

[1] For a detailed introduction to 'Systems Thinking' see the second chapter of (Kollias, 2007).

composer is capable of influencing the mechanism from the outside.

Di Scipio and Audible Eco-Systemic Interface

Di Scipio proposes a self-organised music system, what he calls *Audible Eco-Systemic Interface* (Di Scipio, 2003). His model is based on his:

1) problematics on Xenakis' mechanism for the application of the hypothesis of second order sonorities
2) his critique on the conventional interactive music model and
3) on principles found in Systems Thinking.

I have formulated a model of Di Scipio's self-organised system according to the model of second-order cybernetics (**Fig. 1**):

1) The system *observes* auditorily its environment which is the sonic space of the performance. The process of *perception* is possible through the microphones (the sensory organs) representing the sound digitally.
2) The representation of sound is treated in two different lines: the Digital Signal Processing (DSP) and the Control Signal Processing (CSP).

In the CSP, combinations of values of psychoacoustic characteristics influence the values of the DSP through a linear and non-linear mapping function (**Fig. 2**). In this way, the DSP's characteristics are defined from the CSP at the same time with the DSP's processing.

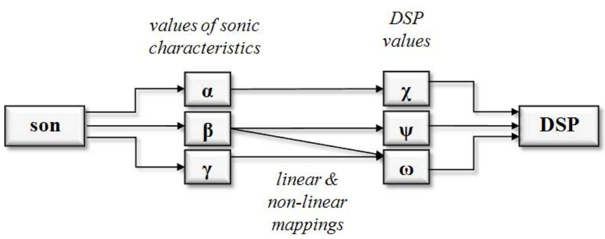

Fig. 2 *– Mapping between sound characteristics and DSP processes*

Creative System of Symbolic Music

My research into Systems Thinking and its connection with Xenakis and Di Scipio, led me to two lines of work: Firstly, the application of systemic principles into electroacoustic music (Kollias, 2008) and secondly, the approach of instrumental composition through a systemic view. In the second case, I attempted to formalise an experimental compositional model what I call the *Creative System of Symbolic Music*. The term 'symbolic' refers to the focus on the information's flow through symbolic means, in the sense of music notation.[2] In addition, the approach treats 'systemically' the compositional work, applying notions found in Systems Thinking, linked with music through the Cognitive Sciences. Although the approach is orientated towards instrumental writing, is based on a model of *Live Interactive Music*.

Live Interactive Music Model

We consider the conventional manifestation of the 'Live Interactive Music Model' as a simple setting of a DSP device with input and output (**Fig. 3**). An agent-performer is controlling the system by entering data or sound into the input while the output result is sound. The delay between the input and the output is practically very short and thus all operations are perceived to be in real-time. The role of the composer here is the planning of the DSP settings in such a way to get a satisfactory result from the input-output relations during the performance. Finally, between the input (controlled by the performer) and the output (the resulting sound) there is a feedback relationship for monitoring purposes (usually also supported by visual aids). As we discussed above in the model of the self-organised system, it is possible the information from the output to be send directly to the system's input and through this feedback connection the system to regulate its own processes. This is possible through *mapping* operations, where the values of sonic characteristics are addressed to the values of the DSP processes.

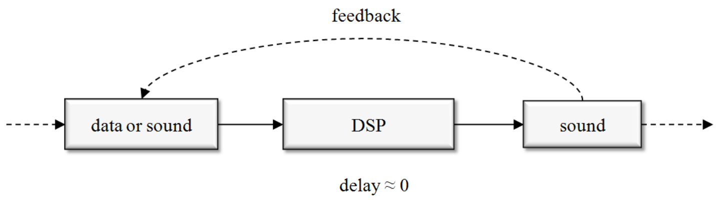

Fig. 3 *– Live Interactive Music Model*

The structure and function of the Creative System of Symbolic Music

Going back to the 'Creative System of Symbolic Music' model, we consider the 'Creative System' as a regulating system controlled by the composer (**Fig. 4**):

- The composer introduces symbolic

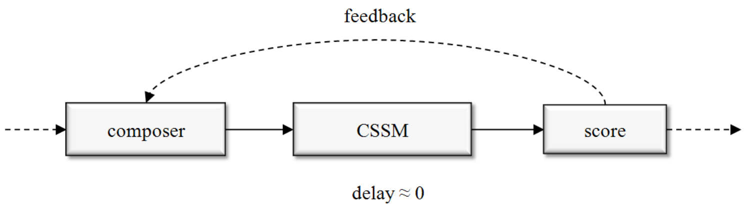

Fig. 4 *– Creative System of Symbolic Music*

[2] I use the term 'symbolic music' (*music symbolique*) as it was originally introduced by Xenakis defined as 'a logical and algebraic draft of music composition' ('une esquisse logique et algébrique de la composition musicale'; Xenakis, 1963).

information in the input and the result deriving from the output after a given delay, forms the emerging score.

- The input information is connected with the output result through a mapping process.
- The composer monitors the result with his own means of surveillance.[3]

The model implies mainly two activities of creation: First, the composer designs the different levels of his Creative System (system's architecture) and second, he controls his 'Creative System' through the input for the score's production (system's control).

In the first stage, the composer decides the level of the model's application according to the sonic entities he is willing to control and he creates relations between these entities. In this way he is designing his own 'Creative System'.

In the second stage he 'puts it into action': He enters symbolic information in the input which results into segments of the score from the output. In general, a 'Creative System' is constituted by elements connected in particular fashion. Each element is also a system with his input, output, delay and 'mapping' function. Each element receives information from his input which then processes, according to his 'mapping'. It finally sends the result from his output after a time span in accordance with his delay.

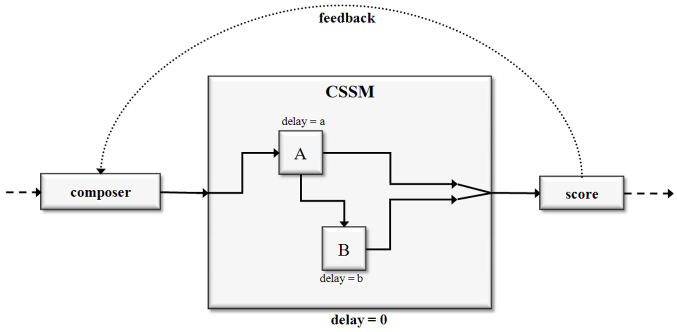

Fig. 5 *– System of two elements*

In order to show clearly the function of the model, we will start with a simple system of two elements, A and B (**Fig. 5**). The output of each element is connected with the output of the 'Creative System'. In this system, element A dominates element B. The delay of element A is zero while that of B is a dotted crotchet. The composer introduces three times consecutively the same rhythmic motif: 

In **Fig. 6** we can observe the different states of the *Creative System's* function.

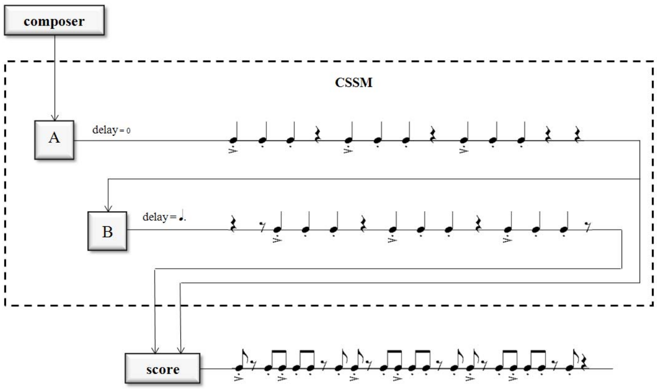

Fig. 6 *–The different states of the Creative System's function*

In order to benefit from the full potentials of the model, we have to create between the elements 'mapping' functions and feedback relations.

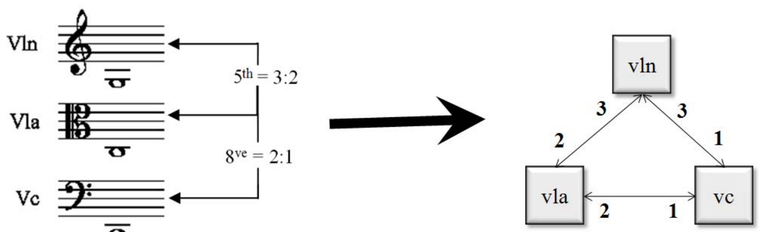

Fig. 7 *– The relations of violin, viola, cello according to their lower pitches*

We design now a system based on the relations of violin, viola and cello in terms of their lower pitch (**Fig. 7**). We use only linear mapping and only between the parameters of the same symbolic domain. We decide that each relation between two instruments defines all the parameters ('mapping' and delay) and that the number of events in each information's transfer stays constant.

In the table of **Fig. 8** we show all the changes that result to the relations among the instruments. We do not add any relations of dynamics.

Finally, in **Fig. 9** we can observe what happens if we enter into the input the information of the violin's first measure.

	vln→vla	*vla→vc*	*vc→vln*
pitch	$G_3 \rightarrow C_3$	$C_3 \rightarrow C_2$	$C_2 \rightarrow G_3$
event's duration	♪ (3) → ♪	♪ → ♩	♩ → ♪ (3)
message's duration	𝅗𝅥. → 𝅗𝅥. ‿ ♩.	𝅗𝅥. ‿ ♩. → 𝅝. ‿ 𝅗𝅥.	𝅝. ‿ 𝅗𝅥. → 𝅗𝅥.
delay	𝅗𝅥 → 𝅗𝅥.	𝅗𝅥. → 𝅝.	𝅝. → 𝅗𝅥

Fig. 8 *– Table of mapping and delays*

[3] There are several different surveillance means used by composers. Some have one monitoring approach others multiple: some experienced composers can imagine the sonic result; others perform arrangements for the piano or another instrument; there are also composers that ask from performers to play them experts of their result; others also use electronic simulation.

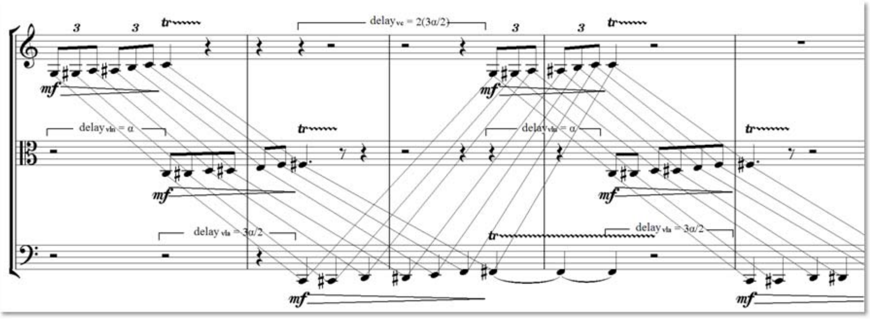

Fig. 9 *– The result of the system's output*

Some remarks

To conclude, I have to say that this model does not aim to be a tool of automatic composition, although that could be also possible. One of the important aspects of the model is that it gives to the composer a multi-layer approach. He can switch between:

1) the different system levels in order to design them or change their parameters
2) introducing material in the system's input

This model makes possible to take advantage of Systems Thinking. Cognitive Psychology that treats auditory perception is concerned with principles of organisation which we use to organise our perception of the auditory world. It can be the link to find isomorphisms between the organisational principles of music and organisational principles of the material world in general.

Acknowledgments

My interest in a systemic approach to composition now dates approximately three years. The survey is the result of my recent research in the University of Paris VIII supervised by Horacio Vaggione. Many different sources and influences have been used in resulting to this systemic model. It was of great significance for my research the influential studies in the different fields of Systems Thinking by Ludwig von Bertalanffy (von Bertalanffy, 1968), Norbert Wiener (Wiener, 1948) and more particularly the work of William Ross Ashby (Ashby, 1956). The bridging of the theoretical concepts with the sound was made possible with the precious help of Albert Bregman's study into Auditory Perception (Bregman, 1990). Finally, very important for the realisation of my systemic model was Agostino Di Scipio's oeuvre in the electroacoustic field and his remarkable attempt of applying to sound notions found in systemic thinking.

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