Application of Systemic Principles in Music Composition

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Abstract

In this paper, I will present the practical results of my research on the interdisciplinary scientific field of Systemics. I will include two experimental approaches to composition based on the application of systemic principles.

Systemics consists of a number of interdisciplinary theories based on organizational approach to problems. From a systemic viewpoint, everything is considered as a system, i.e. as a complex of interacting elements.

In the first part of the paper, I will show how I have applied the theory in instrumental composition. In this approach, I have attempted to develop an experimental compositional model based on a model of live interactive music from a systemic viewpoint. In the 'Systemic Model of Symbolic Music', we are interested 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 Systemics through the help of the Cognitive Sciences.

In the second part, I will show an alternative approach to interactive electroacoustic composition, also based on concepts of Systemics. In this approach, the musical work it appears in time like a 'living music organism', a musical work able to adapt in any given situation but always maintaining a stable and recognisable structural form. This 'organism' results from a live algorithm, a software, installed on a computer. The organism has the ability to 'listen' through the microphones and to 'express' itself through the loudspeakers. In this way, the organism is a self-organised system, in other terms it is capable of influencing its own organisation. Here, I will demonstrate the structure of the 'organism' and I will explain the basic principles of its creation.

Introduction

Systemics or Systems Thinking is a general term referring to a number of interdisciplinary theories that have in common the concept of organisation. Among others, Cybernetics, General Systems Theory and Complexity Science, observe and describe everything through models using concepts like feedback, interaction, self-organisation and emergence[1].

Systemics emerged after the Second World War and over the years that followed influenced significantly the scientific thinking but also the common thinking. In addition, composers based their musical ideas on systemic theories, like Xenakis' model of *Markovian Stochastic Music* or Di Scipio's model of *Audible Ecosystemics*.

In this paper, I will discuss briefly two experimental approaches to composition based on the application of systemic principles. The first approach I call it *Systemic Model of Symbolic Music* and it principally concerns instrumental composition. The second approach I call it *Self-Organised Electroacoustic Music* and it concerns electroacoustic composition[2].

The Cybernetic Model

Both approaches I am going to present are based on an interpretation of the Cybernetic model. In the simplest expression of the model, a feedback system is formed from a *receptor*, a *control apparatus* and an *effector* (Bertalanffy 1968, pp. 42-43) (Figure 1). The system receives stimuli in the 'receptor', which is the system's input, a kind of sensory organ for the system. These messages are sent to the 'control apparatus' where they are processed. Then the result is transmitted to the 'effector', the system's output. The effector responds to the messages with an action. The transmission of the message from the input to the output takes some time depending on many factors perceived as a delay of the effect. Finally, the receptor's function is 'fed back' to the receptor that makes the system able to regulate its own action, i.e. a *self-regulating* system.

Applications of the cybernetic model can be found everywhere, as simple as the thermostat of a boiler or as complex as the navigating system of living organisms.

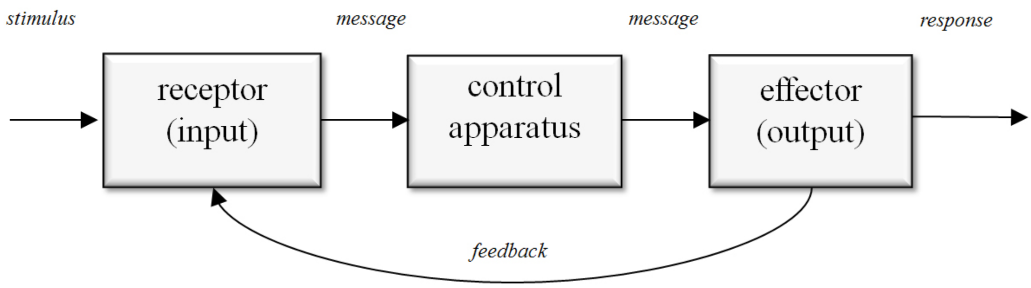

Figure 1. The cybernetic model (Bertalanffy 1968, p.42)

Systemic Model of Symbolic Music

My first attempt to apply systemic principles to music started in instrumental composition, with the *Systemic Model of Symbolic Music* (Kollias 2007, chapter 4; 2008a). In this approach, we are interested in the information's flow through 'symbolic' means, i.e. through music notation[3]. In addition, the approach treats 'systemically' the compositional work, applying notions found in Systemics.

Central role of the model has the *Creative System*, a kind of regulating system controlled by the composer for the production of the music score. The approach implies two creative stages: *system's architecture* and *system's control*.

In the stage of system's architecture, the composer designs a Creative System, which will use for a part of the composition. The designing of the Creative System depends on the elements of his choice and the interrelations he creates among them according to what result he is expecting to get.

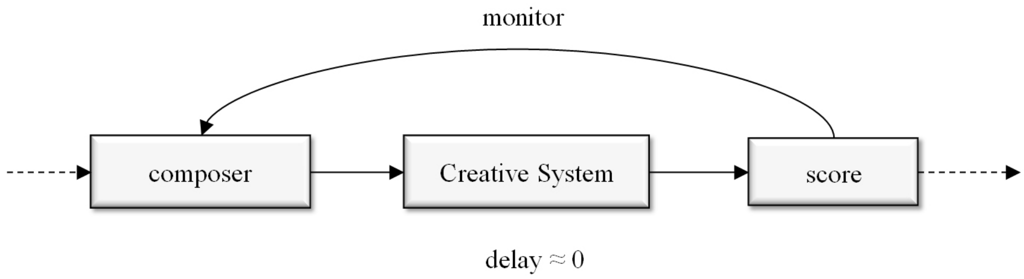

Figure 2. Systemic Model of Symbolic Music

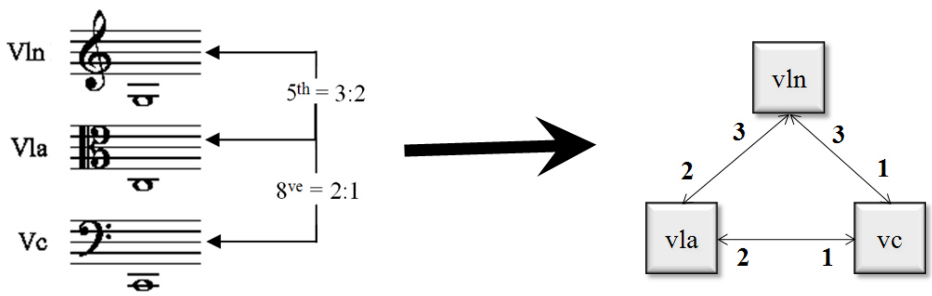

Figure 3. System based on the relations of violin, viola, cello according to their lower pitches

In the stage of system's control, the composer puts into action his Creative System.

- He introduces symbolic information to the system through the input.
- The input information is connected with the output through a mapping function.
- the result derives from the output after certain delay, gradually forming the emerging score.
- The composer monitors the result during the whole process.

I will demonstrate a simple example in order to show how the model works. Let's design a Creative System based on the relations of violin, viola and cello in terms of their lower strings (Figure 3).

To make the result clear, I will use only linear mapping between the parameters of the same symbolic domain, i.e. pitch mapped with pitch, duration mapped with duration and so on. Moreover, each relation between two instruments defines all the parameters ('mapping' and delay) and the number of events in each transfer of information stays constant (Figure 4).

In the table of Figure 5 we can see all the changes resulting to the relations among the instruments. Here there are no relations among dynamics. Finally, in Figure 6 we can observe what happens if we enter into the input the information of the violin's first measure.

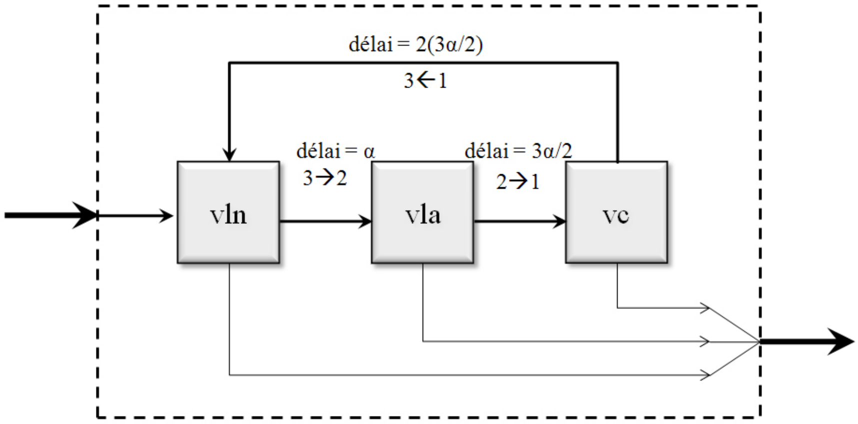

Figure 4. System based on the relations of violin, viola, cello according to their lower pitches

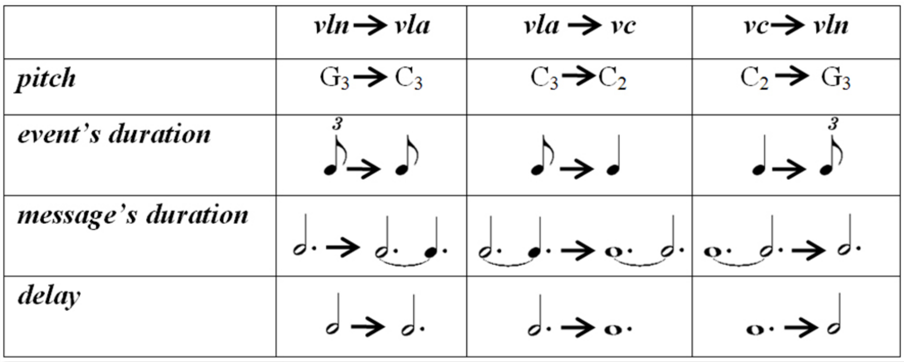

Figure 5. Table of mapping and delays

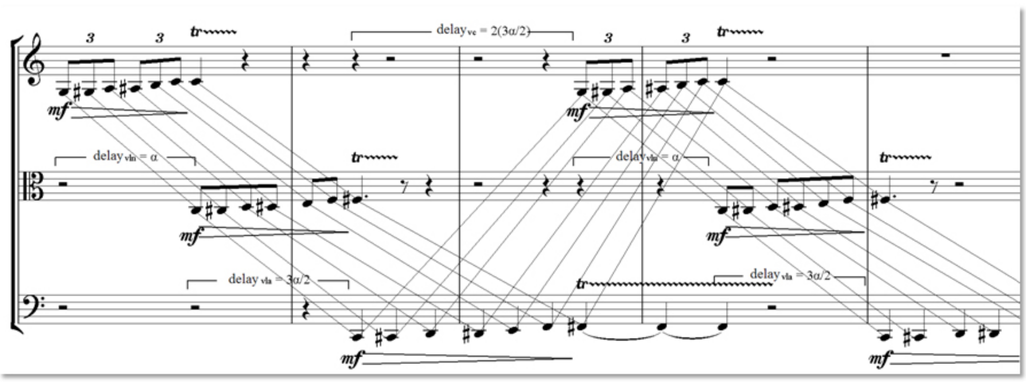

Figure 6. The result of the system's output

Self-Organised Electroacoustic Music

My second attempt to apply systemic principles was in electroacoustic music (Kollias 2008b). Because of the inherited systemic nature of the electronic programming, the applications are easier to prepare and more direct to control. Furthermore, the results are more apparent.

Based again on the cybernetic model, in this approach the electronic device is programmed in a way to be able to organise itself, in direct interaction with the sonic environment of the performance.

I have previously described (Kollias 2008b, p.140) with the term *Self-Organised Music,* '*the result of the interactions between some predefined structures and an occasional context of performance, through a particular interpretational model'*. In the context of electroacoustic music, the 'predefined structures' are represented by the DSP's setting. Moreover, the 'interpretational model' is the definition of the real time control parameters, what Agostino Di Scipio refers to as Control Signal Processing or CSP (Di Scipio 2003).

As in the approach we saw above, the cybernetic model is of central significance here. This time the approach is based on the model of Second-Order Cybernetics (Heylighen and Joslyn 2001), a more advance model to represented self-organised systems.

In this general model of self-organised electroacoustic music, we consider the music work as a self-organised system (Fig. 7). Its goal is to *control* a number of preferable variables. These variables represent particular features of sound. At the same time, there are unforeseen sounds that destabilize the system's preferable variables, in other terms *noise*, described as *perturbations* in cybernetics.

To begin with, the system *observes* its sonic environment. Here, the system's input is the microphones. In the process of *perception*, sound is represented digitally within the system. The representation of sound is treated in two different lines of processing: the DSP and the CSP. Within the CSP setting, combinations of values, representing specific sonic features, influence the values of the DSP through a mapping function. In this way, the DSP's characteristics are regulated from the CSP, at the same time with the DSP's processing. The result of the system's process is going to the output, which are here the speakers. The speakers are *acting* in the sonic environment by diffusing sound. This sonic action has an impact on the 'dynamics' of the sound environment. At the same time, the *perturbations* of the environment influence sound's dynamics and indirectly destabilize the system. Finally, the circle restarts with the whole sound result in the performance space that again is perceived from the system.

Based on this model, it is possible to program a self-organised music system. From the interactions between the system and the environment, a music organism will emerge. Notably, the artistry here is not how to construct interesting events in time. Instead, the creative challenge is how to create a network of interaction, i.e. the setting of the CSP, which can give a satisfying sound result in different circumstances.

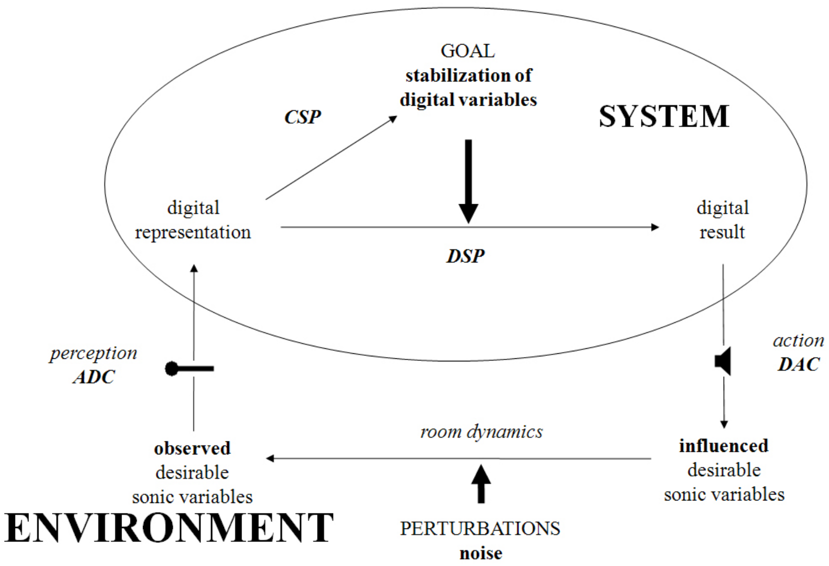

Figure 7. A general model of self-organised electroacoustic music

In my approach, my intention is to acquire spontaneity and unpredictability of self-organisation in the creation of sound. At the same time, to be able to control the result from a higher organisational level in order to develop formal structure. I have shown that this is possible by applying the systemic principle of *equifinality*.

Equifinality

According to von Bertalanffy (1968, p. 39), in a closed system, i.e. a system isolated from its environment, the initial conditions determine a particular final state. As a result, a change of the initial conditions results to a different final state. However, this is not the case in open systems, that is to say systems like living organisms. One of the properties of open systems is to achieve the same finals state upon different initial conditions, what is called *equifinality* (von Bertalanffy 1968, pp. 142-143). For example, the property of organisms of the same species is to reach a specific final size even though they start from different sizes and going through different growth's courses.

Control over Self-Organised Music

In order to acquire control over self-organised music, I have formulated the following hypothesis:

> '[I]f we consider the music organism as an open system, it is possible to create certain conditions in which the organism will show tendency for 'equifinal' behavioural states. […] I believe that we can influence the system in order to pass from a series of behavioural states, which can be similar in any constitution of the same organism under similar circumstances.' (Kollias 2008b, p. 144)

In this approach it is possible to control the system in a basic level, by designing its elementary structures. At the same time, we can acquire control over a higher organisational level, that of macro-structural form, without interrupting the system's ability of self-organisation. In other terms, we can let the system constitute itself, showing emerging properties over the different organisational levels and by indirectly influencing these properties we can acquire a desirable result of distinctive character. Notably, in this approach *the composer is designing in a micro-structural level and at the same time, through the role of the performer, he is controlling the sound result from a higher organisational level.*

Ephemeron

In my work *Ephemeron* (2008) I applied the above hypothesis achieving to create a 'live' organism with a specific formal constitution in time. The basic concept of the work is that the composer creates a DSP as a living music organism. This organism is able to 'adapt' in a given concert's space, the organism's *environment*. The sound result depends solely on the organism's interactions with its environment and the minimal influence of the user upon his behavioural states. *There is no pre-recorded material used at any point during the performance*. The organism's adaptation is the result of the *organism's properties* causing changes to the organism's processes as a consequence of its constant communication with the given *spatial properties*.

Conclusions

In this paper, we have seen two approaches to composition based on the applications of Systemics. Both approaches are based on the cybernetic model of a self-organised system.

The first approach is applied to instrumental music, the 'Systemic Model of Symbolic Music'. Here the composer creates a system, which he then uses by introducing symbolic information and which results to a music score.

The second approach is applied to electroacoustic music, what I call 'Self-Organised Electroacoustic Music'. The composer designs an electronic algorithm which interacts with the given concert hall causing to emerge a music organism.

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1 For a more detailed presentation of Systemics see: Kollias 2007, chapter 2.

2 The two approaches are briefly presented here in the context of the conference. For detailed discussion of each approach, see the individual research results.

3 I use the term 'symbolic music' (*music symbolique*) originally introduced by Xenakis. He refers to 'symbolic music' as *'a logical and algebraic draft of music composition'* (*'une esquisse logique et algébrique de la composition musicale'*; Xenakis 1963, p. 185).