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Systema Naturae, by Andrea Valle and Mauro Lanza, experimentation as starting point of a piece of "acoustic computer music"

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Abstract

This paper presents *Systema Naturae* by Mauro Lanza and Andrea Valle as an example of a work where experimentation has played an important role during the conception and the compositional process. Through the observation of the specific case of *Systema Naturae* I aim to propose an answer to the question: "Electroacoustic Music: is it still a form of experimental music?"

Introduction

Keeping in mind the difficulty of giving a closed definition of what the term experimentation in electroacoustic music means, my approach has been to define as experimental what is based on or derived from experience. Consequently, experimentation is understood as a pseudo-scientific way of working, through the practice of making hypothesis and testing them. Through this perspective I will describe *Systema Naturae*, pointing out the experimental approach. This approach has supported the genesis and the compositional process of the work, even if the final result has been strictly fixed in a score for the ensemble and in the score – intended as a set of instructions – for the electromechanical devices.

Furthermore, I will outline how the idea of the catalogue informs many aspects of this work: it is not only present in the formal structure of the piece, made up of a collection of short pieces, but it informs also the way the composers have worked. A catalogue model could be detected in the way the two composers have named and classified all their new sound-generators, and in the way they have collected and archived many different data, especially audio samples of the sound material, providing the possibility of experimenting with it.

The four *Regna* of *Systema Naturae*

Systema Naturae is a complex work, written between 2013 and 2017. It is a four hand composition by Mauro Lanza and Andrea Valle. Though the two Italian composers belong to the same generation, they come from slightly different backgrounds. Andrea Valle (1974) is an electric bass player, who studied composition with Azio Corghi. He is now a researcher at the University of Torino, and many of his projects involve computational control of physical objects, for improvisations, sound installations and multimedia performances. Mauro Lanza (1975) instead, studied piano in Venice and Computer music at IRCAM, and his pieces are now performed by many ensembles for contemporary music. In his compositions, he often

seeks to bring together classical instruments with less conventional sound sources (such as toy instruments, noise-makers, physical modelling synthesis). The two composers share a common interest in using less conventional sound sources. In this sense, the peculiarity of *Systema Naturae* lies in the co-existence of traditional acoustic instruments and different setups of electromechanical devices, made up of what might be called "hacked objects". *Systema Naturae* is a cycle of four works, each one dedicated to a different natural kingdom: *Regnum Animale*, *Regnum Vegetabile*, *Regnum Lapideum* and *Fossilia*. From the title it is immediately clear that the main reference is to *Systema Naturae* (1735), the important scientific work by Carl Linnaeus, a Swedish botanist, physician and zoologist, who relied on the classification of nature in three kingdoms — animal, vegetable, and mineral — and introduced the binomial nomenclature, i.e. a formal system of naming living beings by genre and species. The latter could be seen as a rationalistic attempt to order the polymorphic appearance of nature, which is not the case of the other references, represented by the Medieval books of bestiaria, herbaria and lapidaria. These were, in fact, heterogeneous collections of miscellaneous animals, plants and stones, multifaceted catalogues of both existing and fantastic creatures with much information and many illustrations and descriptions.

The concept of the catalogue is quite central and it could be seen as a model that informs different aspects of the work: first of all its general organization. Hence each *Regnum* is structured as a catalogue, made up of a sequence of short pieces, each one dedicated to an imaginary animal, plant, stone, or fossil. From Table.1 is possible to observe the structure of each piece. Within the four *Regna* the number of the pieces decreases, while their length increases progressively: *Regnum Animale* collects 28 pieces of approximatively 40" each, *Regnum Vegetabile* has 18 pieces, with a duration between 1'00" and 1'40", *Regnum Lapideum* has 12 pieces between 1'20" and 1'45", and *Fossilia* has just four pieces, where the longest is about 6'. Tab.1

Regnum Animale	***Regnum Vegetabile***	***Regnum Lapideum***	***Fossilia***
approximate duration 20'	approximate duration 20'	approximate duration 19'	approximate duration 14'
28 Pieces – Each piece is between 40"/45"	**18 Pieces –** Each piece is between 1'05"/1'30"	**12 Pieces –** Each piece is between 1'20"/1'45"	**4 Pieces –** Each piece has a different duration
External reference: medieval tradition of Bestiaria Linneaus' *Systema Naturae*. Title are generated starting from the **BINOMIAL NOMENCLATURE**, in Linneaus' *Systema Naturae*	External reference: medieval tradition of herbiaria Linneaus' *Systema Naturae*. Title are generated starting from the **BINOMIAL NOMENCLATURE**, in Linneaus' *Systema Naturae*	External reference: medieval tradition of lapidaria Linneaus' *Systema Naturae* Title are generated starting from the Marbodus Rhedonensis's poem *De Lapidibus*	External reference: For Linneaus *Fossilia* is not the fourth kingdom, rather an articulation of the mineral one. However, the authors choose fossils as an interesting conclusive notion for the cycle
I. Minaeptacta gringi **II. Phola reicha** **III. Taleus photothodecae** **IV. Zampychis flalutengla** **V. Cteromelis udivetusi** **VI. Graphas lopongens** **VII. Sectiditomys stonisius** **VIII. Urysilomys hyssii** **IX. Omysomysomys cacaca** **X. Pteronulephis urachotrons**	**I. Nononophis janeziarii** **II. Uelerinea ballus** **III. Tocactocepia eventaeticans** **IV. Hipseus lanthicus** **V. Schinia groumbusia** **VI. Ferocyclopia erossini** **VII. Ismosia papanabuis** **VIII. Ariolactus usteginsiphillemena** **IX. Hodolindereus hyboalga** **X. Eralmatus clens**	**I. Aligurius** **II. Gagalida** **III. Echelechelena** **IV. Metastontes** **V. Anionidia** **VI. Eliteralates** **VII. Elenion** **VIII. Chrisopiris** **IX. Iactopia** **X. Caracon**	**I. Hinicinichnia** **II. Aranichnia** **III. Seuschylichnia** **IV. Totalatelonteminchnia**

XI. Ioris casachocii	**XI. Canochia usiva**	**XI. Gerillidon**	
XII. Zamonicomus monica	**XII. Disia belga**	**XII. Alatia**	
XIII. Nomotaus yansicomolis	**XIII. Hipseus valos**		
XIV. Adius geradii	**XIV. Reocerantroma phenaudi**		
XV. Cteromelis melins	**XV. Chylicerela eucucta**		
XVI. Onomys ucetasolanzondaroma	**XVI. Melonthora cirencesus**		
XVII. Vinteroicis intermans	**XVII. Bindronocereus ligenatos**		
XVIII. Hoopus lindens	**XVIII. Pentochtelacinia xissisiis**		
XIX. Durophos wienocia			
XX. Atottotis melitopuma			
XXI. Wiluscomylanycanonis			
XXII. Cistomalpha notus			
XXIII. Acaprimomyda tibie			
XXIV. Onomys valloruesca			
XXV. Urophoturonta glistrispus			
XXVI. Daripessus yantillippicus			
XXVII. Urochronopus stoniarens			
XXVIII. Feriocetus petrii			

The actors of the play

The model of the catalogue could be detected also in the way the two composers have classified the hacked electromechanical devices. The starting point of the whole cycle was the design and the building of the sound generators, conceived as instruments, according to a basic and essential definition of instrument as a "device capable of generating sound, once a certain amount of energy is provided" (Valle, 2015). Referring to the setups of electromechanical devices the authors call it the *residual orchestra*: the term *orchestra* is clearly pointing out the presence of a plurality of instruments, each one with its different features. *Residual*, instead, refers to the fact that the different setups are all made of recycled objects. Moreover, the term residual is also used to hint at what remains after an experimental process, in this case, a process of hardware hacking. The latter is the practice of modifying an object in order to make it do something for which it was not originally designed. Through a DIY (Do It Yourself) practice the sound generators are built following empirical experimentation, which leads to serendipitous and unexpected sound result. In one of his articles, Andrea Valle explains how, in this context, the design and building of the setups have been based on constraints of low cost, transportability and easy-maintenance. Moreover, the composers have followed clear principles of sustainable design, such as:

- *Sustainable design* and r*e-fabrication*: i.e. the attitude of recycling and reshaping old and out-of-fashion objects, whose cultural meanings end up being changed. In a capitalist context, characterized by a huge amount of wasted resources, re-fabrication means to develop strategies to reuse available material, including technological fossils, such as clock-radios or electric knives, mainly chosen for their sound potential.

- S*oftening*: it refers to the corporeality of the objects: their hardware aspects resemble software features in the sense that objects, or parts of them, can be easily modified and replaced; also, cables and connections remain open and accessible for manipulation.

- *Flexibility*: i.e. the capability that each object should have to be quickly replaced and modified, according to any specific need of the moment.

Part of this flexibility is provided by computational control: physical objects are connected to a computer via microcontroller boards[1]. The behaviour of the electromechanical devices is controlled at a computational level. In fact, there is no interaction between musicians and electromechanical devices – musicians of the ensemble rely on a click track to be synchronized with the electromechanical devices. The energy needed to generate sound is electricity, which is provided by low voltage motors, and, the context is that of physical computing. With this term are meant all those practices of building interactive physical system by the use of software and hardware that can translate analog input to digital input for a software system and/or can control electro-mechanical devices such as motors, lighting, or other hardware. In its common use, the term physical computing often describes handmade art, design or DIY hobby projects, that use sensors and microcontrollers to sense and respond to analog signals, to create systems where analog and digital signals communicate. In the context of hardware hacking and physical computing the main references have to be found in the work of Nic Collins *Handmade Electronic Music. The art of hardware hacking* (Collins, 2009), and Tom Igoe, Making things talk (Igoe, 2007). Within *Systema Naturae,* a computer provides a score - a set of instructions - for the electromechanical devices. The digital signal is converted in an analog signal by the microcontroller interfaces – in this case Arduino[2] boards have been used – and the electromechanical devices are activated from the received electrical signal. In this sense, *Systema Naturae* represents an example of *acoustic computer music* (Valle, 2015). In fact, the computer is involved, but not to process instrumental sounds or to produce digital sounds. It simply provides a set of instructions, to the electromechanical devices, which play live as the real instruments. But, what kind of instruments are they?

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1 A microcontroller is a small computer on a single integrated circuit, which contains one or more CPUs (processor cores), a memory and programmable input/output peripherals. A microcontroller board is a microcontroller built onto a printed circuit board. This board provides all of the circuitry necessary for a useful control task: the microprocessor itself, I/O circuits, a clock generator, RAM, stored program memory and any necessary support. A board is immediately useful to application developers, without requiring them to spend time and effort to develop controller hardware. There are many easily accessible platforms, which aim at traditionally "non-programmer" groups, such as artists, designers, and others interested in creating interactive objects or environments. Within *Systema Naturae* two Arduino boards (Arduino Mega 2560) were employed. These boards are able to read inputs - from the computer - and turn them into outputs - as, in this case, activating a motor. Arduino is not only the brand of the board, but also an open-source electronics platform based on easy-to-use hardware and software.

2 See note 1. Further information is available here: https://www.arduino.cc (last access 01/03/2018)

Again I am referring to the notion of catalogue, to show how the two composers have built a classification partly following the existing taxonomy defined by Hornbostel and Sachs3, which classifies instruments as idiophones, chordophones, aerophones, membranophones and electrophones4, and partly following criteria of time responsivity (which is related to the temporal behaviour of the object and to its capacity to provide a fast attack and a fast delay, to allow complex rhythmical organization), control behaviour (distinction between objects with a discrete behaviour - on/off - or continuous one), presence or absence of pitch, and so on. Idiophones consist of sound-generators that directly produce sounds by their whole body and in this category there are ten different kinds of electro-mechanical devices, such as, for example, *Spremoagrume* (Fig.1), a juicer featuring a low-pitched rumble caused by the friction between its rotating elements, or *Lampadina* (Fig.1), a light-bulb that can be turned on and off via a relay, which produces exclusively a sonic relay click, while providing at the same time a visual rhythmic cue.

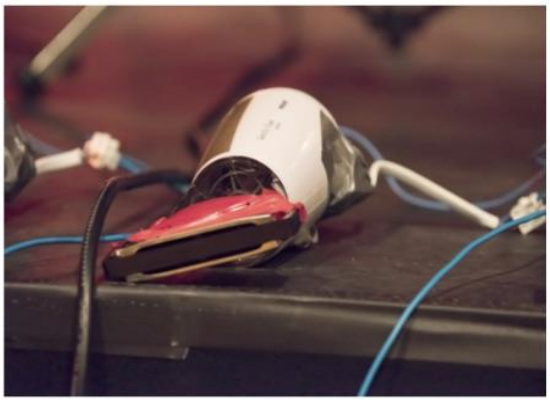
Fig. 1. *Spremoagrume* and *Lampadina*

The aerophones – pitched wind instruments – are also ten different kinds of electro-mechanical devices, all built from modified hairdryers, which generate air with controllable and variable pressure, capable of activating the sound through reeds or tubes. *Zampogno* (Fig.2), for example, is a set of three recorders (which may include different recorder sizes, from tenor to sopranino) connected to the same modified hairdryer, which acts like a bagpipe. Tuning is provided by closing some holes with Scotch tape, and the instrument can produce microtonal variations by means of the hairdryer's pressure. Similarly, the tuning of *Armonica* (Fig.2) is obtained by closing the holes of the harmonica with scotch tape, but, to use both blow and draw reeds the direction of the flow of air is inverted by the inverting the motor polarity.

3 See Hornbostel, Erich M. von and Curt Sachs 1961.

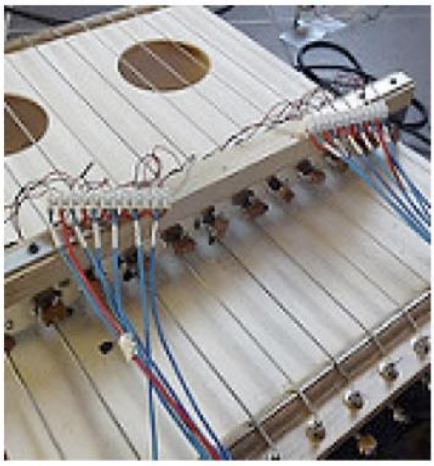
4 To be noticed that among the electro-mechanical devices of *Systema Naturae* none is classified as *Membranophones*. The category of *Electrophones*, instead, is a later extension to the original taxonomy, proposed firstly by Francis Galpin in 1937 (see Kartomi 2001).

Fig.2 . *Zampogno* and *Armonica*



There is only a single chordophone, the *Cetro* (fig.3), which is a sort of automated zither, built with twelve tuned steel electric bass strings. The electrophones comprise just two kinds of devices. The first is *Girodisco* (fig.3), a low-quality self-amplified turntable with a direct connection between the motor and the rotating plate; it produces a gliding sound speeding up and down the plate, by increasing and decreasing the power to the motor. The content of the vinyl played is irrelevant because this glissando is primarily what is heard. The second electrophone is *Radio*, a small radio clock in which the loudspeaker is interrupted by an associated relay, which can be rapidly opened and closed, producing a clicking burst of sound. Each electro-mechanical device has an invented name, often a distortion of the original name of the object itself.

Fig.3 . *Cetro* and *Girodisco*



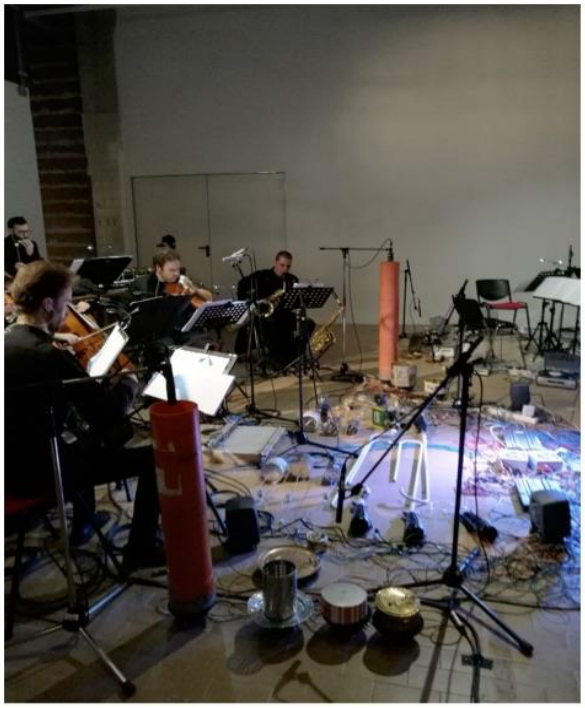
The sound-generators are distributed into three different setups, one for each *Regnum*, so that each piece has its own setup, with recognizable features, underlining the dominant features of the instrumental ensemble. While *Regnum Animale* has a more heterogeneous setup, with a significant proportion of hacked domestic appliances, *Regnum Vegetabile* presents only wind sound-generators, and *Regnum Lapideum* has a setup largely made of objects with metallic and percussive features. The last piece *Fossilia* uses all the setups of the previous *Regna*. *Fossilia* works as the conclusion of the entire cycle, and for this reason includes all the previous setups, which could be seen as fossils of the previous *Regna* (see Table.2 for the

complete instrumentation). It should be noted that the placement of all the different setups in the space has also been prescribed (Fig.4).

Fig.4. *Regnum Animale*

Regnum Vegetabile

Regnum Lapideum



Fossilia

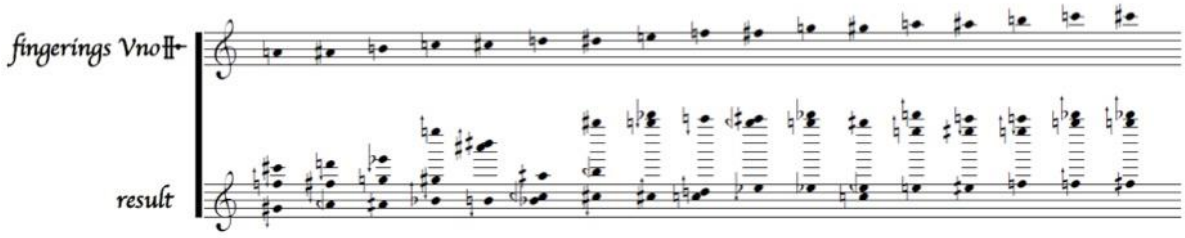
Regnum Animale	***Regnum Vegetabile***	***Regnum Lapideum***	***Fossilia***
TRADITIONAL INSTRUMENTS	**TRADITIONAL INSTRUMENTS**	**TRADITIONAL INSTRUMENTS**	**TRADITIONAL INSTRUMENTS**
	Flute (also Piccolo and Bass Flute)	Flute (also Piccolo and Bass Flute)	Flute (also Piccolo and Bass Flute)
	Oboe (also English horn)		Oboe (also English horn)
	Clarinet (also BassClarinet)		
		Alto saxophone Eb (also Baritone Eb)	Alto saxophone Eb (also Baritone Eb)
		Piano	Piano
		Percussion	Percussion
		Guitar	Guitar
Violin	Violin		Violin
Viola	Viola	Viola	Viola
Cello	Cello	Cello	Cello
ELECTROMECHANICAL DEVICES:	**ELECTROMECHANICAL DEVICES:**	**ELECTROMECHANICAL DEVICES:**	**ELECTROMECHANICAL DEVICES:**
***Animali* (25)** in most cases controlled by a DC motor. Divided in 7 families: Girodischi (3) Molatori (4) Armoniche (3) Zampogni (4) Radio (3) Segopiatti (4) Speciali : - spremoagrume (1) - meshugghello (1) - rasoio (1) - lampadina (1)	***Plants* (30)** 30 modifying hair dryers. Divided in 4 families: Trombi (10) Zampogni (7) Armoniche (7) Speciali : - ancetto (1) - fischietta (1) - ocarina (2) - sirenetto (2)	***Stones* (23)** modified hair-dryers, loudspeakers, boxes and motors. Divided in 7 families: Coni (8) - lingamMinor (1) and lingamMaior (1) - panettone (1), biscotti (1), arancio (1) - ottone (1), cappello (1), tibet (1) Eolii (4) Tole (6) Sistri(2) Cimbali (2) Cetro (1) Speciali : - cocacola (1) - anciolio (1)	***Stones* (78)** all the electro-mechanical objects used in the previuos *Regn*
Placement String trio surrounded by the “Animali” (circle)	**Placement** Ensemble in a row behind the “Plants. (row)	**Placement** Ensemble surrounded by the “Stones” (placed at the sides)	**Placement** String trio in the circle of the *Animal* (RA's setup). Winds in the row behind the *Plants* (RV's setup). Percussion, guitar and piano behind the *Stones*, (RL's setup).

Building an integration between two different sound world

As already mentioned, the use of electronics does not provide a direct alteration of the instrumental sound but allows incorporation of sounds produced by electro-mechanical devices, which play together with an ensemble of traditional instruments. The inclusion of these peculiar sound-generators introduces a different sound material, which influences the way of conceiving instrumental sound during the compositional process. Therefore, it is interesting to observe how the two composers have worked in order to reach an integration between these two different and heterogeneous sound worlds of traditional instruments and electromechanical setups. On one hand, the electromechanical devices have been exploited with an instrumental approach, creating rhythmical events, exploring their spectra, organizing their dynamics. On the other hand, the two composers have looked for an object-like approach for the classical instruments with a wide use of extended techniques and a strong preparation of the instruments. String instruments, for examples, are prepared with patafix[5], that has to be placed on indicated harmonic nodes in order to alter the spectrum of the string where it has been placed. In this way, all sound material, both from instruments and from electromechanical devices, presents different degrees of controllability and complex harmonic spectrum[6]. Fig.5 presents, for example, a detail from the performance notes, where it is shown the resulting spectrum of the II patafixed string of the violin, in relation to its usual fingering. Fig 6, instead shows how the four *Zampogno* of *Regnum Animale* are tuned.

In the following figure (Fig.7) there is the score for the electromechanical devices of *Hipseus Lanthicus*, the fourth piece of *Regnum Vegetabile*.

Fig.5



5 *Patafix* is a sort of gum produced by UHU, similar to *Blu-Tack*, produced by Bostik, or to *Tack-it* produced by Faber-Castell.

6 The composers are aware of the different grades of controllability. Concerning violin, viola and cello, for example, a chart in the performance note resumes the sounding result of all notes produced on the patafixed strings. Nevertheless, often in the score "patafixed" sound are coupled in double stops with not-prepared note, as to guarantee a certain grade of precision of the required pitch-content.

Fig.6

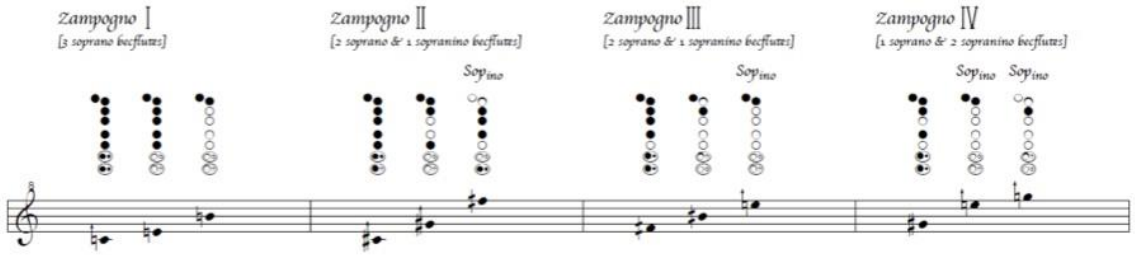
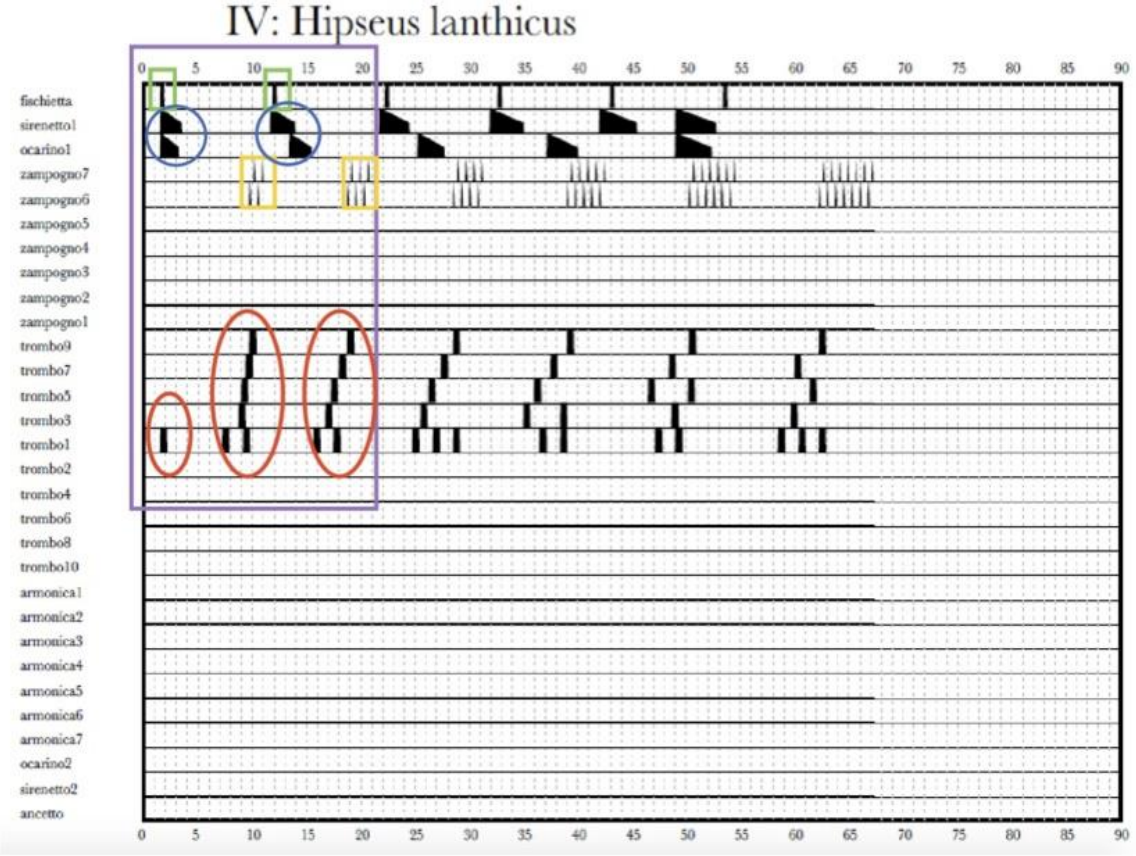
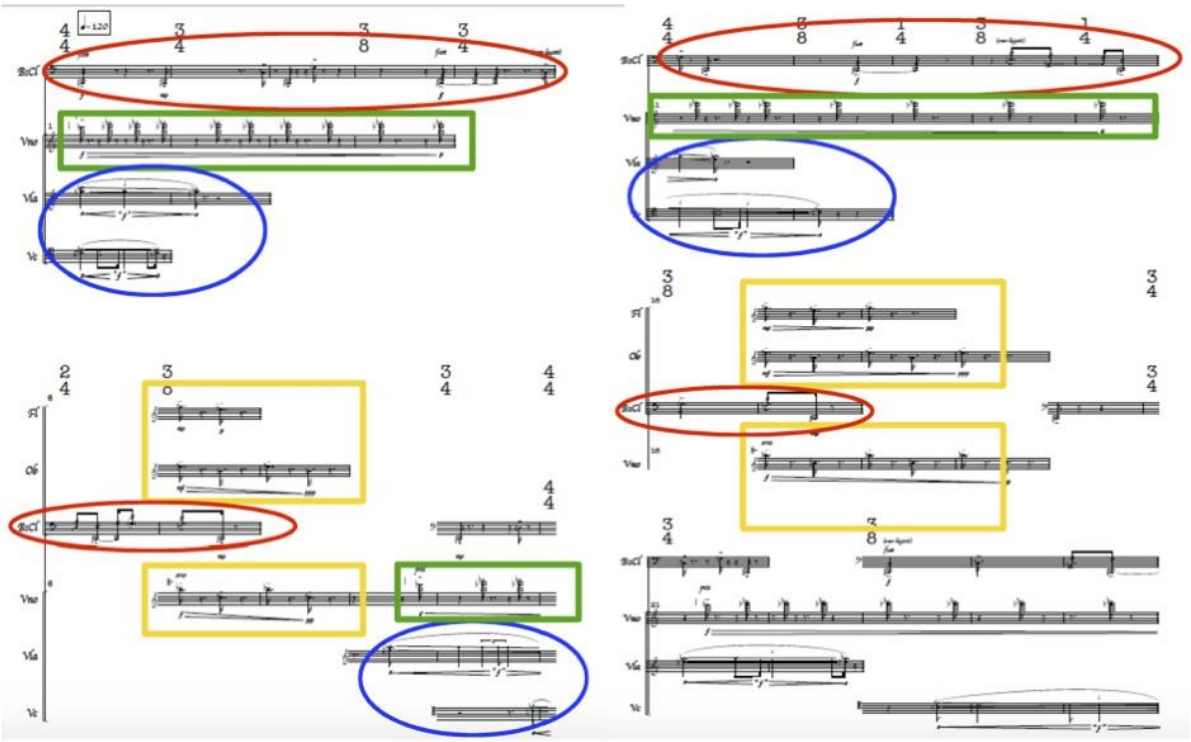


Fig.7



Marked with green there is the sound of the *Fischietta* – a toy whistle which plays a D monesis, in blue the combination of ocarina and *Sirenetto* – the latter is a toy siren-like unpitched gliding instrument – in red the part of the *Trombi*, low pitched aerophones, in yellow the part of two alternating *Zampogno.* All together those sound build a sort of phrase, which is repeated six times, with small differences during the piece. In the next figure (Fig.8) it is possible to see the instruments part of the corresponding section.

Fig.8



The same colors are used to point out the correspondence – also concerning the harmonic content – between the gestures of the electromechanical devices and instruments:

- the short and *forte* sound on *the Fischietta* – is matched with a high harmonic pizzicato (E*b*) on the violin, which is repeated, marking a rhythm in diminuendo.

- the glissando of the *Sirenetto* is expanded by the viola and the cello gliding,

- *Trombo1,3,5,7,9* are doubled by the bass-clarinet, which plays in the same register and range of the *Trombi*

- and lastly, the alternating sound of the *Zampogno6* and *Zampogno7* has its correspondent in the violin, oboe and flute, concluding the phrase, repeating two descending chords.

The way the two composers have worked in order to build this kind of relationships between the sound world of the electromechanical devices and classical instruments is again linked to the model of the catalogue. In order to orient themselves amongst the different degrees of controllability and the complexity of the available harmonic spectrum of sound material, the two composers created a database of recorded sounds, where they have collected both sound samples of electromechanical devices and instruments (mostly recorded from scratch, in order to include special playing techniques). The necessity of classifying and collecting all the rough sound material in a database could be seen as a need for awareness and a step in the metacognition process of (self-)knowledge. The creation of a catalogue – as a sort of personal archive – of all the collected material, has provided the two composers with a deep knowledge and understanding of the available sound material, and the consequent possibility to experiment with its organization. All sounds have been analyzed to gather spectral data and

used also to feed the algorithmic compositional environment[7]. Many audio files and intermediate material such as algorithms, graphics, intermediate score have been then exchanged. Simulations have been created in order to provide feedback on the final results. The latter are extremely accurate and they have played an important role in providing a precise prevision of the final sound result. Moreover, they have not only provided a remarkably accurate forecast of the final result, but have been, and are, also important for rehearsals with the musicians; since it is quite complicated to set all the electromechanical devices, playback of the sound files of the sound-generators has always been useful to provide accurate feedback for performers during rehearsals.

Conclusions

In the case of *Systema Naturae*, the need to rethink the possibilities of electroacoustic music, including traditional acoustic instruments, renewing their potential through the combination with less conventional sound sources, has explored new knowledge and new technologies in the context of physical computing, creating an original example of *Acoustic computer music*. In spite of the fact that the work in its final form is extremely defined and accurate in every detail, – notation, simulations for the rehearsal, placement of the setups in the space, etc. – it is possible to detect a strong experimental approach during its creation and its compositional process. Nevertheless, the authenticity and the originality of this work lie not only in the fact that it is the result of DIY practices and experimental processes but also in the long process of analysis, classification and organization of the rough material, which has provided a deep understanding and awareness of its potentiality. The model of the catalogue pervades the life of *Systema Naturae*; it provides its aesthetic-structural stimulus, the context and tool for the work's creation and the containing form for its representation and execution.

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[7] The two composers are used to work with different compositional environments: Andrea Valle works with SuperCollider, while Mauro Lanza with Open Music.

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