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Timbre hybridization processes and strategies.
A Portfolio of Compositions

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Abstract

This document describes the processes and development of my compositional work, particularly concerning the introduction of modifications of timbral qualities, including combinations, and hybridization procedures. It describes compositional methodologies, developed within a technological environment, and the interrelation between theoretical thought and computational approach.

The following chapters present time, frequency, and timbre as materials of investigation, analysis, and re-composition, through real time electroacoustic strategies and treatments. The preparation and design of specific software, through the utilization of programming language Max/MSP Jitter, will illustrate the computational approach to composing, its inner correspondence with the theoretical approach, and interconnections with preparation and performing activity. Procedures progressively applied to the portfolio of compositions are presented in the final chapters of the document.

The portfolio consists of six works completed during the last six years, for instruments and real time electronic treatment, presented as a CD with the complete recordings of three compositions, four scores, and a DVD, containing video recording of two works.

The last three compositions presented are also part of a cycle of works –still in progress- dedicated to the whole instrumental spectrum, in which the voice represents the physical-musical material of each work.

Contents

1.1 Acoustic and electroacoustic compositional environment

The main focus of my compositional work and theoretical research is the characteristic of combining acoustic instruments with electroacoustic and electronic-device treatments: in particular, the practice of investigating the interrelation between acoustic phenomena - the sound and its own natural and physical qualities - and compositional/theoretical approaches developed within a technological environment.

The naturalistic aspect of acoustic phenomena is central to the research, which aims at the development of a primary methodology that contains the potential for infinite manipulations. In this way, acoustic and physical properties of instruments are analysed and treated from an electroacoustic sonic perspective, in which any compositional operation takes place.

The work prepared and composed during the last six years has been conceived following a more specific experimentation, which tends to emphasize the instrumental physical qualities of timbre, and particularly their interrelation and combinations.

The utilization of electroacoustic and electronic devices, and the working process in a dynamic and flexible studio, lies at the base of such creative practice, in which a primary poiesis relies upon scientific theories and speculations, and which considers technologies (and machines) as substantial instruments necessary to assist any creative activity.

Work in a studio nowadays, whether it is home-based or within and with the support of an institution or organisation, is in general considerably changed, particularly considering the fundamental technical shift between analogue

and electroacoustic-digital technologies. In my activity, the primary technological necessity is of operating within a specific and adaptable electroacoustic environment within which it is possible to experiment with different phases of the composition activity. My work originates in such an environment, equipped with the technologies needed to aid any related activity: computers and software, associated audio equipment, video cameras, and especially devices such as midi fader consoles, sensors and corresponding interfaces, which will allow one to flexibly and dynamically approach the process from multiple and different perspectives. The software, necessary for preparatory work and later performance, is usually programmed – in its essential structure - in advance, updated step by step, and finalized during the working process. In my research the software is entirely self-designed, usually employing interactive programme environments, such as Max/MSP Jitter[1], enabling my activity to managing complex interrelations between different networks, and disciplines. The specific interest is here in the programming (and subsequently working) of a dynamical sonic environment, particularly dedicated to live signal analysis, processing, and treatment. In such procedures the use of pre-fixed parameterizations, as restricted modules, is usually avoided in favour of a more flexible field of experimentation, and therefore of results.

The use of technologies in my compositional practice and research has, therefore, an active and generative role, representing that terza pratica - third

[1] Max/MSP Jitter is a programme language designed by Miller Puckette during the 1980's, and later developed by IRCAM *(*Institut de Recherche et Coordination Acoustique/Musique), Paris. It was originally implemented for sound treatment, and subsequently extended to multimedia, particularly to the video. It is a modular software, a vehicular language, which works through interconnected libraries, and based on an object graphical interface system.

practice[2] - that well characterizes a new modality in composing. A substantial differentiation, and distinction, between the old practice that would separate the acoustic compositional activity from its subsequent electroacoustic or electronic treatment, juxtaposing the two – and thus different – results in a second procedure, usually during the preparation of the work for its performance. In my work, the proposed processes (which generally differ from work to work) substantialize a more constantly fluid, and interactive interrelation between theoretical models, and their acoustic and electroacoustic compositional results. Theoretical models are applied, and expanded, at the very same moment, towards both acoustic and electroacoustic development and treatment.

[2] Claudio Monteverdi in his introduction to the *Fifth book of Madrigals* (1605) defined his own aesthetic, formalizing a compositional difference between a first and a second practice, represented in his own work. The introduction concerned theory, practice and poetics, presenting the inseparable mixture of his *aesthetic*. The same topic (although within a different historical perspective and context) was delineated by Konrad Boehmer in *Music and Politics / Towards a Terza Prattica*, in *Order and Disorder, Music-Theoretical Strategies in the 20th Century Music*.

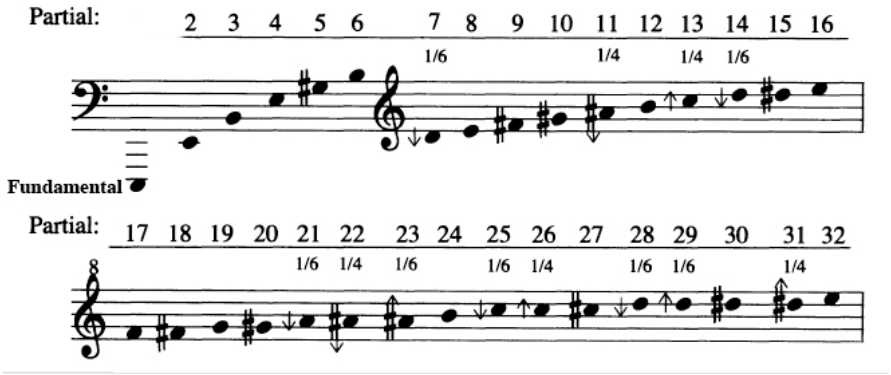
2 Time and Frequency

2.1 Time

The composition of a new work represents, in my activity, the finalization of a usually extensive creative polymorphic (in its Greek meaning of ‘having multiple forms’) process, often formed by several operations running concurrently, and where the preparation of the score is, in fact, the first concretization of such process. The activity of composing represents the substantial moment of achievement of a specific – and complex - practice of symbolic formalization. The time of composing starts at this stage, and undertakes a precise physiognomy that influences my entire creative procedure. The term ‘time’ is seen in my work as a multifunctional object which groups together different sub-categories, where, similarly as in a circular dynamic chain, distinct elements elaborate different information in order to achieve a temporary or final solution that will constitute a new level of material. The time needed to compose a new work is the starting point, essentially to discipline a process based on a dynamic progression: time becomes an object into which is built the entire proceeding of the work, and constituted from different zones that are dedicated to the utilization, meaning and scope of time. I usually summarize the course of the composition in these three areas, where if the utilization of time represents the formalization and concretization of a compositional process, meaning and scope denote respectively the interpretation (therefore also the performance aspect), and perception of such work, its physical and critical realization.

2.2 Frequencies

The sound and more specifically the pitch, in its theoretical and pragmatic approach it is considered and treated within my activity as frequency, and the relationship with part of its own origin, the timbre, becomes subsequently fundamental. Frequency, similarly to the consideration of time, represents also a complex polymorphic object, in which theoretical and pragmatic approaches introduce several reflections and speculations upon subcategories, and combinations that such methodologies manifests. In my activity, frequencies are considered and treated as micro-harmonic-structures, resulting from the sum of several multiple sub-frequencies, in which frequency organizational structure does not specifically involve a hierarchic, serial, or functional relation between note and note. A single pitch is considered an independent entity, formed, for instance, from its several smaller partials -harmonic or inharmonic- also indicated as overtones. This well-known theorization describes a set of vibrations in which the frequencies are integral multiples of a fundamental (f_1). The other elements are their partials, or overtone series, where for instance the second partial is equal to 2 x f_1, the third is equal to 3 x f_1 and so on, Example 1. Therefore, the term frequency implies not only a practical approach, but, more important, also its physical aspect that can be easily expanded to several and different compositional methodologies and techniques. Working with electroacoustic devices emphasizes, enriches and aids such theorization in an interdependent interrelationship between theory and machine.



Example 1 – Representation of first 31 partials calculated from a fundamental frequency

3 Timbre and Parameters

3.1 Timbre

Timbre, while generally defining and distinguishing the quality and qualities of a sound, represents in my work a whole micro - and macro - sonority environment, substantially interconnected with the evolution of time and frequency, exposed in the previous paragraphs. Timbre, similarly and together with Time and Frequency, represents in my work that foundation in which sound (as complex object) needs to be de-constructed in its whole parts, and then re-assembled in order to generate a unique entity. The sound is seen thus as proper matter, raw material that physically needs to be worked through a practice that aims to sculpt it as a unique object.

In my work, the compositional technique of structuring a work on a single fundamental frequency, and its spectral series, is similarly applied to a basic procedure and research dedicated to timbre. The choice of one or more specific instruments and their timbre, from this perspective, radically influences and permeates a section, a small zone or even an entire piece, giving that unambiguous specificity needed during the creative process of a new work. The juxtaposition of two different harmonic spectra (belonging to different instruments) becomes in my work an interrelated operation, which is concurrently expanded to the timbral procedure of the work. It is an intrinsic technique that relates two-object timbre, combining their physical qualities and properties in order to initiate a hybridisation process. Such procedure is usually based and developed through the use of electronic devices,

fundamental to address the theoretical hybridisation process to the sonic result: a practice rich in possibilities and combinations, opened to substantial experimentation, which in my work has gained a primary role in constant development and evolution. The role of electroacoustic devices is crucial within such compositional techniques, introducing a new generative layer that deals specifically and univocally with the physical qualities of timbre. It represents a new diversified level of experimentation and research, directed to a physical modelling of timbre and specifically to a real-time physical synthesis of acoustic and electroacoustic sources.

The subsequent relationship between Timbre and Parameters becomes, in the theoretical dynamic chain (Time, Frequency, and Timbre), the natural evolution of a process constituted by close interrelations and interdependencies between self-articulated objects, as proper self-sonic environments.

3.2 Parameters

As research towards a different conceptualization, and subsequent compositional procedure, of sound the concept of Parameters starts in my work from the necessity of *integrating* several physical and perceptual properties in a same (and unique) subject-object: a complex territory in which the parameters of a sound are analysed from different perspectives, deconstructed in order to understand their own diverse physical elements. The result of such an analysis, and process, inevitably widens the range of constitutive elements (in their qualitative and quantitative effectiveness), and therefore the possibilities of their implication in a more defined practice of composing. In this perspective, the interrelation of musical parameters is substantial to Timbre, and to the (real time) physical modelling system as procedure, which combines physical and perceptual elements to each other.

The parameters-object represents then the final multidimensional function of my creative dynamic chain, combining physical properties and perceptions in the same setting.

This process I consider to have two main classifications:

1) Analysis, integrating Timbre, Time and Spatialization categories.

2) Hybridization, as core of the process, integrating Acoustic Instrumental Synthesis, Electroacoustic Instrumental Synthesis, and Performing categories.

3.2.1 Analysis

Analysis is the first formal step of any new work as formalization of the compositional process. The analysis groups together different approaches and processes connected by the necessity of achieving a pre-audibility of the compositional material, if not of the work as a whole. The moment of pre-audibility works in parallel and together with the level of predictability but, although similar and sometimes juxtaposable, they have often-different meaning and functions.

In my work, pre-audibility has the main function of exploring, differentiating and preselecting the musical material and its electronic treatment - micro and macro sonic, rhythmical, and temporal events - and contextualising their interrelationships within the entire composition. Frequency, time (the relative notion and application of it, as perceivable or chronometric), and electroacoustics are paralleled, and their development will shape the composition from the beginning. The predictability of events will also be determined and managed within the same process, as unavoidable inner considerations of the composition.

Timbre (as physical matter) is the main sound property investigated in the analysis process, and concurrently connected to time and electroacoustics. The pre-audibility process involves, in fact, also the time transition and or transformation from a known state to an unknown one, as well as with the amount of information that each state or event introduces. Time is investigated in its micro and macro forms, and in its relation with rhythm and rhythmical modulation. The temporal aspect has to be chosen within this

initial process and, if necessary, differentiated and integrated between different sections of the composition. A final aspect is dedicated to what I indicate as electronic structural time: the perception of a different time generated by the contrast between perceivable and chronometric time, and by the contrast between electroacoustic treatment and its spatialization.

The electroacoustic and electronic treatment, as the third concurrent layer of the analysis, includes several possibilities, and therefore it strongly coexists with the evolution of the composition.

The spatialization, or the placement and displacement of acoustic and electroacoustic sound propagation in a specific space-place, is an essential part of the electroacoustic process of the composition, also specifically related to the performing set and location where the piece will be performed.

The following scheme indicates three primary categories and sub categories of the analysis process, as well as summarising their topics:

Timbre - the acoustic qualities of one or more instruments

- Physical qualities of an instrument - or group of instruments: the construction material; its physical quality and density; its weight and height in relation to traditional and extended playing techniques;
- Physical qualities of an instrument's timbre - or group of instruments: nature of the timbre's colour; its relation with sound propagation, impurities;
- Computer frequency analysis of an instrument - or group of instruments: to determine the acoustic range expansion possibilities, against or in favour of its priorities; its shape and physical

characteristics; physical and mechanical possible alteration or modification, as extended instrument;

Time - perceivable, chronometric and interrelationship; electroacoustic structural time

- Perceivable time: the perception or non-perception of (a) time (mainly related to performers); the interrelation and/or contrast with chronometric time (mainly dedicated to a pulse); the relation between micro and macro sections of the overall composition form.
- Chronometric time: the perception of recurring and/or non-recurring beats and rhythm; the interrelation between different beats and rhythm, their predictability and unpredictability.
- Structural time: the internal generation of a differentiated time, expressed by the acoustic and electronic treatment; the outcome difference between perceivable, chronometric and structural time, if and in case of their partial or concurrent juxtaposition.

Spatialization - placement and displacement of sound:

- Placement: the distribution of acoustic and electronic sound (through speakers) in specific zones and or spaces in the performing area: such proceeding is usually pre-assigned during the composition.
- Displacement: it relates to unusual and/or unpredictable distribution of electroacoustic sound through speakers in specific zones and/or spaces in the performing area.
- Composing for speakers: the process concerns all the above

categories, it relates the pre-assigning of the acoustic and electroacoustic sound outcome to specific zones and thus to specific speakers in the performing area.

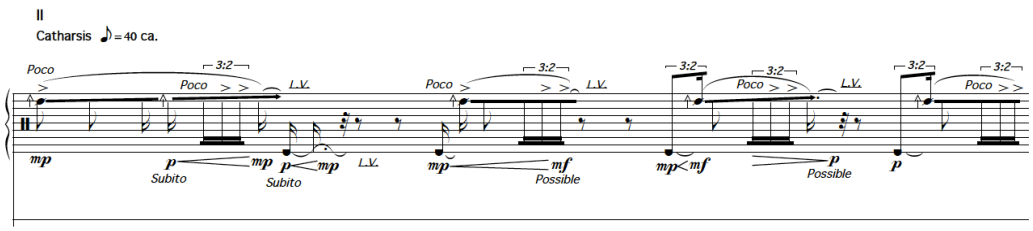
3.2.2 Hybridization

In my compositional practice, Hybridization indicates the process of merging two or more identical, similar, or different timbres, in order to provoke a new timbre-object. It is a triggering generative procedure, a transitional process from one state to another (from A to B), in which the generative result of a third entity (C), or timbre-object, is generally considered, and if the case integrated in the compositional process. The hybridization between one or more sounds is a complex method, in which physical and perceptual (sound) characteristics are investigated and examined.

The perception of timbre is essentially multidimensional and involves aspects that I will indicate as models. Such models correspond to the physical (performing) aspects, such as the attack, release, and decay times (temporal modelling); the spectral shape of the hybridized subjects; the harmonic consistency, full or partial, organic to the hybridized subjects (harmonic modelling); the noise component, specifically external sound elements incoherent to the hybridized subjects (physical modelling). The analysis of models, and their behaviour, is essential to predict the effectiveness to any acoustic and electroacoustic treatment, and therefore to the hybridization process itself. It is a procedure that belongs to the acoustic compositional context, which substantially deepens the theoretic and pragmatic approach to consideration of and work upon timbre. Hybridizing is a compositional methodology which triggers any generative sound treatment primarily during the writing process: the electroacoustic treatment is intrinsic in the theoretical development of the work, and to the consequent composing procedure.

It is a fundamental differentiation in respect of previous methodologies and techniques, representing the actualization of previous theoretical and analytical approaches. The composing process involves concurrent actions with the aim of achieving the same hybridizing result. A specific notation, in fact, signifies the character of a specific zone of the composition, as well as preparing the very same zone for a possible further sonic treatment, acoustic, electroacoustic, or both. The action of notating becomes then multifunctional and multidimensional, and fundamentally based on the pre-audibility and predictability analysis process.

In RO - *Première danse de la Lune*, Example 2, the Cymbal and Bass Drum's notation deprived both instruments of their habitual orchestration and sonic characteristics. Here, in favour of one only timbre-object, the percussionist needs to isolate the entire sonic possibilities of both instruments, controlling respectively the generation of only one cymbal partial, and the production of a muffled inharmonic (but irregular) bass drum frequency.



Example 2
RO - *Première danse de la Lune*
for amplified Drum-set percussion & real-time electronics (2011/2012)

The percussionist's sound production, at the same instant, triggers the real time electroacoustic treatment, which will complete the hybridizing of that particular section, interdependently.

The hybridization is, in my work, a micro-macro process; it is applied to micro zones of the score (even to one single figure or gesture), and to the macro areas in which hybridizing will also effect the same micro process, generating a third formal layer, which 'hybridizes the hybridization'.

The physical qualities of a timbre involve our hearing and perceptual systems that associate and compare what we are listening to with previous similar experiences, determining what family of sound we are hearing, what instrument is playing. The hybridization procedure is active on this particular action: merging different hearing sources and perceptual experiences, controlling the predictability of such experiences for both performers and listeners, and proposing a new imaginatively inexperienced listening.

The process of hybridizing different timbres depends therefore on the interrelation between timbre and physical qualities of the instruments, and such physical qualities and models can be classified and then re-composed to obtain a specific result. The timbre's physical and perceptual aspects are in fact defined by the consistency of its elements.

In the later works submitted, physical qualities are extrapolated in favour of a compositional parameters' conceptualization, both acoustic and electroacoustic, corresponding to perceptual characteristics and models,

independent elements characteristics and behaviours, as shown in the Scheme n.1.

HARD Matter	*Grain*	*Porosity*	*Thickness*
	Density	Density	Density Saturation
Physical Models	Attack	Attack Release	
SOFT Matter	*Brilliancy*	*Elasticity*	*Luminosity*
	Density Distortion	Distortion Anamorphosis	Density Saturation Distortion
Physical Models		Noise Decay	
LIQUID Matter	*Liquescency*		
	Density Anamorphosis Distortion		
Physical Models	Noise		

Scheme n.1

The scheme proposes a theoretical and empirical methodology, which largely involves the programming and use of specific software. The topics, dedicated to the physical performing models, constitute that particular area which will determine the character of the final timbre, and its utilization in the composition. The components of such characteristics need a specific

treatment, in order to avoid unclear musical propositions, and therefore a substantial coherency of the work. The components of the models, in fact, will finally create the timbre, giving that specific character, or signature, reached in the hybridization process.

The physical performing components are shown below in four main categories, to clarify and facilitate their specificities to different, but fundamental, aspects of the hybridization, Scheme n.2

Components of the Models	
Temporal	Analysis of Attack, Release, and Decay of a timbre-sound.
Spectral Shape	The form of the spectra of two or more timbres, their interrelation in the hybridization process.
Harmonic consistency	The values of frequencies and their partials of a timbre-object.
Noise content	Involvement of noise; residual noise; hybridization noise produced and residuals.

Scheme n.2

4 Real time electroacoustic treatment

4.1 Software Programming

The preparation of a new work and the consequent score, as anticipated in previous paragraphs, requires the concurrent programming of the software necessary for the audio signal treatment, sound material, and for the performance. In my activity, the composing process and software programming influence each other in a parallelism that does not constrain the creative action itself but, on the contrary, stimulates and intensifies a new set of rules, fundamental in any creative process. The software, growing together with the score, establishes a dynamic interrelationship with the written composition, becoming a tangible part of it, completing the score and the work as a multidimensional entity, and its performing as final process.

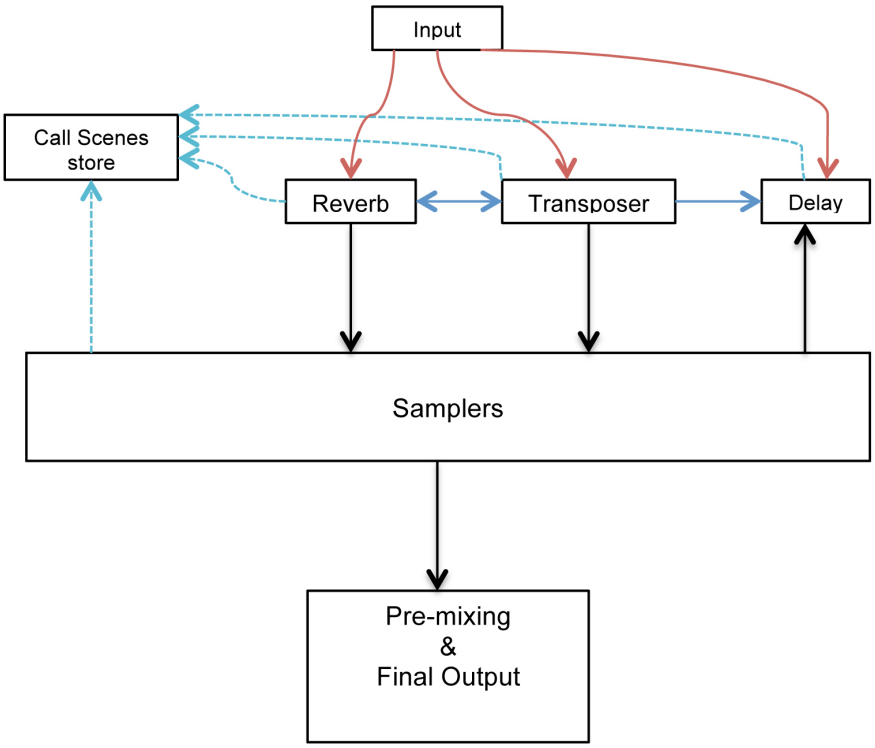
The two main aspects of the software programming in my works are respectively a high flexible dynamicity, and real time audio signal treatment.

The dynamical aspect of programming incorporates two connected methodologies. On one hand, software is exclusively dedicated to generative procedures such as calculation of partials, interrelation between harmonic fields and possible nodes, morphological aspects related to harmonic and timbral similarities, and interconnections between harmonic fields in relation to the overall form of the work. On the other hand, software is exclusively developed to integrate and complete the generative procedures, different from work to work, and dedicated to both compositional activity and its final performance. This second aspect of programming (which is also dedicated to

the real time electroacoustic treatment of the work) aims to emphasize the compositional timbre-hybridization procedures and results. It also usually integrates technical dynamical flexibilities, aiding the software to physically adapt and adhere to the performer's interpretation, creativity, and necessities, and finally to the performing space characteristics and particularities.

The compositional process involving real time audio signal treatment necessitates the construction of a specific environment dedicated to such activity. The programming of specific dedicated software becomes then fundamental in order to guarantee that complete autonomy which such methodology requires. Written and electroacoustic parts are interdependent, sharing microelements, molecules, with each other, therefore the only possibility of guaranteeing such independency is to programme the necessary software in all its parts. From this perspective, the compositional environment expands, integrating a computational methodology which is theoretically and constructively interrelated within the activity.

In the following examples, the software and graphical interface, programmed for *RITUAL* for Viola d'Amore and Real Time Electronics, 2006-2007, was realised with Max/MSP jitter. In this work, the main electroacoustic topic is the real time instrument signal sampling, and consequent treatment of such signal through sample stretching/contracting, and frequency transposing operations, Example 4 and Example 5.



Example 4 – Diagram of the electroacoustic treatment for *RITUAL*, for Viola d'Amore and Real Time Electronics (2006-2007)

Example 5 – First version of Max MSP jitter software and graphical interface programmed for *RITUAL*, for Viola d'Amore and Real Time Electronics (2006-2007)

In the work, the software is programmed to obtain generative-material parallel with the composing process: an electroacoustic environment that allows the juxtaposing of multiple voices, extrapolated from the very same source, the Viola d'Amore. The software engineering (and its final preparation) substantialises the composing activity, its inner conceptualisation, and actualisation through the writing procedure. In the software, each part of the engine is therefore specifically prepared to perform a definite action, which is concurrent and or consequential to the acoustic performing.

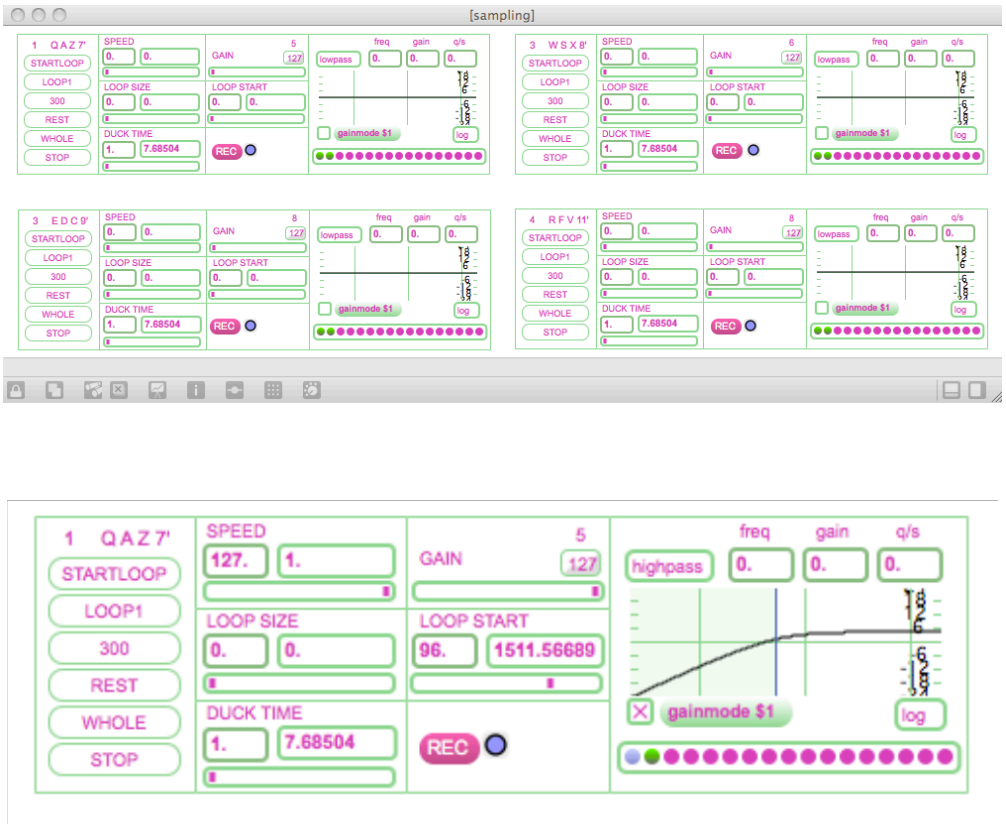
The majority of my work, completed during the last years, has been composed following these procedures, in a corresponding progression that reflects theorization and empirical practices.

4.1.1 Real time synthesis

Real time electroacoustic instrumental treatment considers acoustic and electronic contexts at a very similar level, generating, integrating, or separating two (at least) different sound territories: a practice that, in its inner particularities, can often differ from work to work, but which fundamentally always maintains a rigorous interrelationship between the two sound universes. This methodology has the ultimate theoretical and empirical result of combining those two close universes, through complex real time synthesis operations, a process that has its roots from electroacoustic techniques developed throughout the second half of the 20th century. In my work, the synthesis process principally concerns the real time instrumental sampling and live interaction with performers, which most often integrates the parts of the hybridization technique, as well as functioning autonomously. The real time sampling is primary assigned during the composing, in the score, and therefore pertains to defined sections of the work. The writing process specifies its own electroacoustic treatment and, in this case, in which modality the section, fragment or gesture will be sampled, synthesised and re-performed. The time scale of the sampling is assigned in this moment: its length (micro or macro scale) is an expression of the acoustic part, becoming generative compositional material.

Example 5 – the second version of the software program for *RITUAL*, for Viola d'Amore and Real Time Electronics 2006-2007 - shows the window containing four sampler engines prepared for the instrumental synthesis. The samplers, having identical characteristics and controllers, differ only over the

time scale of sampling, which is assignable in each case, and may be of different lengths.



Example 5 – second version of Max MSP jitter software and graphical interface programmed for *RITUAL*, for Viola d'Amore and Real Time Electronics (2006-2007) and detail.

Each sampler is basically a recording system, with functions to loop the sound sample at different assignable speeds, and time durations. The speed controller also influences the frequency of the sampled sound, in pitch-shift modality. The loop size bar controls the time duration of the sample, which can therefore be reduced to the preferred proportion. The loop start bar activates the prefixed sample starting point, again accordingly with the proportion needed. Such starting point can be also softened (as fade-out

modality) through the duck time bar in order to reduce, or cut-off, any undesired broken sound occurring during the sampling. This way of programming, and managing the sound treatment, actualizes the real time synthesis procedure, taking a further step to a more precise interactive methodology between the performer and the score, and the performer of the electroacoustic parts.

4.1.2 Hybridization programming

The research developed through the years within real time synthesis, has expanded in favour of the hybridization's theoretical and empirical work, further connecting the two methodologies.

The engineering of specific software, for a specific treatment, often raises questions concerning its theoretical and practical realisation - its actualization within a musical context. The hybridization of two sounds introduces, in fact, the problematic aspect of their inner relations, and particularly their qualitative physical interrelationships, and juxtaposition. In my work, hence, the process of hybridizing has been based upon three compositional categories, dedicated to instrumental and non-instrumental sounds:

a - hybridization of two or more similar sounds -belonging to the same instrumental family, or similar non-instrumental sounds.

b - hybridization of two or more related sounds - belonging to different instrumental families but with a compatible instrumental timbre, or related to non-instrumental sounds.

c - hybridization of two or more different sounds -belonging to different instrumental families, or different non-instrumental sounds.

Such categories are decided during the composition of a work, and its software programming. Instrumental physical aspects and qualities, in fact,

will influence the preparation and coherence of the software, and its contextualisation, determining appropriate proportion and balances of the electroacoustic (hence the sound) treatment. Physical sound qualities and models are necessary to conceptualise and realise a new hybrid category, and consequent physical and perceptual characteristics of hard, soft, and liquid matter. The methodology actualises the predisposition, or incoherence, of timbre merging, confronting and distinguishing such inner characteristics as density, harmonic and noise component; attack, release, and decay, which will be treated as integral physical parts of timbre.

The software for the hybridization is programmed essentially for real time signal treatment, although it can be used in a non-real time mode. The core of the software works with the particularity to enable three different modes of interaction, interchangeable with each other, directly connected to the three hybridization categories presented above, and to other parts of the software itself:

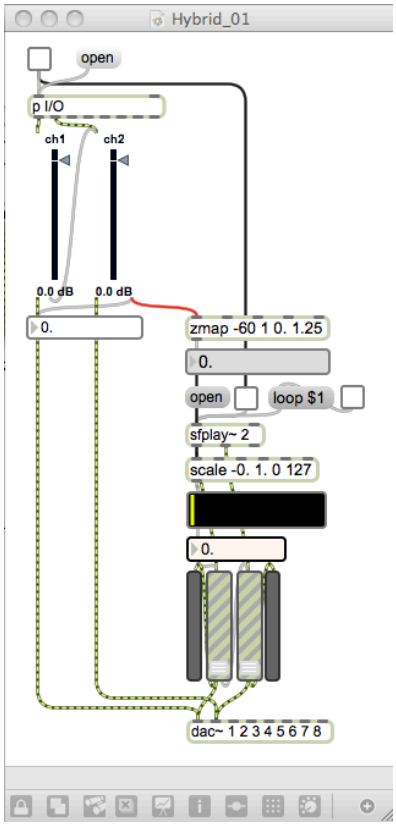
- instruments + instruments: a live instrument activates a (similar or different) sampled instrument;
- instruments + sound file: a live instrument activates a particular sound file, prepared in advance;
- sound file + sound file: a sampled instrumental sound activates another sampled sound file.

Such empirical categories represent different interactive modes, fundamentally to provide a more flexible and flowing supervision of

electroacoustic parts, and their consequent utilization and interaction within the performance setting.

The instrumental hybridization (instrument + instrument) is generally the most complex to manage in real time mode. In my methodology, for instance, the merging of two instruments (where one is sampled and recalled into the hybridizer in real time, and therefore pertaining to the same material that we are hearing) requires a very reliable sampling and looping engine. A fast, and dynamical flexible environment, in which the sample reproduced needs to be of the highest accuracy and quality, identical in perceptual quality to what we are hearing from the live instruments.

The following example, programmed with Max/MSP jitter, shows a basic hybridisation of an instrumental (live) sound with a pre-recorded sample.

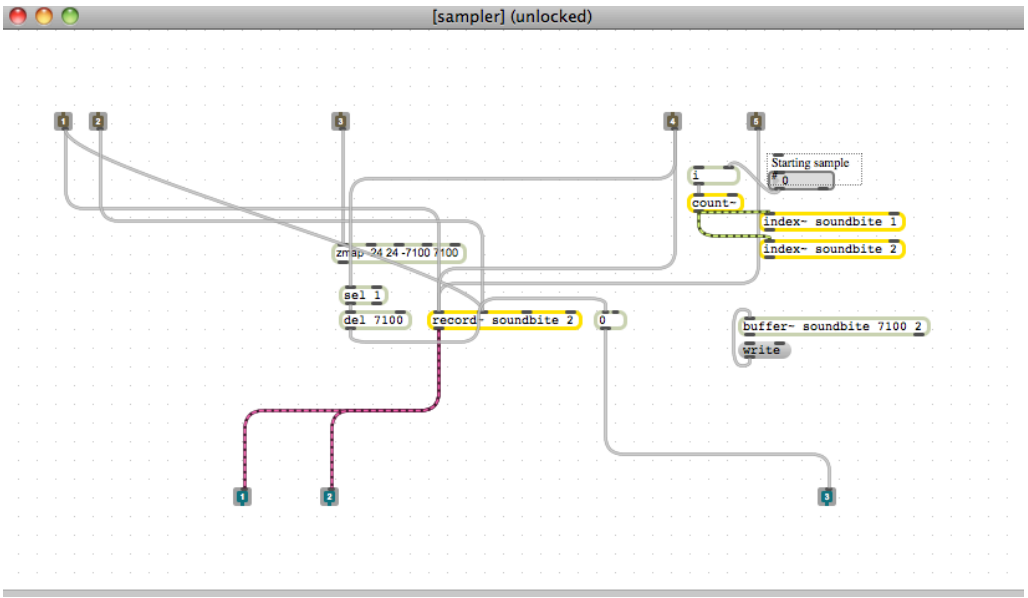


Example 6 – Real time Hybridisation process realized with Max-MSP jitter

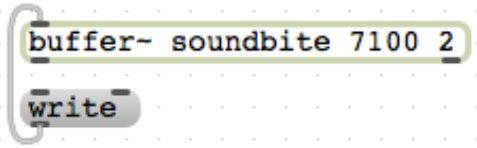
Here, the instrument, with one or more microphones attached, connected to a digital sound card and then to the computer, passes the audio signal through the rectangular object called p I/O. The pre-recorded sample, of any length, is uploaded by the rectangular object called sfplay~ 2. The two engines are then connected to an audio signal output object called dac~ (the numbers in the object specifies the assignable outputs). The dynamical input level of the instrument, p I/O, and therefore the performer's playing, will trigger the pre-recorded sample engine sfplay~ 2. Such action juxtaposes in real time the two different inputs, delivering a first merging result, which will need further optimization, usually through a dedicated final mixing engine.

The sampling procedure usually parallels the hybridization interaction, and can be activated at any moment during the performance. Samples are compositional material - integral parts of the composition - hence the programming of specific engines, connected to the hybridization ones, managing a simultaneous process.

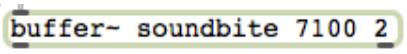
In the following Examples 7 and 8, the sampled sound is automatically sent to a sub-menu within the hybridiser engine window, facilitating the operation of sample uploading.



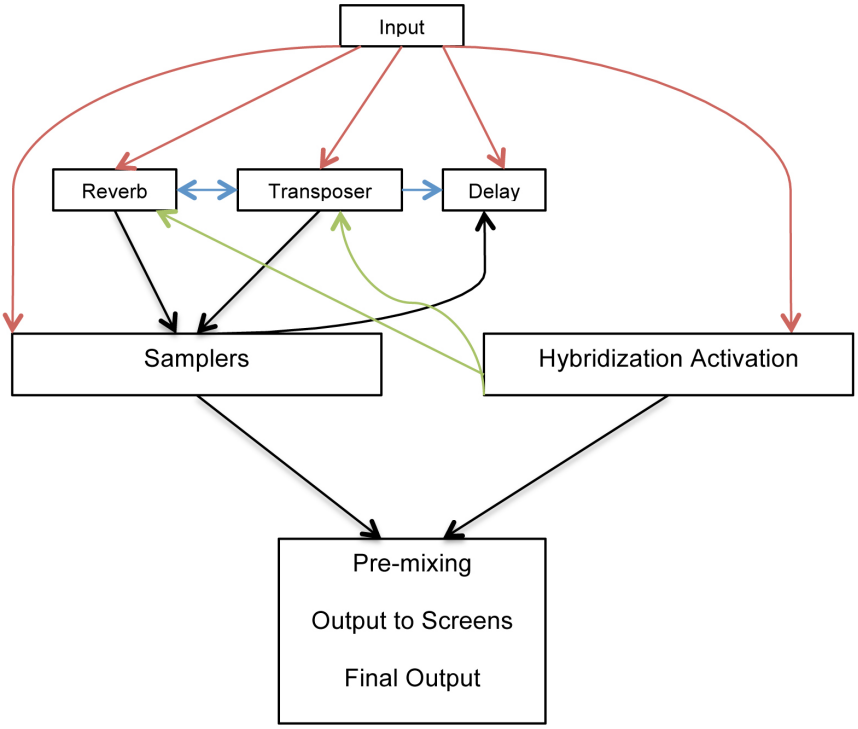
Example 7



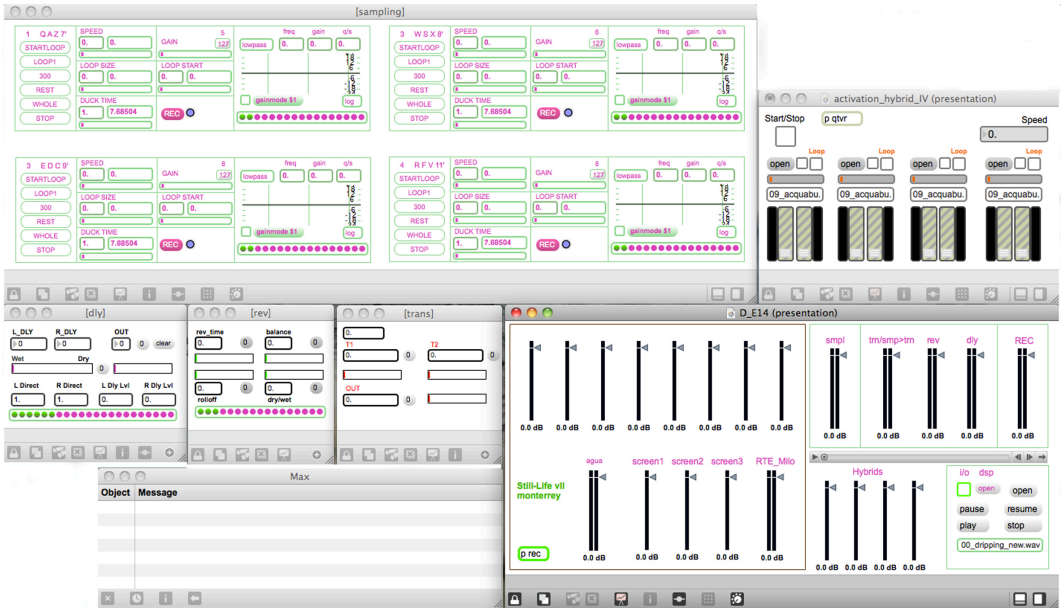
Example 8

The  object (in the examples) is the place where the actual sample is stored temporarily: any new sample recording will overwrite the previous sampling, which will be substituted with the current one. The sampling engine manages, and interpolates, two different interactions of the live signal treatment: the micro and or macro sampling (of a sound, phrase or section), and real time hybridisation process (of same sampled material) with live instruments. The two interactions can also be managed in different modes, such as: running concurrently, parallel, but independently from each other; running concurrently juxtaposing and interacting their outcomes; running non-concurrently (separately, and with different purposes) within small or larger sections of the compositions.

The final software preparation is shown in Example 10 (a version for STILL LIFE V. II, a film-opera realized in 2013 for the Festival Mediarte 11.0, Monterrey – Mexico). Different windows, containing different engines for parallel-interrelated operations are connected to each other, sharing a considerable level of data and results. Example 9 presents a diagram of the electroacoustic treatment.



Example 9 - Diagram of the electroacoustic treatment for *STILL LIFE V. II* (2013)



Example 10 - Max MSP jitter software and graphical interface programmed for *STILL LIFE V. II* (2013)

4.1.3 Controlling surfaces

The software prepared for most of my works is usually managed in real time interactivity between performers and composer (or sound engineer assistant). The complexity of this creative process necessitates a simple technological interaction, specifically dedicated to the person who operates machines and devices, and prepared software.

The programming usually comprises two settings, utilised simultaneously, implemented within the software, to manually control the different operations in order to manage the real time interaction. The first uses the computer keyboard to input program commands; the second uses an external Midi controller, or Midi fader mixer board.

The first manual control allows the managing of several operations using the computer keyboard's keys: any single key can be, in fact, programmed in order to transmit information, command, or data within the software itself. For instance, a simple Play or Record button can be assigned to a particular key facilitating the manual operation, saving a quantitative and qualitative amount of time that the use of a mouse would normally require. Moreover, such controlling assignment will substantially reduce the margin of error that can often occur using the mouse-pointing-clicking operation. In this way the computer keyboard becomes an active part of the performance, a modern 'complex organ'.

The second setting is a more sophisticated controller, a Midi board (that usually combines faders and knobs) directly connected – via Midi language- to the computer and thus to the software. This controller allows the operator

to manage sensible parts of the software, for instance the faders assigned to the sampler engine and their manipulation, but also to control the different audio outputs present in the software. The faders enable better and smoother changing within the values of the different sections of the software, helping to assign different specific numbers needed during the managing of the performance. The faders and knobs also facilitate any kind of passage between two values, increasing the fundamental flexibility that is at the base of any interaction between performer and real time electronics operator.

4.2 Spatialization of Hybrid and interpolated timbre objects

This section introduces theoretical and empirical approaches concerning the placement and displacement of hybridized and interpolated timbre-sound, spatialization, in the location where the performance takes place, indicating the treatment of the electroacoustic objects as experienced in my practice.

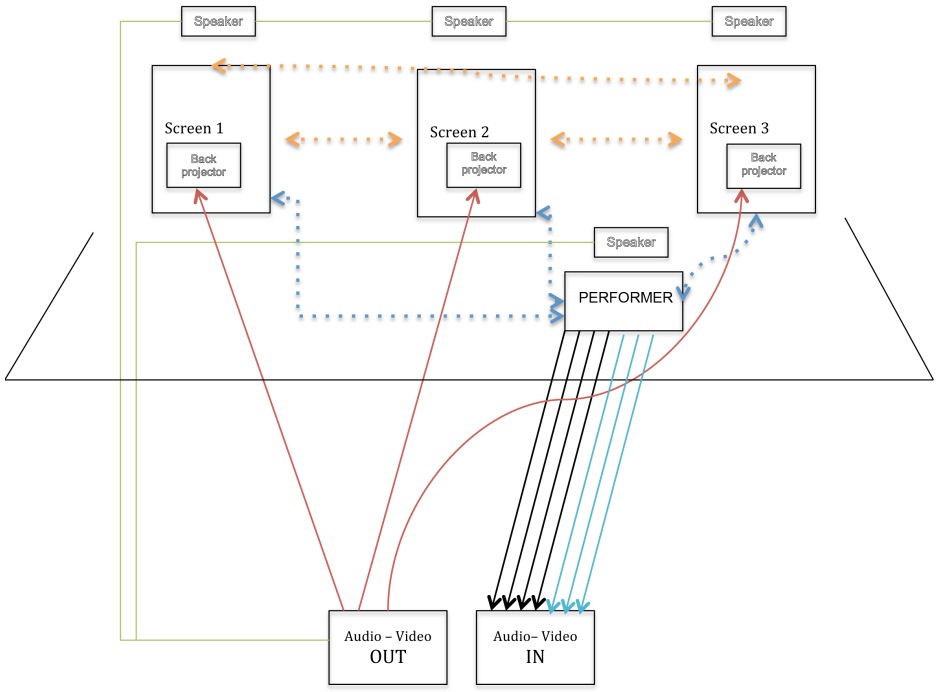
The distribution of sound in a given space, and its interrelation with instrumental and electroacoustic treatment, represents a further compositional element and methodology. The physical perceptional dichotomy, which inevitably arises between acoustic and electroacoustic material, generates the constant problematic of sound placement (or displacement) coherently with the composition. The electroacoustic treatment results from instrumental and vocal sources, as primary objects of the composition and performance, which gain in this perspective their own particular relevance - their own place within the compositional process. The interrelation between acoustic (the performer) and electroacoustic (the speaker) is a substantial compositional subject, which involves the physical propagation of sound, and the perceptual qualities that define a particular sonic-object. Sound travels or propagates through the air, transmitted from a source to the surrounding air particles, which vibrate or collide, and pass the sound energy to our ears; without air or particles to vibrate we would not be able to hear any sound. In the same manner, in my work, any electroacoustic treated sound object needs to be identifiable and related to a specific place, rather than left to be perceived as an anonymous sonority, floating imprecisely around our ears.

The moment when we hear, specifically, electroacoustic sonic objects is the instant when treated sound (hybrid, interpolated, or generically diffused) is manifested and then unequivocally proposed as a functional part of the work. A nonspecific diffusion of this consistent part of the work would instantly become only a generic sonic happening, irrational and non-functional to the preparation and performance of the work.

In the hybridization context (and generally in electroacoustic treatment) the compositional placement of a sonic object, and its consequent perceptual identification, is thus fundamental when proposing the perception of a – possibly previously unexperienced - sound event.

The distribution of electroacoustic treatment in specific areas is determined, in my work, by the number of instruments involved in the composition, and by the place in which the (first) performance will happen. The detailed placement of electroacoustic results in a given space corresponds to my other compositional methods and strategies, which tend to avoid generic surrounding distributions, or special effects. The electroacoustic result is, in most of my work, attached, and as closely as possible, to the source (the instrument or group of instruments) from which such a result originates. The perception of the electroacoustic outcome becomes, in this perspective, a sonic object, part of the composition, because substantialised at the very moment of its production. This practice is intrinsically part of the composition, which will interact with the preparation of electroacoustic parts, their development, and their relationship with the score as interpreted by the performer.

The speakers are usually positioned close to the performer, at the same or similar angle (in respect to the audience) that the performer will maintain during the performance, with a precise balance between performer's output and electroacoustic treatment. Example 10 illustrates the general electronic interaction scheme of Still Life v. II, a film-opera for extended Drum-set, film, & real time electronics video and audio (2013). In this work, the placement of the speakers clearly proposes a very detailed level of listening. A first speaker, corresponding to the performer's electroacoustic output, is placed right behind the player, at circa 2.70 - 3 metres from the floor, at an angle of circa 30 degrees in respect to the audience.



Example 10

Similarly, each one of the three projection screens (necessary for the performance) has a dedicated speaker, which diffuses electroacoustic material assigned to that particular screen projection, at a particular moment. The position of each speaker is approximately the same as the one assigned to the performer, therefore pointed to the audience at an angle of circa 30 degrees.

5 Progressive work towards *The Difference Engine*

5.1 *Ritual* for Viola d'Amore and real time electronics (2006/2007)

commissioned by and dedicated to Carter Williams
duration: approximately 11 minutes
premiere: Gare du Nord, Basel - Switzerland, 15th February 2007

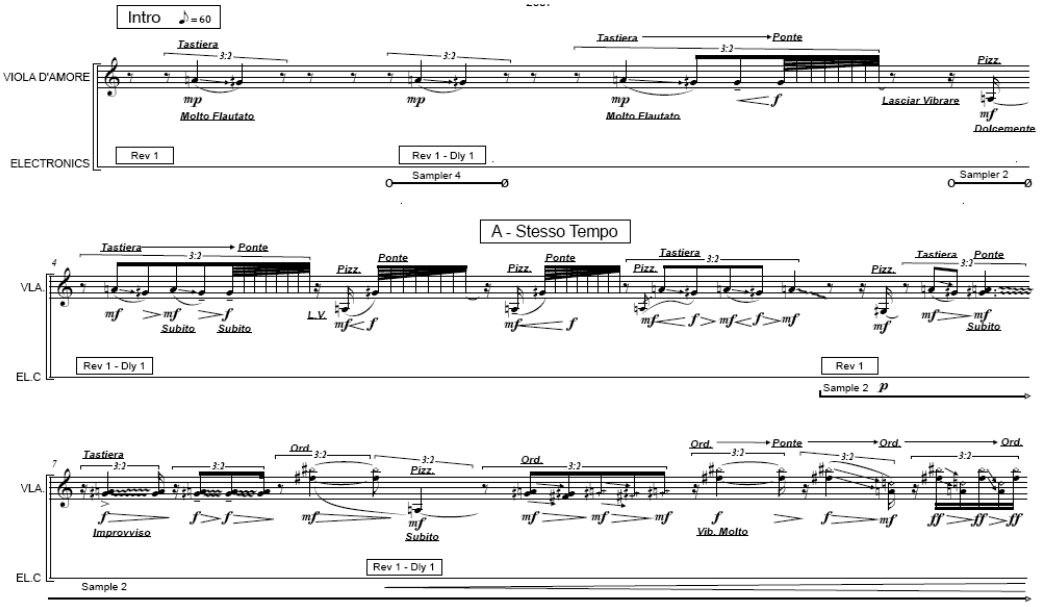
Ritual is a work for solo instrument, the Viola d'Amore, and electronics in real time. The primary compositional concern is to speculate upon the concept of sonic ritualization: the compositional material formalises and generates a second – related but independent - harmonic and rhythmic structure, which becomes integral with that performed by the violist.

This formal concept was suggested by the Viola d'Amore, a Baroque stringed instrument, usually constructed with seven strings over the fingerboard and seven sympathetic strings (which resonate by vibration) under the fingerboard. This last peculiarity, which enables the instrument to produce a prolonged natural reverb effect (or sustain), was the initial impulse for juxtaposing two (or more with electroacoustic treatment) different voices that were chasing each other, as in various Renaissance and Baroque forms. Retrospectively, *Ritual* represents the first work in which – through real time synthesis - hybridization of the same compositional material was taking place. The centre of the work is the expanding of the timbral aspect and quality of materials, to be subsequently juxtaposed over the acoustic source, constructing a complex harmonic and rhythmical structure. The violist playing, as an initial single behaviour (or precursor), is sampled and

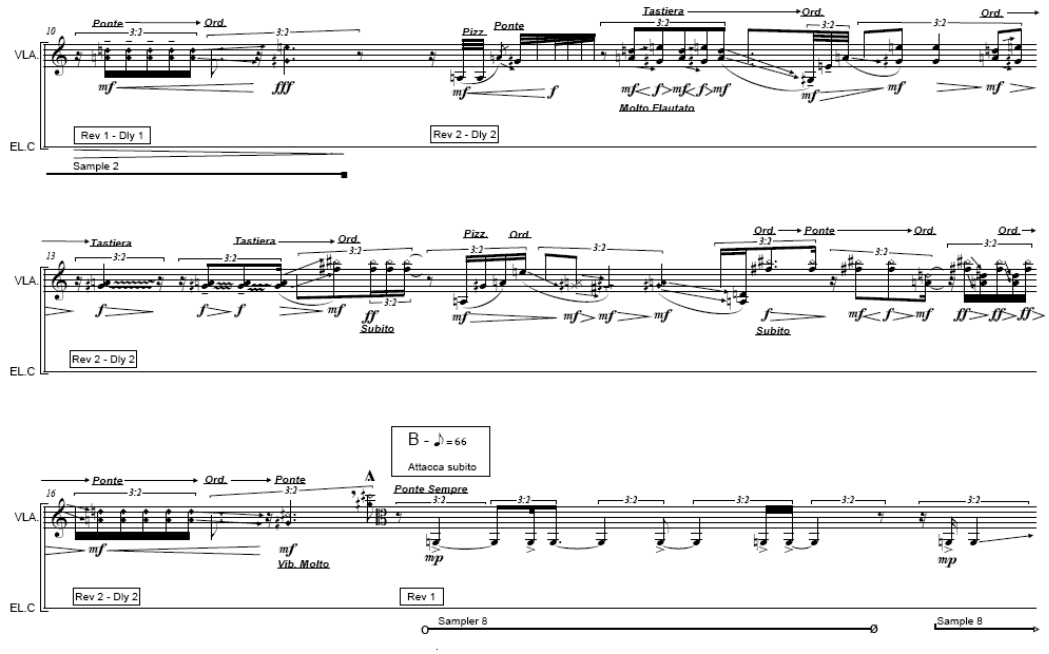
juxtaposed in real time, generating a progression of subsequent voices, which (obtained from the identical harmonic and rhythmical material) culminate in a ritualized process constituted by subsequent signals, that are unambiguous, and which cannot be confused with the initial voice.

The organization of the Viola's harmonic series spectrum develops and adapts throughout the overall macro-form of the work. The idea of micro internal transformation, especially when determined by the electronic treatments, was achieved by assigning a general meter to each section (with macro periodical changing) simplifying the main concept and macrostructure of the piece. Basic rhythm fluctuation was the key to generating the idea of ritualized behaviour or gestures: tiny and ample figures influencing each other, generating new internal micro-movements of stretched or compressed figures.

The real time composition (and live electronics) took also the same benefits: the composition in real time of much bigger figures emphasized the difference between certain gestures (behaviours) and their very similar ritualized concepts, interpolated with the necessity of redesigned timbre objects, offering new propositions not confusable with previous ones but as (possible) direct consequences of them (Example 11).



Example 11 - *RITUAL* (page 1)



Example 11 - *RITUAL* (page 2)

This compositional methodology was also intended as a parallel generative process: the Viola's micro internal relationships were building, at the same time, on the one hand the development (and behaviour) of electroacoustic

sections, on the other hand the construction of their own timbre-objects. The real time electronics became then real time composition: the electroacoustic material would closely follow the performer step-by-step, emphasizing those diverse gestures that were representing the conceptualisation of a ritualized compositional form.

In *Ritual*, the Viola d'Amore's timbre and its consequent electroacoustic expansion are the foundation of the overall form and sonic experience of the work. Such assumption, from both theoretical and interpretative perspectives, is developed throughout the work in the primary idea of timbral sculpting of a composition. The research towards a generative timbral parameterization process is (partially) achieved through the use of real time synthesis. This central topic, in distinction from the works that will follow, is mainly concerned with relatively large sections (or behaviours) of the Viola part. These sections, or figures, have had an active role within the pre-composition and pre-audibility processes, determining the development of the work as a whole.

In *Ritual*, the electroacoustic treatment, the level of interaction with the performer, and the final sonic and perceptual result of the work are sensibly limited: the real time synthesis consists only of juxtaposing the recorded samples (of specific gesture, phrase or sections) to specific different areas of the work.

The utilization of real time synthesis, as the main subject of *Ritual*, is the major limit of the work, representing nevertheless a consistent research, and a natural step in favour of more specific processes. In the works that will follow *Ritual,* the interrelationships between instrumental timbre object and

electroacoustic treatments achieve a predominant position, actualising a significant sonic timbral environment as main topic of the composition activity.

5.2 *Discombobulator*

for electronic music, dance, video and real time electronics (2009)

commissioned by 53rd Biennale of Venice – Festival of Contemporary Music
duration: approximately 15 minutes
premiere: Venice – Italy, 2nd October 2009

In 2009 I was invited to a residency at the 53rd Venice Biennale - Festival for Contemporary Music. The residency was a multidisciplinary project involving different artists from different countries, who were invited to work together to produce a short piece, in a relatively small amount of time, during the Biennale. The initial idea and proposal was to work on a piece involving a choreographer, focusing on the transformation of the physicality (physical movement and not necessarily only dance) into a self-generating sonic environment: the dancer's physicality - movement and stillness - would generate the happening itself. The performer's corporeal presence - whether on stage or in any part of the hall – would trigger several performing areas equipped with sensors, as well as on his/her own body, transforming the human physicality into different sonic objects.

The focus of the work shifted, after this first proposal, to a larger multidisciplinary and cooperative project including music, choreography, video and dramaturgy, maintaining and evolving the initial concept. The further development of the work integrated these four different perspectives, and four different actual layers, substantially homogeneous both in the creativity and finalisation process, and within the merging of different disciplines and media. *Discombobulator*, distinct from my usual activity and

approach, (and due to the nature of the Biennale residency) it is not a scored composition, with the exception of a general temporal scheme structure, or mapping.

Discombobulator is a fantastical solo set against evolving projections of a neglected Venetian façade. The liquid agility required for the performer's interpretation triggers, in real-time, the live electronic composition and computer-generated imagery. A media interplay explores the ultimately insurmountable separation between the physical presence of the human body and the imaginative possibilities of a virtual reality. *Discombobulator* represents a human being entrapped by his/her dreams of escape from city life, desperate to make enough effort to bring a world to life that he can never enter, a contemporary myth of Sisyphus. He is alone, in a room, not knowing why he is there - only aware that he is trapped. This room is his mind, or a real space, it is the entrapment of routine, of the demands of contemporary life, or a prison cell. He dances to produce sound and imagery in the space which he believes to be his only possibility of escape – if he can only visualise the virtual, if only the physical body could make a world of images real, he will be able to escape into his dreams: the human being as itself or as a multitude: surrounded, trapped, juxtaposed, or superimposed; exploring the contemporary impossibility of the simple condition of living one experience at a time in a virtually networked world[3].

The very nature of the residency, and the limited time available, forced the choice of a more practical but still effective working mode. The piece was

[3] The work process had its reference from Georg Simmel's essay *The Metropolis and Mental Life* (1903): "*A person does not end with the limits of his physical body or with the area to which his physical activity is immediately confined but embraces, rather, the totality of meaningful effects that emanate from him temporally and spatially. In the same way the city exists only in the totality of the effects that transcend their immediate sphere*".

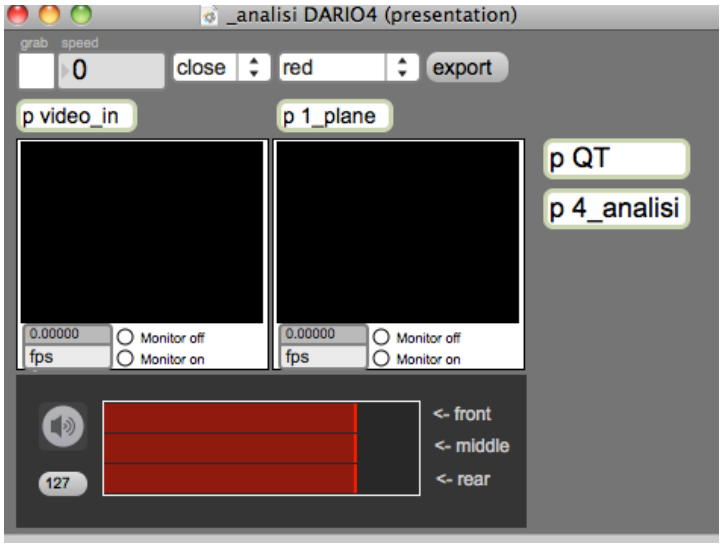
developed through the programming of dedicated software that would work in a double mode. On one hand, it managed a motion capture process, obtained using a video camera as an integrated sensor; on the other hand it managed pre-recorded audio materials and their mixing and playback control. The first part of the software was implemented to interact with the performer's body movement, placed in a specific given position or area of the stage. The software, through a FireWire[4] video camera[5] connected to the computer, translates the performer's movement into data (numbers) that then triggers and controls, in real time, different pre-loaded sounds, samples, or sound files. The relation (and reading) between software and dancer's movement is based on the physical energy that the performer puts into his/her gestures. The more he/she moves the more the sensitivity control reacts, and therefore triggers the audio files' output accordingly to the energy produced. The FireWire video camera works as a sensor, pointed at the specific zone of the body (in this case between tibias and shoulders), and from a relatively long distance can capture a considerable performing area, allowing the dancer significant freedom of movement and interaction.

The Example 12 (_analisi) shows the software main control window, which start and stops the software, and transmits the video input reading to the other interactive engines. This window is the core of the software: the interface allows to control and adjusts the video-camera shooting, the video input that is sent to the sensitivity engine (Example 13), to activate and

[4] FireWire, or IEEE 1394, is a serial bus interface standard for high-speed communications and real-time data transfer, and developed in early 1990's.

[5] FireWire video cameras are not too intrusive as often sensors are, allowing the performer to more independent movement and relation with the surrounding.

control the audio input and output, with the option to assign such audio to a surrounding mapping.

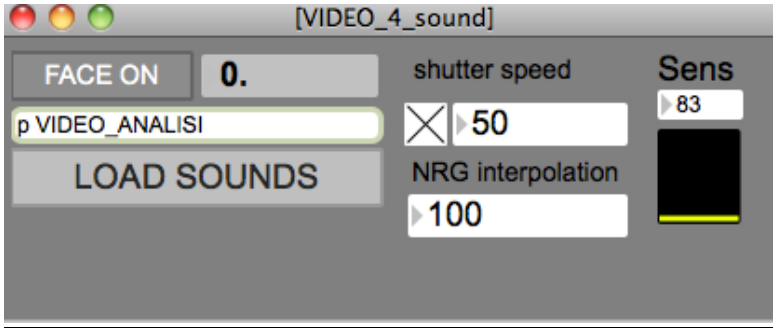


Example 12

The data collected from the engine in window _analisi is sent in real time to the other engines, as in the case of the following VIDEO_4_sound window in Example 13. In this window, the engine reads and translates the sensitivity, and energy interpolation produced by the performer. As we can see in the example, the numbers within the white squares represent a balance between the physical energy that performer is putting into his gestures and the sensitivity allowed (by the composer) to control the speed of such movements.

A third parameter, the shutter speed, works in the same way as a camera shutter does, and with the same balance between sensitivity and energy (NRG) interpolation, it controls the dancer's effort captured by the video

camera: the higher the number the bigger the effort required by the performer. From this perspective, the performer's interaction needs to be constantly monitored and adjusted, during the performance, following as closely as possible his/her changes and behaviours.

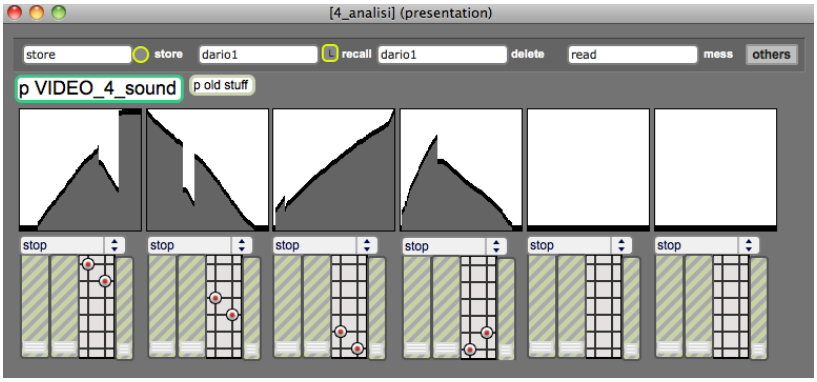


Example 13

The final section of the software controls the audio triggered by the performer's movement. The engine, in the VIDEO window (Example 13), sends in real time data that directly operates the volume sliders in the window 4_analisi, in Example 14. In this, six audio engines are programmed to enable the loading (also in real time) of several different audio files, of any size. Each engine is also paralleled with a graphic window in which it is possible to assign a specific audio output trigger mode. The graphic window enables the drawing of any line, or curve, which determines (independently of the audio sliders) the quantity and quality of the triggered audio output. Drawing a diagonal through the square, for instance, reduces the audio output volume, where a more complex curve (as in the second graphic window in Example 14) considerably cuts a central part of the selected audio

file. This graphic drawing mode has also an essential double feature: a diagonal drawn from left to right will be the one triggered by the performer's movement; in contrast, a diagonal or curve drawn from right to left will trigger the performer's complete stillness. In this way, as the work progresses, it is possible to assign to particular sections of the piece a duality that is completely controlled by the performer, without the need for an external control.

Finally, each audio engine has an independent assignable audio output matrix module (the grey square with black lines and red dots next to the audio sliders), which can assign different audio files to different speakers, in this case up to six, allowing the spatial control of audio distribution in a surround mode.



Example 14

Discombobulator is, and was intended to be, a miniature, and particularly a study, compact but still maintaining, in its approximately fifteen minutes length, the body and experience of a full-scale work. The piece fully contains

the theorisation, preparation, and finalisation produced in almost three weeks. Nevertheless, the composition of the work represented, in my experience, a further evolution in which frequency, timbre, and parameterization interrelationships are interconnected, developing and actualising my research towards hybridization processes. In *Discombobulator* the performer's movement, and non-movement, becomes frequency, and furthermore timbre, evolving the theoretical approach of hybridising different or diverse timbre. The work, at same time, initiates a parallel process in which the (performer's) body, and his/her surroundings, are considered as compositional material - an integral part of the happening. The performer is responsible for confronting his/her own physicality, perceptions, limits, and desires, and interrelations within and in regard to the piece. The body is solicited to engage in a dynamic duality: the centrality, of the performer's traditional role, expands to the whole surrounding, putting in vibration the performance space, which becomes structural to the work. Energy is moved from the centre to the perimeters, and from there is then re-integrated, re-absorbed, by the performer's perceptions and behaviours.

The musical material prepared was divided in two groups: sound files activated by the performers, through the video camera (in given position); and sound files activated together with the video projection, but not controllable by the dancer.

In the first group, the sound files were based on the imaginative, emotional, and dreamed physical and mental state of the dancer's role: a man entrapped by his own dream of escaping from one (supposed) reality to

another. The sound files were predominantly based on water, electrical distorted transmissions, non-homogeneous drumming (faintly resembling the heart beat), and guttural and multiphonic singing, similar to the technique used by Tibetan monks.

The second group, relatively disconnected from the protagonist's inner territory, was rather linked to that idealized other world, or reality, that the protagonist was desperate to reach. For this second group I prepared longer files, closer to structured miniature compositions, with a more ample shape (even if of small lengths) and compositional development. Those miniatures were primarily based on the voice: an articulated male voice singing, and, from a sonic perspective, a distant reminiscence of the protagonist's world.

5.3 *Trance, Five abstract stations*
for male voice and real time electronics (2009)

composed for and dedicated to Jean-Michel Van Schouwburg
duration: approximately 14 minutes
premiere: Sonic Arts Series - UEA, Norwich – United Kingdom, November 2009

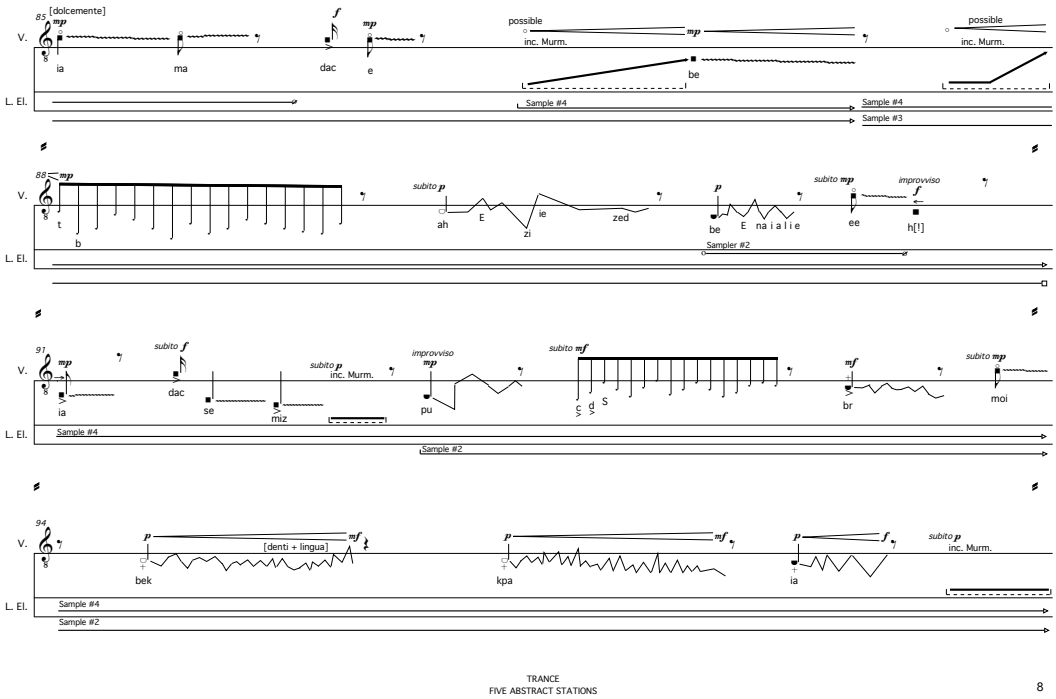
The composition of *Trance* represents the starting point of, and first work in a relatively long new cycle with forces ranging from solo instrument to large ensemble or orchestra. The voice – male and female – has a role in all these compositions, characterising the entire cycle. The conception and preparation of *Trance* has been an integral part of my research towards different timbral parameters interrelationships, and timbre hybridisation processes. The compositional specificity of *Trance* resides, in fact, in those characteristics, focusing upon distinct particularities of the human voice and of the interpreter's subjectivity.

The complexity of the human voice has directed my work towards the composition of a virtuoso piece, for a specific performer, as often has happened in my practice. The central concerns of the work have merged with that of virtuosity since the very beginning, bringing about the possibility of a piece in which experimenting with vocal complexity determined the structure of the work itself.

In *Trance*, biological and physical vocal characteristics, and pure singing vocal aspects, are subject-objects (material) of the work, paired in a constant fluctuating correspondence, which structure the shape and form of the work.

This theoretical approach was intended to bring about the observation and consideration of vocal particularities and qualities as a whole, while allowing their utilization as formant qualities of the work. From this perspective, the pure singing aspect is considered and treated as qualitatively equal to other (similar and different) elements of the voice. The voice-instrument is analysed in its constitutive physical parts, as the throat and larynx, vocal folds (or cords), internal cheeks and tongue, as well as lips and nose. Such physical parts are furthermore associated with their timbre subjectivity, and in comparison and relation to the overall voice sound emissions: vowel and consonant articulation and modalities of pronouncement; throat and guttural sound typologies and techniques (in particular unusual ones); lip sounds preparation and emission, and (possible) extended techniques. This analytical procedure formally influences the construction and structure of the work: the utilisation of phonemes and physical vocal characteristics is preferred to the utilisation of specific text or lyrics: a mode which emphasises the strong central role of the interpreter, who needs his creative capacities to contextualise and construct his own verbal, textual, and sonic territory, where the work will be performed.

The score is largely prepared with a unique graphical notation, in which symbols correspond to a specific sound articulation and production, inevitably subjected to the singer's vocal qualities. Here the performer is the centre of the composition - his inner capability and competence to interpret the score physically, technically and emotionally determining the actualisation of the composition itself (See Example 15).



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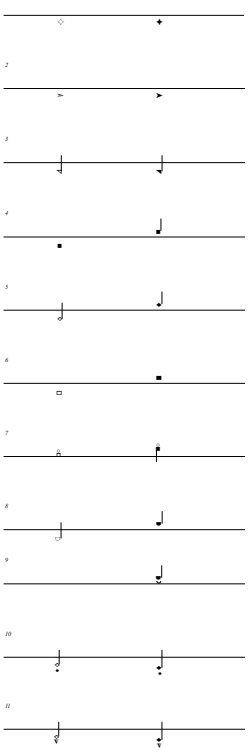
Example 15

The technical preparation required of the singer, is fundamental to achieving the focus of the work, in which the singing qualities determine the very sonic timbral aspects of the piece. Such sonic territory depends on the interrelation between vocal properties and their real time hybridisation with prepared sound samples or files. It is a delicate relationship, fully controlled by the performer in his qualitative and quantitative aspects. The singer's vocal timbre is, in fact, constituted by several elements that are often partially and temporarily isolated (for instance within a section of the piece) generating transitional timbral fields which are formally related and connected to each other. The following Examples (16 and 17) represent the score instruction for the performer, in which any single vocal behaviour is associated with a specific symbol, and thus to a sonic result. The notation is intended on the

one hand to underline (in favour of the interpreter) the interpretative vectors of the work - its overall sonic ‘belonging’, and on the other hand to formally indicate and separate different territories, which correspond to specific timbral fields,

INSTRUCTION FOR THE SINGER/PERFORMER



Lepre or kissing lips. No fixed pitch. [Example 1-4]

Soffiato, both lips and throat. No fixed pitch. [Example 5]

Harmonic *aspirato* on *a E i o u* Also on fixed pitch. [Example 6]

Spoken Singing - Pitch-singing with changing but No fixed pitch.
Like a 'confused' multi-linguistic self dialogue. Fixed on one pitch as a monotone singing line [Example 7]

Throat + breath - Low *sospirato*, short range. No fixed pitch. little bit of multiphonic in the background[Example 8]

Singing with *Stomach,* mostly undefined pitch. [Example 10]

Spoken Singing - Similar to 7 but higher [Also Donald Duck voice] Fats, No fixed Pitch. [Example 11]

Singing Spoken vibrato - Full voice, also a bit of throat. No fixed pitch [Example 12 - 13]. 13 is similar but slower with Tongue strokes and effects.
Almost identical to 7, but more fixed around one pitch and slower

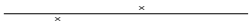
Multiphonic -Throat - Tibetan style, very low with no particular fixed pitch [Example 14]

Throat -Multiphonics - Similar to 14 but much more Vibrato and Throat. Low. No fixed pitch [Example 15]

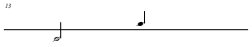
DARIO PALERMO
TRANCE
FIVE ABSTRACT STATIONS

III

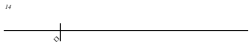
Example 16

12 

Sospirato with *Throat.* Pure sospirato, with stomach. No fixed pitch. Also mid/high range [Example 16]

13 

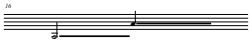
Semi-close Mouth - *Multiphonics.* Given pitch as well as no fixed one. Also high range [Example 17]

14 

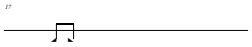
Throat. Pure throat controled emission, as a ratchet. Very low, where the curve ---------- controls the speed. No fixed pitch. [Example 18]

15 

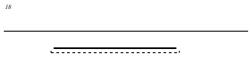
Spoken with *Throat.* Chaotic attitude with throat+spoken+ a bit of singing. Also high range. No fixed pitch [Example 19]

16 

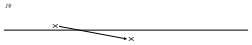
Falsetto. High harmonic on falsetto. Given pitches only. Very sweet. [Example 20]

17 

Generally for Breathing - unvoiced but very intense.

18 

Uncomprehensible Murmuring. Very low and *.far*

19 

Indicates a Glissando. Duration is proportionated to the distance between the two notes

20 

Murmuring - Low/low as possible - High/high as possible

Example 17

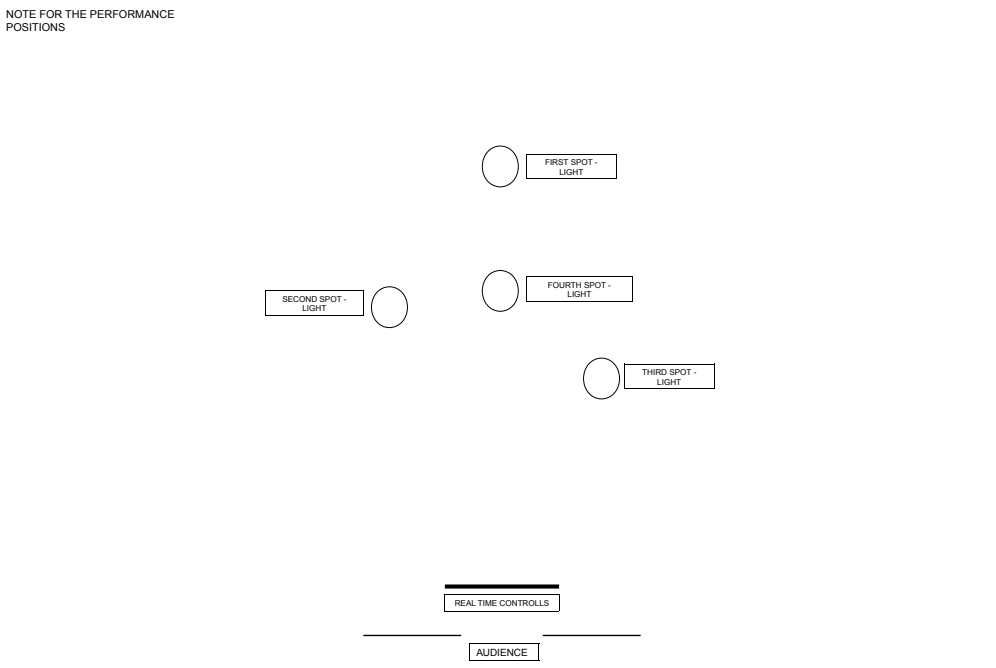
The electroacoustic treatment is consistently dedicated to the real-time sampling and re-sampling of the singing, in which the material is also transposed, inverted, expanded and reduced, filtered and granulized. The treatment follows the main sections of the work, their interconnection, and their compositional subdivision in different areas in which the voice evolves in its inner characteristics and qualities. The notation, translating such (presumed) qualities into timbral fields, structures at same time the progressive electroacoustic development and treatment - its architectural flow. The work is shaped by its own becoming, detailing gestures, sections,

and interconnection of macro areas: any single voice emission contextualizes the moment, as well as being part of broader interconnected sections. This process is furthermore underlined through the utilization of pre-made large audio files, almost repetitive and static (similar to drones), which parallel the real time synthesis, accompanying singing and electroacoustic activity, functioning similarly to ostinati. Such static layers are precisely intended to exalt the complexity of the singing as a whole, as well as to emphasize a further atomized sonic layer produced by the hybridization process.

In this particular work the narrative aspect is intentionally unintelligible, refused as inconsistent with the theoretical development. In this respect, hybridizing only specific and relatively small areas is sufficient to generate a layer basically consisting of atomized sonic particles, controlled and triggered by the performer's singing.

The theatrical aspect of *Trance* is an integral part of the form and interpretation of the work, and concerns its choreographic characteristic: the performer moves to four different positions within the performing area, Example 18. The singer physically enters the area emphatically, underlining that the performance has already started, and at the end of the happening, similarly acting, leaves the scene as if the performance is not finished. The four positions (each with dedicated lighting) represent the four main sections of the work - the sonic and physical interrelation and evolution - in which the choreography plays a transfiguring and integral part. The theatrical aspect is not new in my work (particularly in compositions dedicated to the voice), but in *Trance*, for the first time, this characteristic becomes organic to and

essential within the work. The dichotomy between performer's body and the body-instrument is here bypassed in favour of a unicum in which the two subjects, finally, join together.



Example 18

6 The Difference Engine

6.1 *The Difference Engine*

for amplified string quartet, mezzo-soprano & real time electronics (2011)

co-commissioned by
Dance Umbrella for Dance Umbrella Festival 2011
Royal Philharmonic Society – Drummond Fund
dedicated to the Arditti String Quartet
duration: approximately 28 minutes

The Difference Engine is a multi-disciplinary work for music, dance, video and theatre commissioned by Dance Umbrella for their 2011 Festival, and prepared by the same artistic team that produced *Discombobulator* at Venice Biennale - Festival of Contemporary Music in 2009.

The Difference Engine is the second composition that, following *Trance*, represents a substantial advance within my research dedicated to timbral fields and hybridisation interrelation.

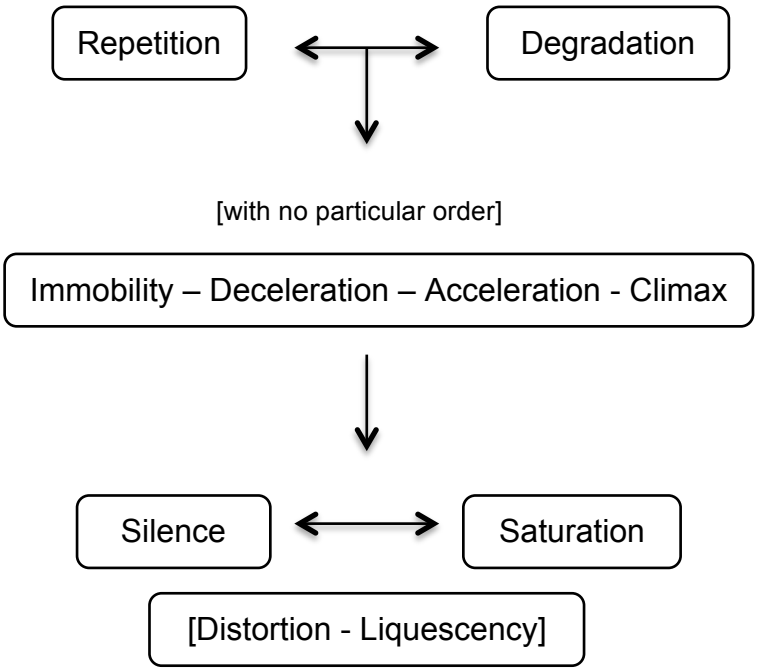
This chapter will present the genesis and composition aspects of the work in its whole, independently from the theatrical realization in which the composition has been subsequently adapted, and substantially differentiated, entitled 'Music for *The Difference Engine*', which is presented in the following chapter.

This work for string quartet and mezzo-soprano was, in fact, thought through and composed as an independent piece, fundamentally autonomous from Dance Umbrella Festival's commission.

The Difference Engine is a large scale work composed as a single movement, without breaks. It is distinctly divided into twenty-one sections, fluidly connected to each other in a process which is intended to degrade its own progression and mutation, in favour of a (formal and sonic) perceptual metamorphosis of its own beginning and becoming. The work presents a concrete formalization of parameters, timbres and hybridization interrelation, and the acoustic and electroacoustic results that such interrelation produces. The formal and overall harmonic structure of the work is organized as a single macro object, which integrates aesthetic and technical propositions within the same progression. This compositional method, and process, is intended to interrelate any aspect of the work at the same quantitative and qualitative level, where each characteristic evolves in its relation to others, in a circular and vertical modality.

The following scheme represents the overall structure of the composition: physical and perceptual states, internal and external qualities and models are integrated within the same form, Example 19.

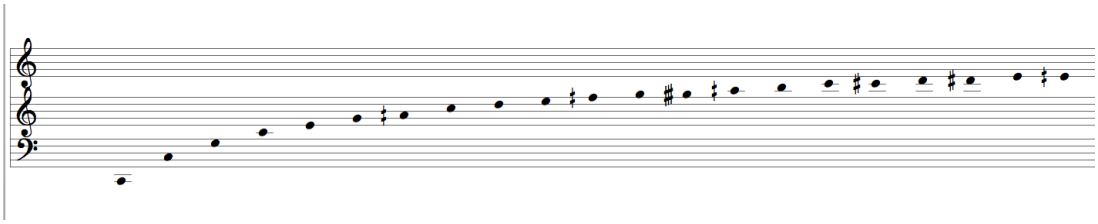
The Difference Engine



Example 19

The predominant topic of the work is a generative compositional method, which organises form, timbre and harmonic interrelations from the instrument's physical and sonic properties. The entire formal structure is therefore organized considering frequency the core of such a generative process, this being based on the general instruments' range, and the polarity provoked by this methodology. The violoncello and violin become then the two frequency and timbral extremes, intersected by the mezzo-soprano, which constantly contrasts the string quartet (as ensemble) and its compositional becoming. The violoncello represents the origin upon which the structure is built: its lower frequency (C2 at 65.4064 Hz) is the base on

which such structure relies, and the harmonic series extracted from it – the first twenty partials plus the C2 - represent the harmonic field, or spectrum, of the entire work, Example 20.

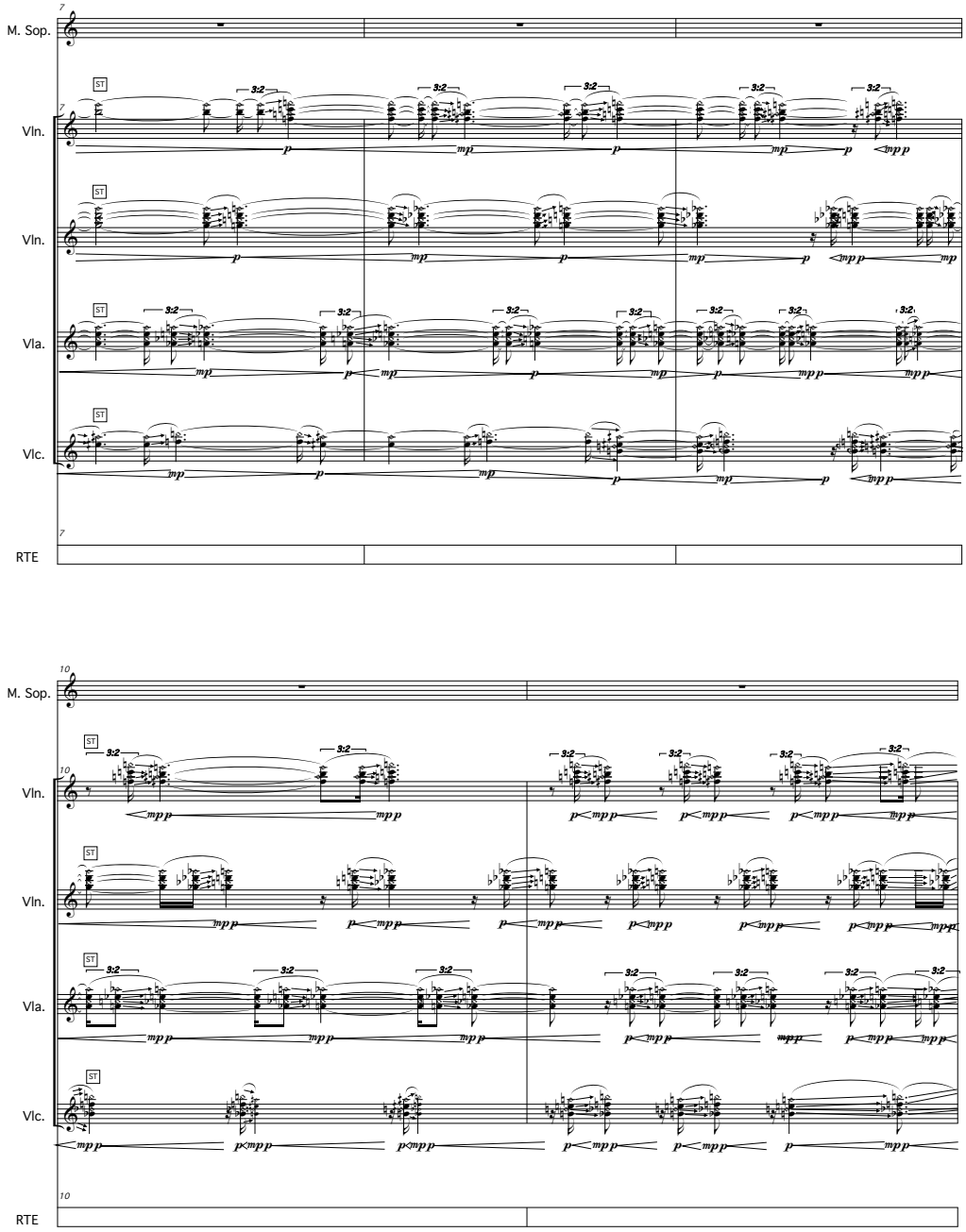


The Difference Engine – Harmonic series
Example 20

The interrelation between different instruments' ranges, frequencies and timbres is a key compositional factor of the work, which permeates and emphasizes the acoustic and electroacoustic timbre hybridization process. The frequencies of the harmonic series are interpolating nodes representing each section of the work, intrinsically connected to each other within fluid structural passages between areas of the work. This compositional formal linearity aims to progressively juxtapose extremes of silence, saturation, distortion, and liquescence - elements that become structural to the composition, delineating the sonic perception of the work. The electroacoustic process (and the computer-aided aspect of to the composition) represents the base of such activity from the very first step. The sonic perceptual characteristic of each node is delineated from the beginning, resulting in a writing process that requires the consideration of several aspects of any single frequency, figure, or phrase. It is a semiosis in

which the notation achieves a multi-dimensional role, synthesising the graphical symbolism with its real time electroacoustic treatment and result.

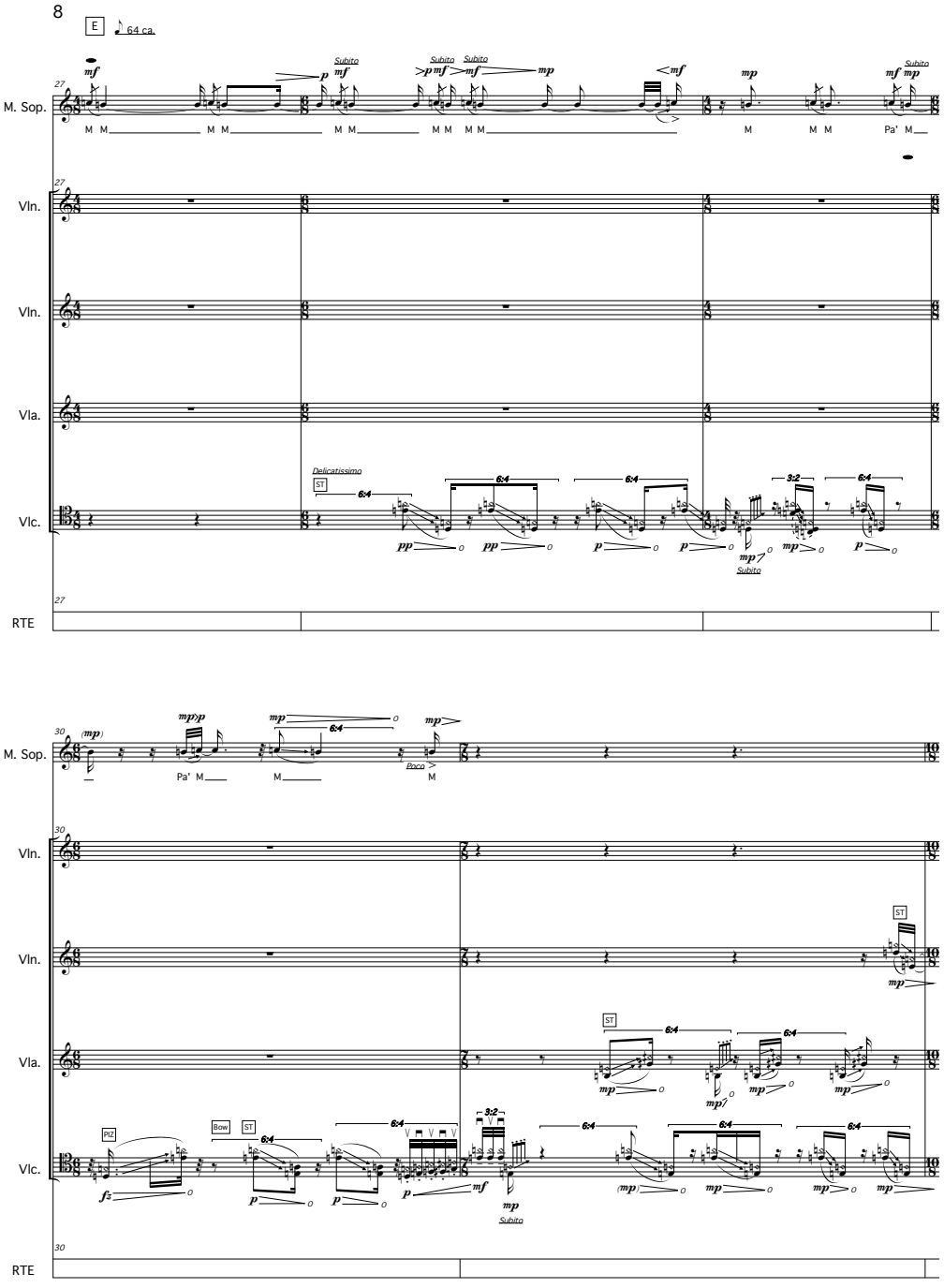
The duality of this interrelation permeates the work, particularly in the case of sections in which the electroacoustic treatment is not involved: here such relation is maintained only acoustically, therefore specifically sustaining and underlining the predominant character of the composition. The difference between acoustic and electroacoustic is bypassed in favour of a generative interaction, which melts the two processes, provoking a sub-structure of full and emptiness that can be hardly recognisable. The entire section Q of the work, for instance, as well as section A, is built following this methodology: passages from different states (acoustic and electroacoustic) are not identifiable by the listener, unless clearly revealed through rhetorical propositions, Example 21.



THE DIFFERENCE ENGINE

Example 21

The mezzo-soprano is in part treated differently: her acoustic and electroacoustic processes are related as counterparts in regard to the sonic development of the work. The voice is delineated as a role that is, at same time, predominant (but not as soloist) and as counter-intersection in relation to the quartet parts. The sonic result underlines the duality of the composition, proposing a systematically multi-layered sonic experience, Example 22.



THE DIFFERENCE ENGINE

Example 22

The timbre hybridization, which arises from this process, interacts, again, dually with the string quartet and the mezzo-soprano, which are substantially

treated as two separate compositional parts. The electroacoustic treatment becomes an actual sixth voice or part of the composition, where the two sonic entities, quartet and mezzo-soprano, are similarly juxtaposed in the acoustic compositional development. This approach necessitated two different audio signal treatments, as well as the management of their subsequent, and sometimes problematic, mixing. In distinction from previous works, in *The Difference Engine* the electroacoustic result is therefore double, and the dual processes are not organically related to each other. Where, for the quartet, the electroacoustic treatment is an elaborate result of the acoustic playing, the mezzo-soprano interacts with prepared concrete sound files, which, even if extracted from the voice, are not entirely and directly associable to singing characteristics only. The mezzo-soprano's acoustic and electroacoustic parts explore different territories, belonging to a more specific physicality (the instrument-body) than to a pure sonic environment. The vocal part represents a physical-effective activation for both performer and audience: it is a living relation between the instrument-body, intellect and the surroundings. The instrument-body is a search for a (re)appropriation of perceptual and performative spaces: it goes beyond the musical aspect only, integrating its inner and outer, as well as any other form that it might comes in contact or relation with. The characteristics of the voice, of the singing, are then unequivocally extended over a multi perceptual and multi-sensory experience which, generated by the instrument-body, is then emancipated towards the other, and to the audience.

6.1.2 Music for *The Difference Engine*

for amplified string quartet, mezzo-soprano & real time electronics (2011)

co-commissioned by:
Dance Umbrella for Dance Umbrella Festival 2011
Royal Philharmonic Society – Drummond Fund
duration: approximately 50 minutes
premiere: London - United Kingdom, 12th October 2011

Music for *The Difference Engine* represents the music, choreography, video, and theatre realization of a Dance Umbrella and Royal Philharmonic Society co-commission of a new work for the 2011 Dance Umbrella Festival. It is both a formal and practical differentiation, which separates the work for string quartet, mezzo-soprano and real time electronics as an independent piece, from its actualization in a multi-disciplinary collaboration and production. *The Difference Engine*'s compositional work was, in fact, formalized since the very beginning, as a modular process constituted by several sections strictly related to each other, but also independent in their inner sonic essence and construction. This methodology, as we have seen in the previous chapter, was based on a substantial compositional process that was representing a sonic and formal – temporal - transformation within twenty-one sections. Such transformation was also (secondarily) considered as a formal and practical proposition for the realization of the multi-disciplinary and theatrical work. In the theatre production, the string quartet does not play during the performance, while the mezzo-soprano has a rather active singing and performing role. The string quartet recording is distributed in the hall through

a specific sound design, and sonic spatialization. A simple front-stereo is assigned as main hall sound diffusion, with two crossed-stereo speakers placed in the back. The performing area was rebuilt as an end-stage tunnel that was facing the public. Inside the performance area six smaller speakers were placed at the ceiling, face down at an approximately thirty-degree angle. This solution was ideal to the sonic development of the work, in which part of the overall sound needed to be projected from inside the stage toward the audience, and then sonically connecting with the stereo speakers assigned to the hall and surrounding the audience, Example 23.

Example 23

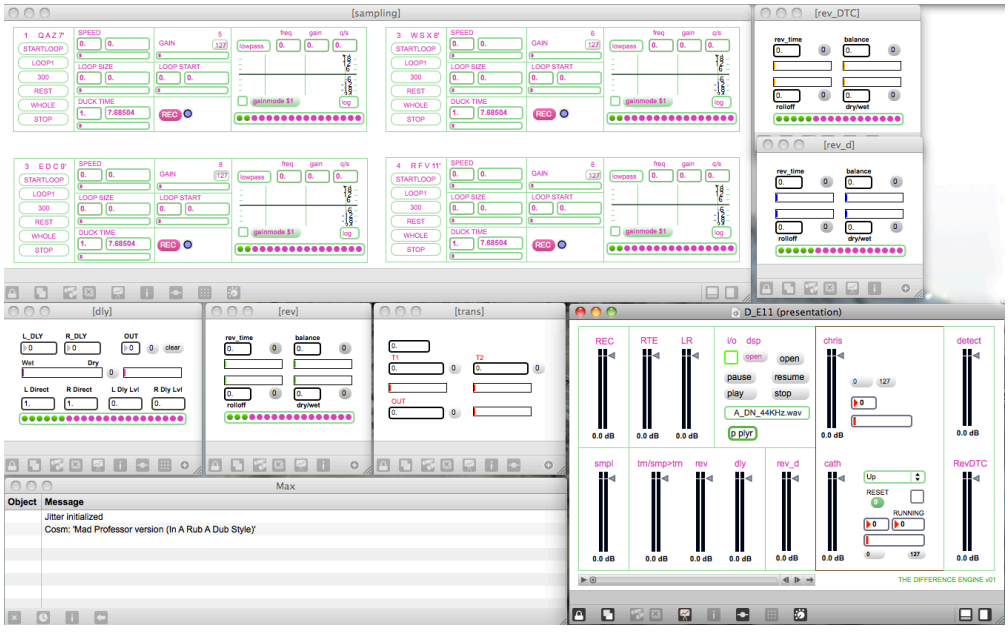
In Music for *The Difference Engine*, the sections are mapped and re-arranged in order to meet the evolution and development of the teamwork. In the theatre realization, the compositional construction connects the original sections through a new real-time electroacoustic layer: a new electronic level

which basically aims to connect and assign to music, choreography and video, a common and basic sonic perceptual environment. This layer is functional independent from the string quartet and, more specifically, from the mezzo-soprano's singing, and electroacoustic treatment. It is interconnected with the overall evolving of the music, but at the same time this level proceeds as a constant autonomous voice throughout the entire performance. The string quartet recording, and mezzo-soprano's live singing, are integrated with this different electroacoustic layer, in a parallel proceeding. At the same time, string quartet and mezzo-soprano's electroacoustic, and their sound projection, are treated singularly, as required throughout the compositional and finalisation process. This fourth voice is a formal – provocative - sonic interference in the performance as it represents a parallel sonic environment, to which performers, and audience, need to relate, as an independent counter-voice. Timbre is here re-thought and re-organized: the hybridization process is applied to the string quartet as an out-of-sync voice that constantly, but distantly, counterpoints with the quartet, and the mezzo-soprano.

The fourth part is extracted, and synthesized in real time, from the string quartet recording through four separate samplers (one for each instrument) which, constantly during the entire performance, generates a second string quartet, derived from its several formal and sonic characteristics. This operation, extrapolating from the original recorded parts, reduces the thickness, the presence of each voice by re-creating a transposed sonic shadow based on one only harmonic, or overtone. The sound is hence reduced from the majority of its components, transposed, often played with a

different tempo or speed, and finally results in further partial sounds, often belonging to specific and pre-assigned section characteristics, such as for instance soft and liquid matter.

The software prepared for the performance is almost identical to that programmed for a live performance of the work. The difference here, is the managing of the mezzo-soprano within the performance space: her singing is necessarily distributed according to her movements. In this way, the contrasts between string quartet, and both instrumental and vocal electroacoustic treatment results, are clearly separated, underlining their sound projection and separate perceptual characteristics. The mezzo-soprano's voice gains a particular dimension and specificity, which is, in respect to the other parts, perfectly integrated and balanced, melted with the finished sonic preparation, Example 24.



Example 24

6.2 *RO - Premiére danse de la Lune*
for amplified drum-set percussion & real time electronics (2012)

commissioned by and dedicated to Emilio Tamez
duration: approximately between 15-16 minutes
premiere: Mexico City - Mexico, 14th September 2013

The composition of *RO - Premiére danse de la Lune* has had an extended and problematic genesis, and a compositional process that lasted more than three years. The work was commissioned as part of a modern repertoire specific for drum-set, or extended drum-set. This characteristic, almost naturally, directed the preparation of the work towards a virtuosic composition, which at the same time would have become a further specific advancement of my latest research.

The first peculiar topic of *RO* is, in fact, to consider any single part of the drum-set as a proper instrument, with its own sonic and perceptional characteristics, techniques, history and evolution, which is often transcultural. This starting point paralleled the idea of considering each instrument from its own sonic perspective, rather than from its acknowledged playing technique, as in habitual instrumental writing and use. Any composition starts from a consistent research on and around that particular instrument or instruments. In this case, those two topics generated a compositional process that was fundamentally built on an extensive research of different possible playing techniques, and their sonic results. Percussiveness, the action that in this case defines the species, or family, of the instrument, is not the subject of this work, and compositionally is partially treated as inconsistent - as a

contradiction. In *RO*, the instruments of the set are formally treated as different voices, connected to each other through different playing techniques. The drum-set, in this light, becomes, and is compositionally organised as an ensemble, in which voices have their own specificity, and a specific sonic finalization. The sonic, choreographic, and conventional ritualistic role (routinely assigned to percussion instruments in general) is therefore in this work unequivocally removed, in favour of a re-integration of the instruments to their own subjectivity and historical belongings. This emancipation of percussion instruments is reached, in the preparation of the work, re-territorializing their own roots, inheritances, cultural traditions and cross-cultural relations, and possible evolutions.

The extensive percussion instrumentation family is, in *RO*, restricted to the unpitched class, and to the subcategories of idiophones (cymbals, gong, cowbell, woodblock) and membranophones (bass drum, drums). These characteristics intrinsically directed the work process to extracting specific sonic elements, qualities, and treatments. The finalization of the drum-set's instrumentation was a choice between the instruments suggested by the performer, Examples 25, and comprising:

one bass drum, vertically played without the use of the pedal

one tom-tom drum, preferably of 12 inches diameter

one snare-drum, always without snare

one medium wood block

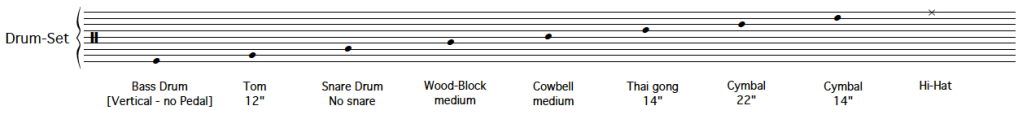
one medium cowbell

one Thai gong, of 14 inches diameter, horizontally resting on a side table

one cymbal, of 22 inches diameter

one cymbal, of 14 inches diameter

one hi-hat, with small pair cymbals



Example 25

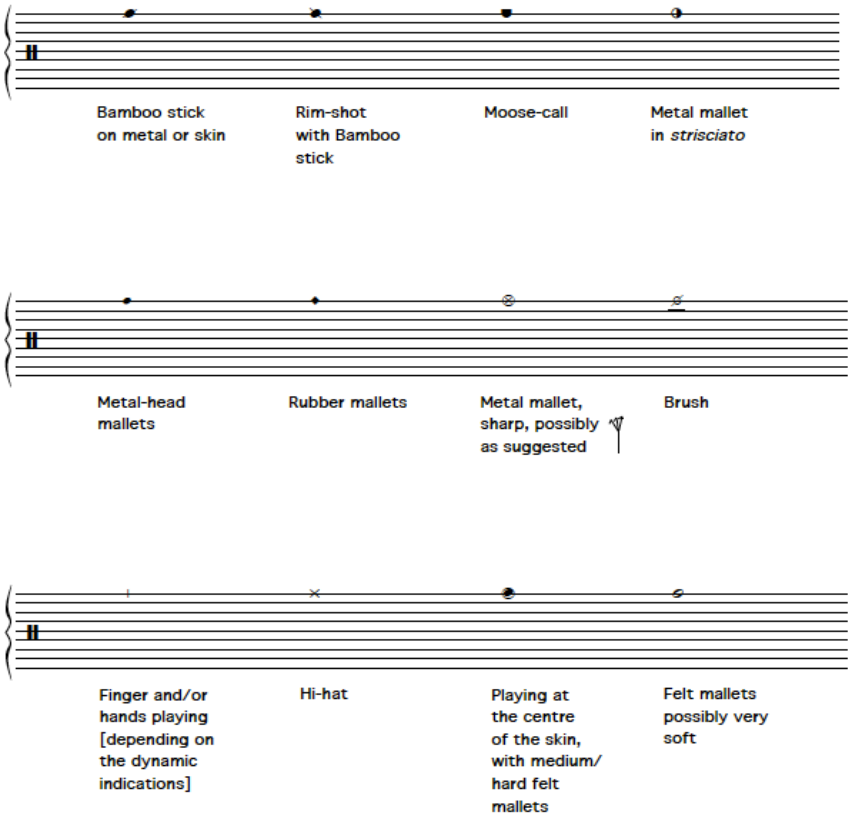
The finalization of this drum-set became the central aspect of the work, in which single instrumental characteristics would define the development and overall sonic environment. In *RO*, where single instruments are considered and treated as unique single voices, the idea of the drum-set as a single-assembled instrument is formally not considered. In this case, instrumental characteristics, and their history, and historical cross-cultural techniques, define the technical and sonic singularity of each instrument, directing and marking the compositional process. Instrument singularities and techniques, developed through the work, are therefore substantially functional also to the electroacoustic part, and performing interaction. In *RO* the performer directly interacts with the timbral hybridization proceeding, controlling most of the process and interaction, in order to merge the acoustic timbres with the electroacoustic ones. The graphical preparation of the work - the score - is therefore dependent on such global compositional and sonic characteristics. From this relation there developed a specific graphic notation, in which each

instrument has its own dedicated line, finalized in a nine-line music notation system.

The instrument's techniques developed, and suggested, throughout the work consider different aspects that form each single instrument character, and mixing together: instrument morphology, primary sonic surface, timbre interrelation within the set, and timbre interrelation in favour of timbral hybridising processes, hence their sonic production and propagation in relation to the electroacoustic treatment. Those theoretical, physical and pragmatic considerations and proceedings will converge, in the finalization of the compositional process, to a further level of sonic interrelation. Here, the different sonic environments find their final output, compressed and mixed but still independently identifiable as single entities. The primary techniques demanded by the work, integrate an immediate sonic result that is linked to a complex performing approach in relation to each instrument's qualities. The idiophones and membranophones are not divided as subclasses, but considered and treated as equal, in both sonic production and results. Consequently, the performer needs to approach each instrument in a similar mode applying a similar technique to each different instrument: a particularity that is demanding of the performer's preparation, research, and interpretation, theoretically and physically focused on sound production details and on the overall sonic result.

The techniques required by the work are divided into three physical and sonic areas, related to the physicality of the instrument's material, to their relation to the utilization of specific and or unusual sticks or mallets (metal, rubber, brush), hands and fingers, and to fundamental sonic procedures such

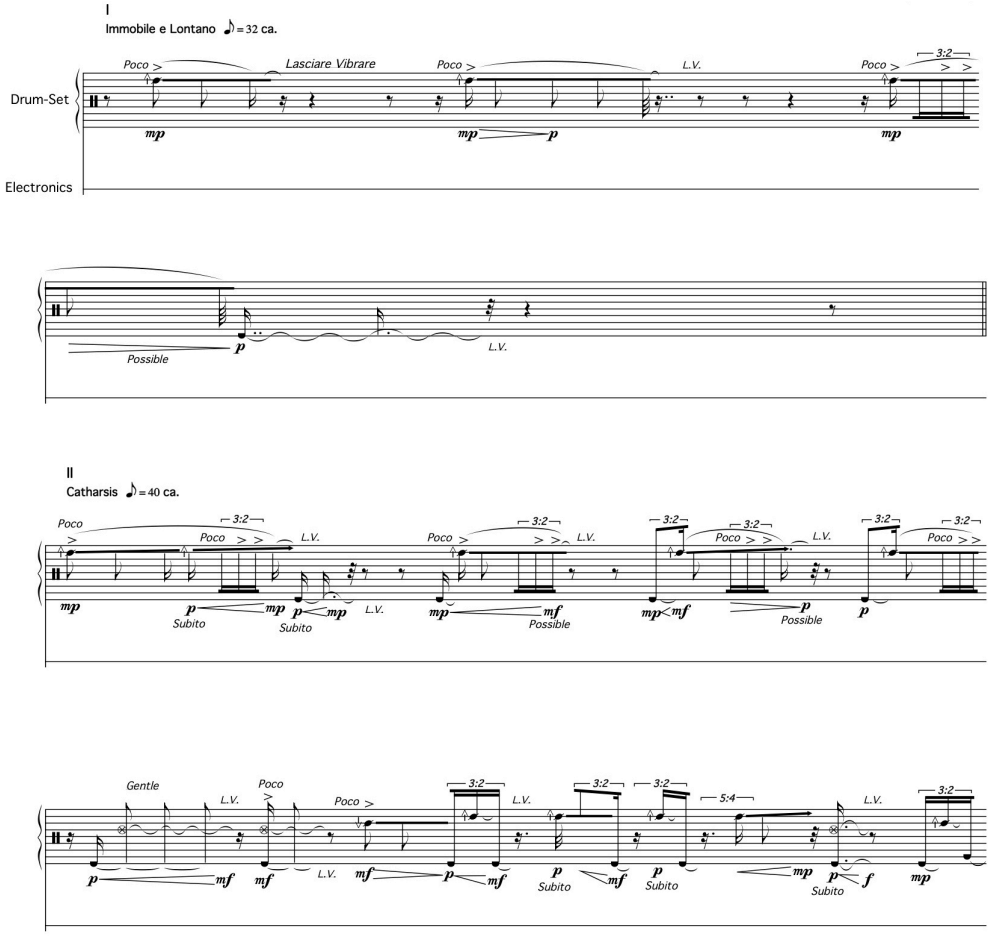
as: friction, scraping, rubbing, and partially percussing – only related to specific stick/mallets and sections of the work, Example 26.



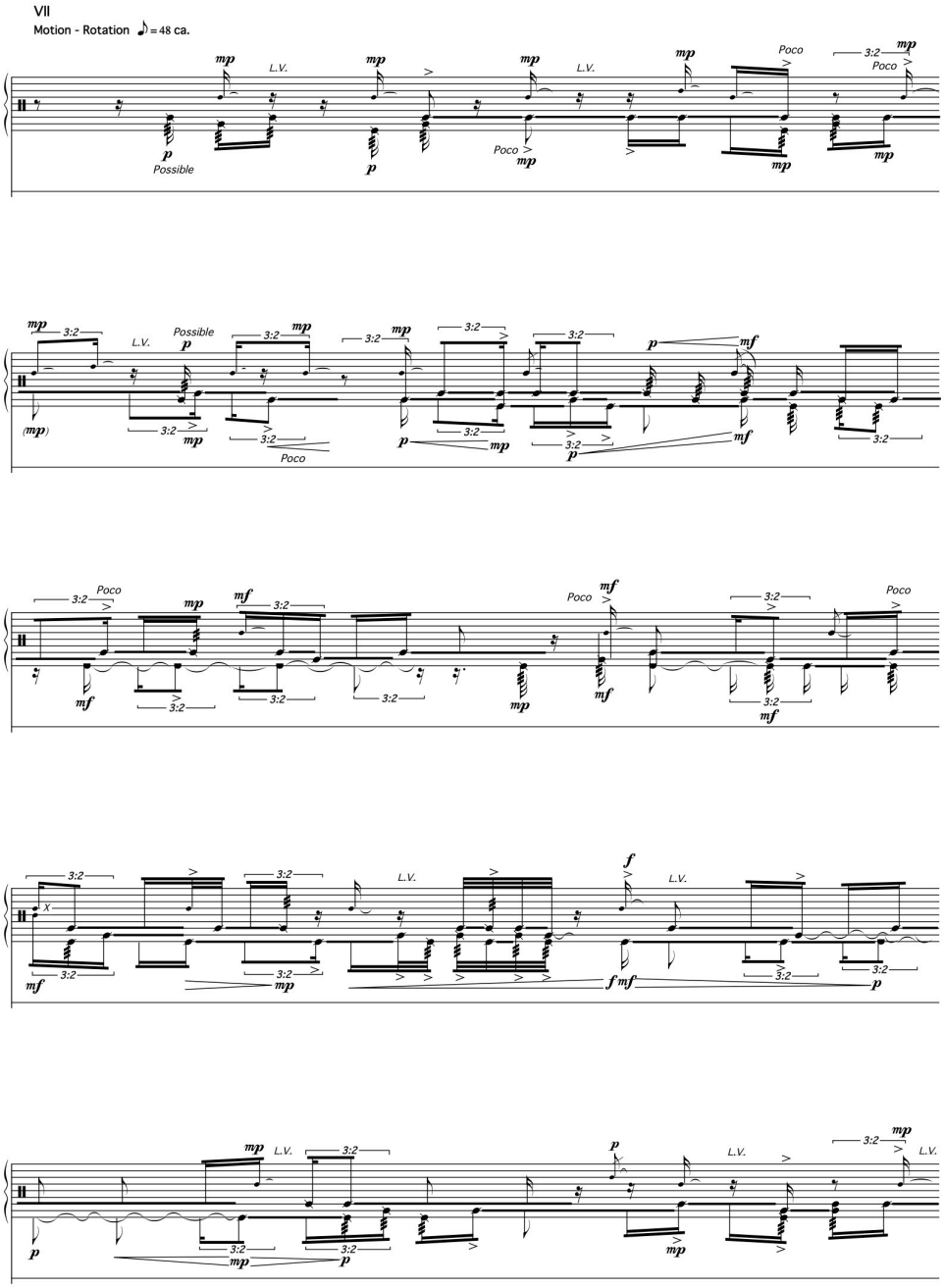
Example 26

Playing and performing technique is functional to the development of the work as it derives from the overall preparation, form and structural organization of the composition: the final sonic result – acoustic and electroacoustic - determines the playing mode, and suggests a possible performed interpretation. This provides a focus which at same time will determine the level of interaction with electronics, between performer and

electronics, and the final effects and outcome of such actions. This particular composition modifies and expands the most common and habitual percussive techniques, and in order to reach a conclusive sonic result, requires of the performer a substantial physical effort, and a redefinition of his/her instrumental approach. A specific characteristic which emerges throughout the work, and which is compositionally connected to the real time electroacoustic treatment adheres to each instrument of the set, specifically through the development of the unusual playing techniques mentioned above. For example morphologies of membranes and idiophones (such as the drum's skin, and cymbals), and particularly their physical materials, characteristics, and sonic results, are compositionally expanded through the use of a frictional performing technique. Several sections of the work are, in fact, based on the idea of a sustained and thus prolonged sonority, which isolates different sonic partials of the selected instrument. Such isolated partials change within the evolution of the piece, requiring of the performer an unusual level of physical interaction. The performer needs to actualise each specified notated sonority (as well as the score in its whole sonic aspect), musically 'carving' each frequency (in this case each partial) out of its historical acknowledged belonging. This compositional peculiarity (applied to membranophones and idiophones) substantialises a composition that bypasses the historical conception of percussiveness: the old idea of percussion and subsequent sonic result, action-reaction. It is a further step, which is intrinsically delineated and connected to a timbral real-time electroacoustic treatment, opening up a further level of sonic perception, Examples 27 and 28.


I
Immobile e Lontano ♪ = 32 ca.
Drum-Set
Electronics
Poco
Lasciare Vibrare
L.V.
3:2
Possible
II
Catharsis ♪ = 40 ca.
Subito
Gentle
5:4

Example 27



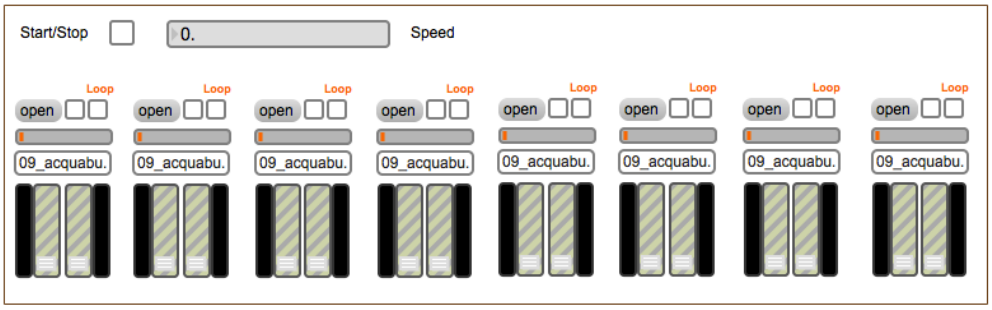
Example 28

RO's electroacoustic parts, and treatments are integral and organic to the work as a whole. The performer's interpretation defines such parts in any

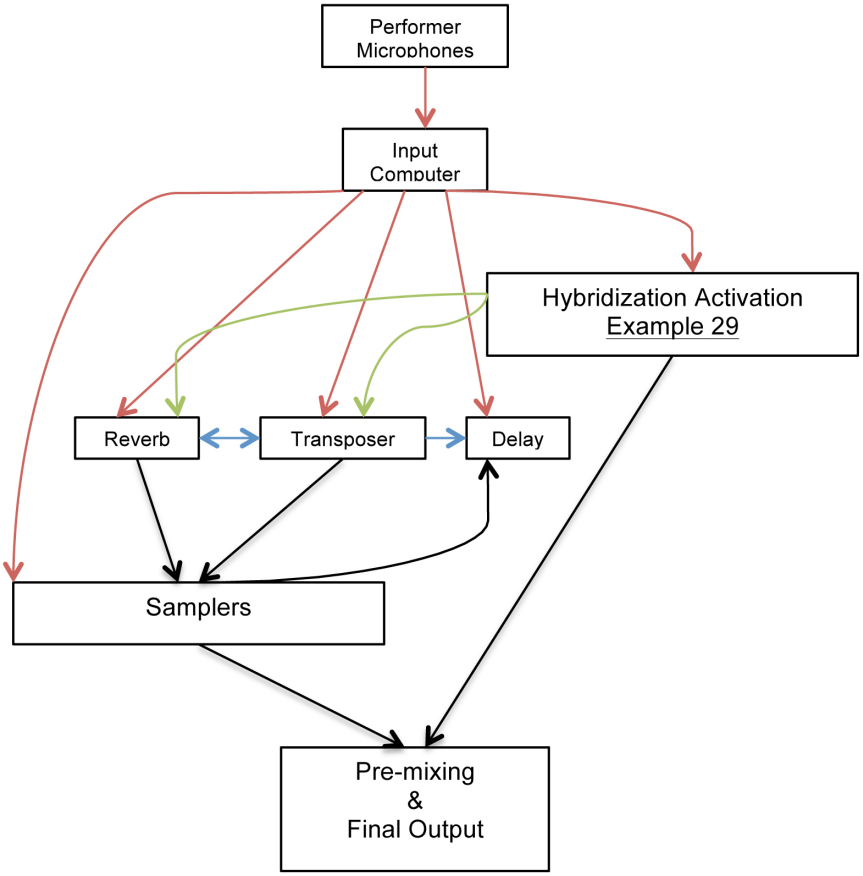
single moment, through his/her playing and level of interaction, physically carving any instrument's sound from its own matter. This characteristic determines also the effort, and preparation of the score, which the performer needs to make in order to attain the overall sonic environment required by the work.

The intensity and preparation required is related to the multiplicity of the score itself: figures, dynamics, and interaction with real-time treatment need to be managed in a constant interrelation with aim of attaining a final perceptual level, which cannot be pre-audible and/or predicted only through an analysis of the score.

The electroacoustic part is organised from the instruments' materials and qualities and, as a consequence, automatically determines the preparation and performance mode of the part itself. The electroacoustic voice, therefore, evolves from the same instrument's subclasses organized throughout the composition, largely involving instrumental timbres that are associated to a specific mode of playing. Each instrument is amplified through a dedicated microphone, which is connected to a dedicated software engine containing prepared sound files, built and derived from the very same sonic drum-set material. The software and engines (programmed using Max/MSP–jitter), and thus their pre-loaded sound files, are triggered by the performer's actions, and with different modalities during the evolving of the work, Example 29 (detail). Example 30 is the overall diagram of the electroacoustic treatment of the work.



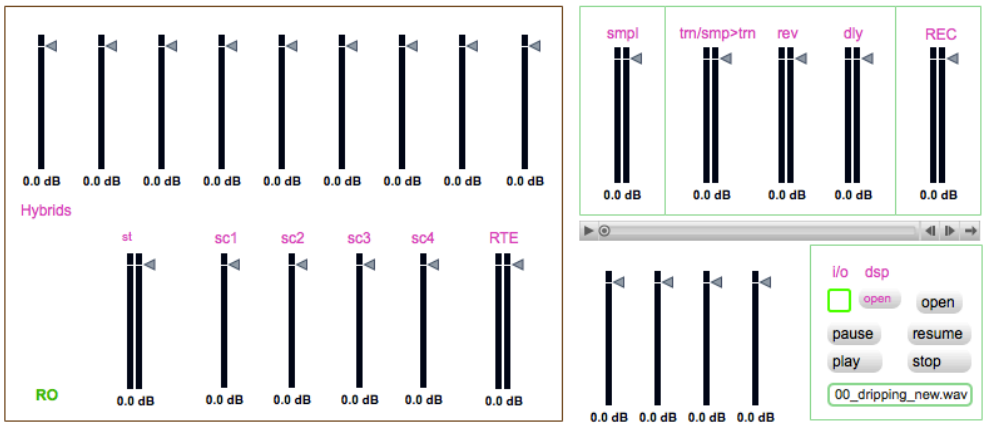
Example 29 - Max MSP jitter software and graphical interface detail (Hybridization engines) programmed for *RO - Premiére danse de la Lune* (2012)



Example 30 - Diagram of the overall electroacoustic treatment for *RO - Premiére danse de la Lune* (2012)

The different idiophones, such as Cowbell and Wood Block, have a similar triggering engine, with a differentiated timbre hybridization process. These instruments are, in fact, separated from the idea of friction, and associated with a more specific – and in this case traditional – percussive action. The peculiar sonorities of Cowbell and Wood Block are nevertheless emphasized as much as possible throughout the work, pointing to a different sonic result, through a percussive modality focused on the sustain and decay of a basic sound, usually obtained by striking. Timbre hybridization is here conceived in its vertical aspect: the triggering is the direct result of a relatively short percussive action, which (even if expanded over an entire section) is related to the proximity of an often millisecond action-reaction process. It is a secondary but important aspect of the work, which constantly parallels the changing of a sonority over time (in this sense considered as a horizontal process) against a similar action that is rather concentrated within the space of a stroke (impact). Two different entities which concretise actions and processes within the very same time and space: different sonic objectives, and within different sonic environments, substantialising the micro (internal) and macro (overall) multiplicity of the work.

The global sonic process is finalized through assignment of specific amplification. Acoustic and electroacoustic parts are managed through a dedicated mixing window, in which any single voice has a dedicated channel that controls the output level, Example 30.



Example 30

This control window manages also the fundamental and final speaker assignment - the sound projection. As in previous works, the overall sonority of *RO* is conceived from the singularity of a work for solo instrument. The drum-set is lightly amplified in order to hybridise acoustic and electroacoustic treatment, and such mixing between the two sonorities as is necessary is balanced to achieve the final global sonic result. The amplification, for this reason, needs to be – usually - barely audible, allowing the acoustic sound to fill the performance hall at the same level as the electroacoustic treatment.

RO's spatialization projection, coherent with the compositional process, involves two speakers, placed within the performance area, above and behind the performer, and possibly suspended or elevated to approximately two meters from the floor (similar to Example 10, page 42). Such sound design completes a complex and delicate compositional process, balancing the different sonic perspectives in the work, possibly proposing new perceptual experiences.

References

Boehmer, Konrad, *Music and Politics / Towards a Terza Prattica*, in *Order and Disorder, Music-Theoretical Strategies in the 20th Century Music*, Collected Writings of the Orpheus Institute (ed. Peter Dejans), Leuven University Press, 2004, 137-168.

Boulez, Pierre; Noakes, David; Jacobs, Paul, *Sonate, Que me Veux-tu?* , in *Perspective of New Music*, Vol. 1, n. 2, 1963, pp. 32-44.

Dissanayake, Ellen, *Ritual and ritualization: musical means of conveying and shaping emotion in humans and other animals*.
Chapter I in Steven Brown and Ulrich Voglsten (Eds.), 2006. *Music and manipulation: on the social uses and social control of music*.
Oxford and New York: Berghahn Books, pp. 31-56.

Eimert, Herbert; Stockhausen, Karlheinz (Eds.) *Die Reihe: a periodical devoted to developments in contemporary music*. Vol. 1 Electronic Music, 1958. London: Theodore Presser in association with Universal Edition.

Ferneyhough, Brian, *Collected writings*, *Contemporary Music Studies*, Vol. 10, Harwood Academic Publishers, 1995.

Ferneyhough, Brian, *Fourth String Quartet*, 1989-1990, Edition Peters

Fox, Christopher, *Music as fiction: A Consideration of the work of Richard Barrett*, in *Contemporary Music Review*, 1995, Vol. 13, n. 1, pp. 147-157.

Gerzso, Andrew, *Reflections on Répons,* in *Contemporary Music Review*, 1987 Vol. 1, pp. 23-34.

Grisey, Gerard, *Tempus ex Machina*: A composer's reflections on musical time; Internationale Ferienkursen, Darmstadt, 1980; revised in 1985 for *Contemporary Music Review*, 1987, Vol. 2 pp. 239-275.

Grisey, Gerard, *Les spaces acoustiques*, 1976-1985

Grisey, Gerard, *Le noir de l'étoile*, for six percussionists, tape, and live electronics, 1989–1990, Ricordi Editions

Grisey, Gerard, *Stèle*, for 2 percussionists, 1995, Ricordi Editions

Grisey, Gerard, *Vortex temporum*, for piano, clarinet, flute, violin, viola and cello, 1994-1996, Ricordi Editions

Grisey, Gerard, *Quatre chants pour franchir le seuil*, for soprano and fifteen instruments, 1997–1998, Ricordi Editions

Handel, Stephen, "Timbre, Perception and Auditory Object Identification", chapter 12 pp. 425-459 in *Hearing* edited by Brian C. J. Moore, Academic Press 1995

Haas, Georg Friedrich, *Trois Hommages*, for 2 pianos (tuned a quarter-tone apart), 2 hands, 1982-1984, Universal Edition

Haas, Georg Friedrich, *In vain*, for twenty-four instruments, 2000, Universal Edition

Haas, Georg Friedrich, *String Quartet n.7*, for string quartet and electronics 2011, Universal Edition

Hewett, Ivan; Barrett, Richard, "*Fail worse; Fail better"*, in *Musical Times*, Vol. 135, n. 1813, 1994, pp. 148-151.

Levinas, Michael, "*Transients of Attack and Hybrid Sounds: Toward a new Mixity"*, in *Leonardo Music Journal* – M.I.T. Press, Vol. 4, 1994, pp. 13-15.

Ligeti, Gyorgy, "*States, events, transformations"*, in *Perspectives of New Music*, Vol. 31, n. 1, 1993, pp. 164-171.

Ligeti, Gyorgy, *"On Music and Politics",* in *Perspectives of New Music*, Vol. 16, n. 2, 1978, pp. 19-24.

Mitchel, Melanie, *An introduction to genetic algorithms*, 1996 M.I.T. Press

Murail, Tristan, "*After thoughts",* in *Contemporary Music Review*, 2000 Vol. 19, part. 3, pp. 5-9.

Murail, Tristan, *Lecture. An excerpt,* in *Ostrava Days Lectures*, 2003.

Murail, Tristan, *Target Practice,* in *Contemporary Music Review*, 2005 Vol. 24, n. 2/3, pp. 149-171.

Nattiez, Jean-Jacques, *Music and Discourse. Towards a Semiology of Music,* Princeton University Press, 1990.

Nattiez, Jean-Jacques, *Reflections on the development of Semiology in music,* in *Musical Analysis*, Vol. 8, n. 1/2, 1989, pp. 21-75.

Punt, Michael, *A Postdigital Universe,* in Technoetic Arts, Vol. 1, n. 3, 2003, pp.191-200.

Romitelli, Fausto, *Professor bad trip,* Lesson I, II, III cycle, 1998-2000, Ricordi Editions

Schaeffer, Pierre, *Traité des objets musicaux* (*Treatise on Musical Objects*) 1966

Schreiner, E. Christoph; Read, L. Heather; Sutter, L. Mitchell, *Modular organization of frequency integration on primary auditory cortex,* in *Annual Reviews of Neurosciences*, 2000, n. 23, pp. 501-529

Simmel, George, *The Metropolis and Mental Life* (Die Großstadt und das Geistesleben) 1903

Stockhausen, Karlheinz, *Gesang der Jünglinge*, 1955-1956

Tegmark, Max, *Parallel Universes*, in Science and Ultimate Reality: From Quantum to Cosmos, Barrow, Davies Harper Eds, Cambridge University Press, 2003.

Whittall, Arnold, *Resistance and reflection: Richard Barrett in the 21st century*, in *Musical Times*, Vol. 146, n. 1892, 2005, pp. 57-69.