Doctor Frankenstein, I Presume...
or
The Art of Vivisection

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ABSTRACT

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This essay portrays a composer philosophizing about his Task, his Materials, his Art. Here you will see a composer at work trying to understand the internals of his Craft as honestly and logically as it is possible for him. As guides, the composer will follow the works and writings of some of his personal "heroes", artists from several disciplines: Maiakovsky, Tarkovsky, Pierre Henry, Schaeffer, Paradjanov, Eco, Khlebnikov, Eisenstein, Drummond de Andrade, Dovzhenko. At the end, there shall emerge an awareness of the complex question "how can one approach the musical sound matter ?".

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INTRODUCTION

Writing a theoretical essay on Music is a very delicate issue for me. This is due to my belief that musical theory is a sort of a natural by-product of practical musical work, the result of the attempts to answer questions posed by the sound matter at that very precise moment when one had to decide what to do with it. For me, it is an incongruity to think that one can formulate a musical theory and then according to that theory proceed to practical work. It is as if one tried to answer a question before it was posed. Worse, some even go further and continue answering all the subsequent questions they encounter in the same way.

Indeed, a conscious musician has to construct theories, all the time, about practically everything on the nature of the musical material: the way it manifests itself, the way we perceive and understand it, the ways we can possibly shape it. Not to mention the supreme question of all, why we are doing all that in the first place. But after having addressed a particular problem, I believe the conscious musician has to be prepared to abandon his theories on it. To each incarnation of a question a unique answer must be given. And it is not even about giving a "right" or "wrong" answer but the important thing is to "address" the question in the most honest way. After all, artistic thought and scientific thought do not have the same nature, as Tarkovsky has pointed out. In Art, two completely opposed and

contradictory trends of thought are true and correct when each one is observed inside its own sphere. In this spirit, the result of theoretical work should be not exactly a tool to be used when handling music, but instead, it should be an increase in the perception, agility and clarity of view of the musician's mind. In other words, it is the great art of "problem-solving".

What I propose here is therefore not a standard theoretical work but instead, a picture of a composer at work, a journal-log of his thoughts when he has to deal with the sound matter, to conjure it, to sculpt something with it. Actually, it will portray my own thoughts as I undergo the task of materializing the acousmatic radio-opera KA, my main DMA thesis. There will be a broad range of ideas in this text, from the meaning of Art itself to specific ways of implementing a Musical System. Nonetheless, here I have to point out that my intention is not to analyze my musical piece nor to explain how it was manufactured. Mostly, I will be trying to define the basic propositions that make the very foundations of the Art I am practicing. I will be here presenting my ideas regarding the nature of the musical material itself and the mechanics behind the work of a composer, ideas that were not only the product of my purely musical inquiries but also the product of my observation of how other arts deal with their own elements. I have always believed that all arts have at their very roots a similar impulse, an intention that is common to them all. Particularly, I am very interested in Cinema, since it deals with issues that are extremely relevant to Music, like the flow of Time and Time-Pressure, for example.

This journal-log of mine has a structure of its own, not necessarily governed

by classical scientific dissertation laws. The logic of its presentation is the logic of the succession of events in a laboratory experiment. The purpose of my text is not to present a unified theory with proposition, development, conclusion (even if it does so!) but as I said before, the intention is to take a snapshot of a composer at work trying to understand his materials and his purposes. At the end of my essay a specific subject shall emerge from the multiplicity of ideas: the question "how can one approach the musical sound matter?". But I shall "address" the question, not "answer" it. To me, this seems to be the way a composer should always proceed.

"I offer no doctrine. I refuse to give advice and I shy away from discussions,
but I know that many today are searching for someone to believe in.
To them I say: trust those who seek the truth,
beware of those who've found it.
Question everything, but believe in yourself."

André Gide

quote taken from François Truffaut's film *"La Peau Douce"*

1. Launch

1.1. Space vs. Time

"ASTSU !

In those times they still believed in space.

Little was thought about time. "

The Scientist from the year 2222 (from scene II of KA)

I recently found myself extremely irritated listening to some of my older pieces. The music in them seemed so perfect for me at the time of composition but now, years later, everything in them seems to reveal a deficiency of something crucial. In the middle of the irritation, all of a sudden a phrase came immediately to my mind, mysteriously, with the weight of unquestionable veracity, a lighthouse, Eureka:

"In those times you still believed in space. Little was thought about time."

There I had it. Those old pieces developed in Space, not in Time. In music, physical time is equivalent to Musical Space, not exactly Musical Time! And those old pieces of mine showed a composer ignorant of this principle.

It has been said many times that Music is a time-based art, that Music unfurls in time. Not intending to question this notion (very much on the contrary), I

think it is extremely necessary to understand the exact nature of this "Musical Time". A good point of departure is to observe the different ways in which our senses deal with visual images and with sounds.

An image can be frozen out of time in its totality. When you look in one direction you see instantly everything within your visual field. The sense of visual space and the forms, colors and positioning of the seen objects, all comes instantly to you, independently from the elapsed time it took you to see the image. Visual Space relates directly to physical tridimensional space. The visual shape of an object is apprehended through physical space perception. To our eyes it is even possible to accept the very concept of a frozen image, a picture, a photography.

On the other hand, sounds are apprehended differently. Our ears depend on time to perceive the sonorous space around us. The ear uses time to go through a sound more or less in the same way that a computer scanner moves through a picture. The shape of a sound object is grasped through the sound's development in time: physical time perception. That's why a frozen thing such as a "sound" photography (a sonography) doesn't mean anything to a human ear perception. A sonography ends up existing only in the realm of visual images as a graph of the instantaneous state of a sound to be seen by our eyes. It would be mandatory for a frozen sound to come inside of a slice of time.

The conclusion is that in Music the dimension of Time splits in two other dimensions: Musical Space and Musical Time.

I will explain. Sound can only show its properties, its colorations and its

shape by moving in time, by occupying a slice of time. This "slice of time" is the Musical Space occupied by the sound. It can be measured by standard time units like seconds, beats, or any similar unit. A sound object that takes a large chunk of physical time to show itself is then said to be an object of large dimensions (it therefore occupies a large chunk of Musical Space). Nonetheless, our mind still recognizes the time element in this "time-to-space" exchange and the process of a sound object filling the musical space is considered to contain motion elements to it, a time-motion, to be more precise, an evolution. Because sound is perceived to be moving in time, sound objects will appear to have a trajectory. Now, select an isolated point in this trajectory and imagine that we can actually analyze the state in which the sound object finds itself at that precise given instance frozen in physical time. We are then measuring the psychological entropy of the sound object at that moment, the state of agitation of its musical "molecules".

Obviously, this entropy of the sound object varies through physical time and we can also measure the rate in which it varies, its delta. I will call this delta Musical Pressure and it is to the flow of this Musical Pressure that I give the name of Musical Time, an idea quite alike Tarkovsky's concept of *Pressure of Time* (here referred as time-thrust) and *Rhythm* in Film:

"Rhythm, then, is not the metrical sequence of pieces; what makes it is the time-thrust within the frames. And I am convinced that it is rhythm, and not editing, as

people tend to think, that is the main formative element of cinema." [1]

Three very important concepts are here being hinted at: Musical Space, Musical Time and Pressure. The proper understanding of these concepts is the key for successfully handling musical form. The study of these procedures will then be the study of Montage.

1.2. What are we doing here ?

People come to me and ask: "So, what type of music do you write, what does it sound like?". Flabbergasted, I usually don't know what to say. "I write contemporary music" is sometimes my best effort. Contemporary Music... hmmm. What type of music are the so called "classical contemporary composers" writing ?

The amount of individual labels makes anyone dizzy: Minimalism, Spectralism, Serialism, Maximalism, New Complexity, Post-Modernism, and blah, blah and more blah, just to mention a few. Regardless of whatever uniform one decides to wear, willingly or not, coerced or not, the only truth is the reality of the lack of a common language for western erudite music, that started to be noticed towards the end of the 19th century and only grew exponentially to the beginnings of this 21st century of ours.

It is not surprising that the use of musical meta-linguistics grew so much in

[1] A. Tarkovsky : "Sculpting Time".

the 20th century.[2] Not having a language to speak and facing the impossibility of inventing a language of his own, a composer naturally tends to refer to the old languages handed in by tradition, western or not. And that is a legitimate effort. What is not legitimate is to believe one can create a language on one's own and, worse, then go out with megaphones propagating it as if it were the only salvation for our desperate Babel.

Strictly speaking, a language can only be created by a society. Nonetheless, what you CAN do is to work with a simulation of a language. This may work well in music, since music doesn't mean anything that is semantically concrete. In Music, communication may be possible even if the listener does not possess the "keys to the code".

I would say that music doesn't "talk" about things. Instead, it "shows" things. When you listen to music you have the impression that something was transmitted to you (something unspeakable in terms, but transmitted, nonetheless). This impression happens through the observation ("listening", if you prefer) of the trajectory of some living entity that was materialized before you out of thin air. If you can sense that the sound elements have a mind and life of their own, then information is being transmitted, music appears. If you can't sense this life-force in the sounds, all reverts to non-musical noise.

In music, this "life spark" finds its origin in the use of a musical system, a

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[2] "*Le musicien de notre époque désespère de la musique passé, et remet tout en question*." Roland Manuel

collection of rules of behavior, so to speak. If within a society there is a traditional use of a particular musical system, then this system is considered a musical language, spoken by that collectivity.

Another important element: inside a society, traditional music is usually connected to an idea of social function. This or that piece of music will serve to some actual purpose, that can be from funeral music, to dining music, to the function of making you meditate at the end of an afternoon.

We are supposedly making "Art Music". In a philosophical degree, this is a music opposed to the music for weddings, funerals or military parades, music that has a more down-to-earth functionality to it (I say "in a philosophical degree" because in some capacity these can still remain under the aegis of Art). In a more visceral way, it is a music opposed to the prostituted capitalist-corporate-media "music" of our times.[3]

So, what is "Art Music", after all? I definitely conjure Aristotle and his Cathartic function for Art in general (although the actual scenarios of the modern classical music concerts hardly provide for that, very much on the contrary). Defining a function for our "Art Music", I would say it is to attempt Epiphany; it is to show naked what is utterly human, to materialize the spark of human thought through the medium of sound. And this happens through an unique special act: the

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[3] A Brazilian journalist once defined his views on the difference between Hollywood movies and Art films by comparing Hollywood movies to a prostitute: you pay and get what you want.

"concert" session, or rather, the "listening" session. More verbose, Xenakis put it this way:

"Art, and above all, music has a fundamental function, which is to catalyze the sublimation that it can bring about through all means of expression. It must aim through fixations which are landmarks to draw towards a total exaltation in which the individual mingles, losing his consciousness in a truth immediate, rare, enormous, and perfect. If a work of art succeeds in this undertaking even for a single moment, it attains its goal." [4]

This type of music is of a special nature, it needs to be sipped carefully and thoughtfully.[5]

Back to the notion of music system, in every art there is a level of abstraction and it is in these abstractions that content is "shown" rather than "spoken about". Now, the abstraction in Music is controlled by the musical system. In a world orphaned of a language, what do we do? Exactly how to communicate? Even with all our scientific inclinations, this is the great mystery and here we need a leap of faith.

What interests me the most in contemporary music is its attempt to exist outside the orbit of a Musical Language, marginal, sometimes pointing to some

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[4] Xenakis, I. : "Formalized Music".

[5] Going further with this idea is quite possible. For example, some Indian ragas prescribe that they can be played only in certain special occasions and only during certain hours of the day, or else their spiritual purposes will not be attained.

known Musical Language, sometimes delving into such an individualistic position that it becomes unintelligible except to itself (or even to itself, in some more unfortunate cases). Maybe the best term to describe what we are doing is "Experimental Music", precisely because of its marginal "linguistic" character, because of its "tabula-rasianist"[6] aspirations. The experimental composer desires this "Tabula-Rasa" even though he knows this is unattainable, that history cannot be wiped out. This is a music that tries to speak no Musical Language but nonetheless can't help but to remain informed by all the languages past and present.[7]

An interesting idea: maybe Experimental Music represents to traditional music what Khlebnikov's Zaoum language represents to the spoken human languages. Or even bolder: maybe Music itself is the supreme Zaoum language.

Zaoum language is the language beyond the limits of the rational mind. It is made of incomprehensible words, syllables that the intellect can make no sense of. It is the language of spells and incantations, as Khlebnikov explains:

"If we think of the soul as split between the government of intellect and a stormy population of feelings, then incantations and beyond-sense language are appeals over the head of the government straight to the population of feelings, a direct cry to the predawn of the soul or a supreme example of the rule of the masses in the

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[6] Being a disciple of Khlebnikov, I can't help but to use and abuse the laws of word invention.

[7] Note that I said "remains informed by" and not "appropriates". In this "experimental" field of work, appropriating a traditional language will most certainly lead to disaster.

life of language and intellect, a lawful device reserved for rare occasions." [8]

At this point one may suspect that, indeed, the spirit of Zaoum language reigns absolute underneath all the possible rationalizations we can ever apply to music.

Anyway, there you have it. An Experimental Music is what we are doing.

1.3. Gestures vs. Inner-Life Drama

Speaking about Epiphany, here is one.

I was at some lucky time enjoying a month working in the Italian Riviera (Genoa) and I used to spend two hours everyday at the end of the afternoons walking around observing the sea at sunset. Basically I had two main choices: walk eastbound and enjoy the sunset eating a focaccia in the fishermen village of Bogliasco or walk westbound through the Nervi passeggiata eating a gelato.[9] The sea there has a magnetic quality to it that is tough to explain with words. I just know that I would simply stare at the waves crashing at the huge rock walls of the shore, totally hypnotized. The weather was quite stormy at times and the sea would acquire this menacing come-here-I'll-grind-you sort of look. When the weather was calm, the

[8] Khlebnikov, V. : "On Poetry".

[9] Tough life ...

waters would be incredibly transparent and you could see little waves crossing each other's paths like huge gliding jelly fish.

The upset sea was what really did it for me. The orchestration of the waves crashing and the infinite variety of trajectories and forms of the water exploding against the shore rocks had such a dramatic quality to them that I would sit at a bench for hours under stormy weather watching the whole scene as if it were an audio-visual masterpiece spectacle of some sort.

I have always been averse to the idea of gestures in music. What do I mean by gestures? You know when people that don't speak the same language try to communicate through arm movements and they modulate the tones of their voices to give an idea of what they are feeling? That's what I'm calling gestures. Some musical examples of these are those neurasthenic scale up fortissimo rushes ("I'm nervous now"), expansive melodic lines with dotted "ta-daaaa, ta-daaaa" rhythms ("Here comes our Hero"), imperious bass tone punctuations and those famous "finishes-with-a-bang" endings.

I feel uncomfortable every time I hear a musical fragment trying to communicate moods through such wretched means. I guess in a way one time or another we all succumb to some (hopefully not all) of these little sins. But I'm trying my best. What I saw in the Ligurian waves crashing was an image of what I have been looking for and trying to do in Music.

The waves weren't trying to "show off" their beautiful choreography. The fact is that no matter if there were spectators or not, the sea would behave just the

same. It was not there for your amusement. It would calm down and let the sun shine through it whenever it felt like it, or it would swallow the whole pier in a splashy grinding blast if it fancied so, or at times it would just simply stay still, nothing there to see. It didn't TRY to say anything to an observer. But to a spectator, just the observation of the sea living and being itself would be enough to arouse such deep emotions that one could see the whole tragedy of mankind mirrored in it. This is quite similar to a piece by J.S. Bach where the musical elements just dwell there breathing and unfolding according to their own inner life, oblivious to a spectator. My pieces have been tending towards this idea for quite some time now (I think since the Lisboa piano pieces) and my experiments with electroacoustic music served to further direct my listening in this direction. This idea is totally in syntony with my conception of music not "saying" things but "showing" things. The listener is not addressed directly, he is no target. But the listener, if he wants to, that is, can follow the trajectories of the musical objects, their adventures. If everything is done right, the lives of the musical objects would seem to be endowed with a human soul (therefore bearing this great burden) and the image of a human pilgrimage will be reflected back to the listener. Communication of a different level than a semantic one has just been achieved.

This idea of an "inner-life" of a musical object is of utmost importance to grasp the concept of musical TIME, that is quite different from the actual physical time that flows in hours, minutes and seconds.

1.4. The Composer's Task

It certainly seems that Music contains a semiotic process. But how and where does it happen ?

I tend to find attempts to "grammarize" music[10] (as if the truths found in the spoken languages could still hold true in Music as well) quite dissatisfactory and actually even harmful to Music itself. This tendency seems to go against the very inner nature of Music and it certainly robs music of the uniqueness of its semiosis. Please note that what I am going to try to sketch below is my idea of a communication that is strictly "musical". Beyond its scope would be any system of meanings generated through the medium of extra-musical ideas, for example the use of the popular Russian tune "Dark Eyes" inside R. Shchedrin's orchestral piece "Old Russian Circus Music" to symbolize specific ideas from the tradition of Russian circus, or a more obvious extreme example, section III of L. Berio's "Sinfonia". If a musical piece makes use of extra-musical elements as signifiers (like elements taken from Music History or elements from the composer's own personal memories), the success of the transfer of the information will totally depend on the listener having the keys, the knowledge of all the references used. Therefore, the study of the mechanisms of extra-musical meaning will be soldered to a study of the total

[10] Here it is interesting to notice that in general the ideas for Musical Semiotics tend to revolve around the orbit of Information Theory and code design. For a nice start, see *Musical Semiotics in Growth*, a compilation of essays edited by Eero Tarasti.

perception of a particular type of listener.[11] I am afraid the scope of such study may be too broad and its results too generalized or particular to be of any use for an experimental composer that is not concerned with the extra-musical.

Back to the track. One can think that if a Grammar for a spoken language is a collection of rules to form words and phrases and if a Musical System is a collection of rules of behavior that shape the musical objects, then these two ideas are therefore related. But they aren't. You just have to analyze the nature of the relationship between each "shaping agent" and the material it forms (the "shaped matter"). The grammar of a language directly shapes and informs the semantic content of a phrase, its actual meaning. It encodes and decodes the meaning of the phrase. On the other hand, the Musical System indeed does shape a musical object, but it has no direct influence on the meaning of the musical passage, its function is only to make possible the establishment of connections and relationships between the sounds, all done without endowing the sounds with any actual semantic content. Another difference is that the vehicle of the spoken language (sound) becomes, at the end of the process, irrelevant and forgotten, only the actual message remains. In Music, the vehicle, the sound, is what is there to be "seen". There is no message.[12]

The semiosis in Music happens exactly at that moment when the listener thinks he has seen human life (and therefore himself) reflected in the sound

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[11] Umberto Eco's ideas on the Model Reader in his book "Six Walks in the Fictional Woods" are particularly enlightening on this subject.

[12] See Pierre Schaeffer's explanations in his "Traité des Objets Musicaux", paragraphs 17,8 to 17,11.

structures. The listener observes the behavior, life and evolution of a sound structure and that ultimately will stand in his mind for a human destiny of some sort that differs according to each listener's individual psychology. The musician who conjured the musical sounds is obviously intentionally providing the means for this process to happen, but he will have absolutely no control of how this actually happens in the mind of the listener.

I would say that Music should not try to communicate directly to the listener. The more someone's piece of music tries to say something to someone, the more it will betray this very nature of Music's own unique communication process. The music objects have to be oblivious to external observers, they should be allowed to live by themselves, relate only to themselves. The composer of Music should endow each of his musical objects with a soul as unique as a human one is and he should provide a setting for these objects to live (and/or die), breathe and interact.

Someone may ask: in this way, isn't the composer alienating the listener ? Not really, quite the opposite. Indeed, here the composer does not conceive the musical objects in a piece so that they face and talk directly to the listener, communicating a precise meaning defined by the composer. Instead, what the composer does is to make sure (by fully understanding and applying the mechanisms of this musical communication) that his construction is pregnant with "latent meaning", a meaning that only defines itself inside the listener's own mind, through his active listening work. Musical semiosis is like an alchemical transubstantiation that takes effect inside the listener, where sound matter becomes Epiphany.

We can now attempt to define the tasks involved in the work of a composer. Supposing that the composer has the technical knowledge of the musical sounds utilized, scientific knowledge of sound itself (because musical sounds are a subset of the whole collection of natural sounds available), and supposing that he possesses accomplished manipulative powers (craftsmanship) at his disposal and control to construct musical objects using the selected musical sounds, the task of the composer is twofold with an addendum, as follows:

1. The composer takes the raw sound matter and transforms it into musical sound matter, that is further organized into musical objects. He has to imprint a soul and the possibility of a destiny upon each sound object, and he creates a musical "physical" world for them to live in. This task is accomplished by means of the creation (and/or definition) and application of a systematic way to assemble and develop the sound matter: rules of behavior, codes of conduct, in other words, a Musical System. Obviously, there can be as many musical systems as there are sound constructs, as many sound constructs as there are human beings, and the more similar two musical systems are to each other the more the sound constructs generated with them will relate to each other.

   In fewer words, here the composer proposes to populate Musical Space through the means of a Musical System.

2. The composer proceeds to create the actual History of the life development of

those created musical objects. It is the process of actually setting the created universe in motion. This task is accomplished by exercising the orchestration act, or in better words, it is accomplished by Montage technique, in the true all-encompassing meaning of the word.

Here the composer allows his created universe to flow in a precise manner, carefully controlling the way in which the destinies of the musical objects intersect. It is from the nature of these intersections, the shock of the internal elements of the music, that "latent musical meaning" is created, very much like potential energy, generated and stored inside a system, just waiting for the opportunity of liberation. It is prerogative of the listener to liberate and to use up this energy. In fewer words, here the composer proposes to maneuver Musical Time through the use of Montage.

3. To ensure that a piece of music created in this manner will allow the aforementioned mirroring semiosis (the liberation of the "latent meaning" energy by the listener), the composer uses his own psychology to guide his hand. He uses himself as a guinea-pig, as a proto-listener. Nonetheless, the composer understands that the real listener will see whatever he (the listener) wants to see in the music.

Here, the composer acknowledges two things: that he shall use his own Listening as the guiding hand for the two tasks described above and that the veracity

of a potential external listener actually being able to extract any meaning from the music is a LEAP OF FAITH !

2. Definitions

2.1. A Network of Sound Relationships

In a spoken language, the correspondence between a signifier (a word, for example) and the signified (the idea it stands for) is not exactly a one to one relationship. Whenever one decides that a word will stand for an idea, this word is actually positioned inside an infinite web-like system of meanings (denotations and connotations) where this new word is put in relation to other words and/or signifiers that represent similar, opposing and/or complementary or supplementary ideas. The actual final idea represented by our original word will arise from the sum (the resultant) of all the elements in this network of connections.[13]

When we observe a non-semantical form of a semiotic process like Music, where the "token-signifiers" bear no actual concrete signified meaning, neither individually nor collectively, we notice a kind of metaphor for that network. In this "metaphorical" virtual network we place tokens (recognizable units of some sort) against other tokens forming a closed system.

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[13] Eco, Umberto : A Theory of Semiotics.

Thus positioned inside this network of tokens, a token refers back to other tokens according to their similarities and differences and the token starts pointing at them with varying degrees of intensity, according to the case. All is done without establishing an actual message at the end of the process. For example, imagine an orchestral piece of music where thick tutti and solo instrumental passages alternate. The solo passages will naturally refer one to each other, they will seem to belong to the same "clan", and they will be intuitively placed in opposition to the tutti passages, and vice-versa. Internal similarities between two solo passages will serve to further strengthen their connections. A solo that shares materials with a tutti passage can be seen as a linking element between those two "clans".

In this way, when presented with one of these token networks, a person tends to analyze the similarities between the tokens, both in macro and microscopic levels, and then proceeds to draw vectors of varying intensities interconnecting the token-points, thus assembling a web of relationships of similarities and oppositions.

Dealing more specifically with Music, we use physical time as the space where we "hang" the tokens, the sound objects. From the fact that physical time (so far, at least) never stops nor rewinds, we conclude that the agent that makes it possible to comprehend and "visualize" this network of connections is Memory. A person who is absolutely unable to form recent memories of any kind would be also incapable of perceiving any musical relationships between different sounds or sound

objects.[14]

Generally speaking, macroscopic musical relationships, like formal and motivic structures, are easier to perceive in a conscious manner by our memory. Microscopic structures, like intervallic relationships (melodic or harmonic), in some degree tend to be perceived in a conscious manner only by those listeners who possess musical training in the tradition of the piece heard. Untrained listeners tend to perceive those microscopic relationships in an unconscious manner, if they can do it at all. When listeners trained in one tradition hear a piece from another tradition they can't help but to draw parallels between those two traditions. In either cases, the fact is that the macro and microscopic interconnections between the sound elements will be perceived part consciously and part unconsciously, according to the degree of musical training and the attention of the listener.

What about our language-orphaned "Experimental Music" defined earlier? How can a listener relate to it in an objective way rather than in a subjective one? In a certain way, the composer himself would be the only trained person in his own "tradition".

Let us imagine the hypothetical very beginnings of a Musical Language. Imagine the first of its musicians facing the raw natural sound world with a necessity, a function for the sounds in his mind. According to his and his society's needs he has to decide which sounds to consider musical and in which manner to proceed arranging them in constructs. Eventually he will invent a set of procedures that will adequate

[14] Of course this would surely be the smallest problem faced by this person.

his sound manipulations to the purposes he and his society find for the music. With his musical descendants taking those procedures further and creating a tradition within that collectivity, a Musical Language is formed. In a way, every musical tradition, or better put, every Musical Civilization is a more or less independent attempt to answer basic questions posed by the sound matter itself. Examples of such basic questions could be:

- What is a musical sound, as opposed to noise ?
- What is a musical instrument ?
- How to qualify and classify musical sounds ?
- Once I classified them, how to organize their pitches, durations, timbres ?
- How to superimpose sounds ?

We can go on and on with this list and even address more complicated questions like "what is a polar (or tonal) center?", "what is a mode?", "what is a tuning system?", etc. The important is to notice that each Musical Civilization faced these archetypical sound problems and provided its own tentative answers.[15]

Operating marginally to a tradition, Experimental Music deals with these musical problems in a raw format, before they were put in some specific shape or

[15] Since Art (and therefore Music) is a cultural phenomenon, it is irrelevant to try to connect the idea of observation and conformation to the physical properties of sound with the idea of correctness and beauty for a musical system. A Musical System can be "correct" and "beautiful" even if its postulates disregard the most basic physicalities of sound, like the harmonic series for example.

form of presentation by this or that musical tradition. Obviously, an Experimental composer has much to gain by observing how different traditions (other than the one he happened to be born in) deal with these archetypical sound questions.[16]

Such an experimental composer has to reinvent the wheel by himself over and over again every time he decides to create music. It is like an architect who has the knowledge of all the different historical types of windows ever conceived, but doesn't allow himself to draw a window unless he achieves a "conception" of one. He puts himself in the skin of the very first human that built a hut and had the crazy idea of opening a hole in the wall for light and ventilation. The intention is to understand what it means to "conceive" a window. A real artist cannot afford to be repeating known formulas, even his own. Here one has to make sure that one can differentiate what is "new" from what is "novelty". As Maiakovsky put it:

In verse composition, innovation is obligatory. (...) Innovation does not, of course, mean the constant uttering of unprecedented truths. Iambics, free verse, alliteration and assonance cannot be invented every day of the week. But one can work on their further development, application and dissemination.[17]

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[16] Actually, we can't disregard the fact that Experimental Music can also make use of references to known traditions also as a means for drawing relations between musical materials. Let us just hope "reference" doesn't turn into indiscriminate "appropriation". On another hand, some full fledged semiosis can start to happen in an extra-musical context. A good example would be when the appearance of gamelan music inside a musical piece is taken to stand for "Bali", or "Orient", or "my Indonesian friend". But such speculations belong clearly to the extra-musical realm and are therefore beyond the scope of what is purely musical.

[17] Maiakovsky, Vladimir : "How Verses are to be Made".

Recapitulating, now in the proper order:

There is an original human necessity for Music. Face to face with the raw sound matter itself, basic archetypical sound questions are posed. As an attempt to address these questions, a set of rules of behavior and conduct codes are then created to adequate sound to our human purposes. The next step is to notice that this set of rules (a Musical System) imprints specific qualities upon the sound constructs and these can now be upgraded to musical objects. Memory makes us able to track these objects (through the listening act) and to place them according to their similarities and oppositions in a web-like network of connections.

Here we have just graphed the need for a Musical System (function, purpose), its instantiation (the tentative answers to sound questions) and its consequence (network of relationships: comprehensibility). We have also localized Memory as the faculty necessary to carry this effort.

We pointed out the particular position that Experimental Music occupies in its desire to rethink the very internals of Music. In these days, you can expect the conception of a Musical System to be a necessity, an unavoidable compositional task.[18]

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[18] Again : "*Le musicien de notre époque désespère de la musique passé, et remet tout en question*." Roland Manuel

2.2. Orchestration: Montage

An interesting subject: the art[19] of blending sound matter. The boundaries of this task can maybe even be extended to encompass the whole act of Composition itself. More traditionally, one thinks of musical instruments, how to handle their sonorities simultaneously. And outside tradition?

I've always liked this example of a forest. If we are speaking about heterogeneous sources of sound, this is certainly their kingdom. At first, no matter how interesting the forest noises may be, they're just colorful noise in their natural state. But then, like a puppet-master you start deciding when the trees should creak, you start controlling the entrances of the birds, the rate at which the wind blows on the tree leaves. Orchestration is all about this very act of imprinting a sense of will upon the ensemble of various sounds. Here one thinks of all the possibilities: densities, textures, coloration, positive and negative values, as well as zeroes: silence. You evaluate the multitude of sounds available at your disposal at that precise moment and you then deploy what is necessary. I'm thinking not only vertically but horizontally as well. Not only the organization of different timbres but of different pitches, the timing of the entrances, the shapes and movements resulting from the montage of the various sound units. Even more, from a bird's eye view it can be also the timing of the entrance of the timings: musical form.

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[19] Although one can (and should) scientifically study the properties of a particular sound and the effects of its combination with others, this "Orchestration" act is not a Science, but an Art.

Montage ... Indeed. Montage is the very essence of this "orchestration" of mine. It is at this point that the scope of the idea bloats and touches the idea of composition itself: how to put things together.

I can already propose a definition:

Orchestration:

The act of organizing sounds that are heterogeneous in nature.

By heterogeneous sounds I mean sounds that are different from each other. But when are two sounds considered to be heterogeneous? Actually, can two sounds be anything else than different? Re-phrasing: can two sounds ever be considered the same? Two different piano tones in some capacity already qualify for being heterogeneous. But even going further, if you want to have EXACTLY the same sound repeated, that can only be achieved through artificial means for no physical sound producing device can play exactly the same sound twice. Worse: even if you can achieve this, the fact that the sounds happen in different points of time already makes them dissimilar. Conclusion: strictly speaking, no two sounds are the same.

Another twofold conclusion: being too strict with our definitions make the boundaries of the field of Orchestration grow and go as far as invading the more traditional concepts of Harmony, Melody and Form. The more we start accepting the concept of homogeneous sounds (i.e. sounds that are similar to each other), the more the boundaries of Orchestration will shrink towards its traditional limits.

Once the concept of homogeneity is accepted in some capacity, interesting sets of combinatorial possibilities could be investigated, like:

- Heterogeneous sounds from heterogeneous sources (ex: C4 on a trumpet versus a piglet screaming) ;
- Homogeneous sounds from heterogeneous sources (ex: C3 arco on a viola versus a C3 arco on a cello);
- Heterogeneous sounds from a homogeneous source (ex: C4 pizzicato on a cello versus a C4 arco col legno on the same instrument) ;

Anyway, at this point it suffices to notice that the problem of putting different things together can be seen through a myriad of different points of view and that these different points of view will sum up to the very act of composing.

Maybe the phenomenon I'm trying to define may be better referred to as Montage instead of Orchestration. A generalized all-encompassing concept of Montage.

2.3. The Filter - Paradjanov

I have explained before my idea of the composer as a person who creates a miniature of a universe (using himself as a proto-listener) with the hope that some

other human may see a reflection of humanity (of himself, the listener) in it.[20]

It is time now to introduce a new idea of great implications: the Filter.

Imagine that we have film images of an alley X. No one can deny that there is a marked difference between looking at the alley X on a screen and looking directly at it in the real world. It is something that goes way beyond the simple fact that one image is "real" and the other is an "illusion". A fundamental idea seems to have been added to the film image, something that can't be found in the real world image: it is as if we were seeing alley X through someone else's eyes. We see the images after they were passed through the very guts of another person.[21] A great photograph is one that is somehow tainted with the psychology of the photographer, his eyes. We can say that the image is then "filtered" by the artist. This is arguably another of the main functions of Art itself: to allow one to experience a reality through someone else's point of view.

In a way, this filter acts in the opposite way real physical filters for liquids or gases do: whatever passes through this artist-filter is "soiled" in some degree by the individuality of the artist. The goal of the artist is to understand and develop the nature of his own internal filter. Developing his own filter, an artist has to forge an amalgam of several and sometimes conflicting elements: the baggage of the artist's

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[20] Of course, this idea extends as well to the other Arts.

[21] Wim Wenders, in his film "Lisbon Story", develops brilliantly the reverse of this idea when one of the characters decides to walk through the city of Lisbon with video cameras strapped to his back so that he could deliberately achieve virgin images, untouched by the filthy capitalist fingers of human beings.

own upbringing and of his posterior education, the effects of the physical (land) and human (society) landscapes that have surrounded him all his life, the artist's personal experiences and history, the nature of his logical conscious mind and, last but certainly not least, the mysteries of his unconscious mind.

This artist-filter has to be cleansed from everything external to the individuality of the artist. That doesn't mean that the artist has to purge his work of the world that is external to him. Instead, the artist has to learn to select and keep only the external world elements that are an intrinsic part of his own individuality (because above all, humans are social beings) and he has to balance it against the universe of his own private thoughts, images and unconscious mind. This purging/selection process is a lifetime task and it is perhaps one of the biggest challenges for an artist. By being unselective with the external world elements, the artist becomes a mere puppet of his education and risks leaving little of himself in his work, therefore turning it irrelevant to another person as an artistic statement. Conversely, by totally purging his work of the external world, leaving only his internal, private conscious and unconscious minds, the artist will run the risk of turning his work into an undecipherable hieroglyph, incomprehensible for anyone other then the artist himself. The best example I can find of an artist that maneuvered back and forth from this idea of complete, total purge of the external elements is the film-maker Sergei Paradjanov (1924-1990). My comments here concern two of Paradjanov's most famous films: "The Color of Pomegranates" (1969) and "Ashik Kerib" (1988). The first will be seen as being made with a Filter that borders that

total individuality threshold, turning the film style so arcane that in some sense it almost ostracizes the viewer. The second will be seen as the result of a Filter magnificently balanced.

To watch "The Color of Pomegranates" is a shocking experience. In this film the sense of universalism (by means of an "ethno-portrait") that we see in his other films (like "Ashik Kerib", "Shadows of Forgotten Ancestors" and "The Legend of the Suram Fortress") is gone, substituted by the solitary individualism of the portrait of an artist. Here, the subjective world of the medieval poet Sayat Nova is materialized through the use of the own subjective world of Paradjanov's mind. The viewer has to have an insurmountable amount of strength and curiosity, otherwise it is easy for him to feel that he was left totally alone and drowning, afloat without a single support to hang on to. This movie is maybe one of the best examples of an artist who throws the external viewer completely inside the deep space of the artist's own mind. You can feel the artist's supreme honesty and the incredible act of concentration it required, but the curious thing is that instead of achieving unlimited comprehension (as one might have expected), he is close to achieving a schism, because the film imagery ends up being seen, on one hand (inside the film-maker's own mind), as a complex system of imagetic symbolisms, and on the other hand (for the external viewer), as a succession of keyless unknown symbols. The internal elements of the work seem to be afloat, arcane to the viewer. Like an extraneous foreign body, the viewer is running the risk of being rejected and expelled from the film.

Another totally different experience is to view "Ashik Kerib". It is one of my

favorite films of all times and here I sense the presence of an agent that easily and gently keeps the whole ensemble of images grounded. The imagery used is very similar to the one in the "Color of Pomegranates" but there is something in the use of the external human world references that anchors the whole work down and allows the individual world of the author's own mind to shine through in a strange and new meaningful way. Paradjanov here makes use of archetypical story-telling devices, complete with masks, dances, allegorical characters, situations and places, everything coming in a guise of a stylized Armenian story-telling tradition. This stylized "tradition" becomes the very anchor that allows the individual world of the artist (the symbolic interplay of colors and imagery, the artist's own "symbols") to be "decoded" in some capacity by the viewer. The viewer sees those arcane symbols under the surrounding light of a world that, although foreign (at least for me, a western person), is somewhat recognizable, strangely universal. In the mind of the viewer, this "light" becomes the catalyst that allows the more arcane elements to react effortlessly and yield meaning, according to the own psychology of the viewer.[22] In "The Color of Pomegranates" there is no catalytic agent, and the whole film can remain inert in the viewer's mind (in a way, it can only "self-react"). It would be quite correct to say that, like Zaoum language, this film bypasses the intellect of the viewer and reaches his depths directly. Nonetheless, "The Color of

[22] For some interesting observations on the impossibility of trying to identify an absolute "decoded" meaning for colors, smells and sounds independently of the particular psychology of the interpretant, see S. Eisenstein's "The Film Sense", particularly the essays "The Synchronization of the Senses" and "Color and Meaning".

Pomegranates" could not have been realized in another fashion. In some sense, the subject of the film itself required the film to be realized in that way. And if we try to watch it, it's precisely to be totally immersed in Paradjanov's unique imagery and to be guided by his hand. And there is something of profoundly Musical in all this.

Dealing with Music we may be in for an even bumpier ride.

Back to the concept of a Musical System, we have already estimated the importance of its function when it takes natural sounds and turns them into inter-related musical sounds. We have seen also that the composer uses Montage as a means to operate Musical Time, putting together sound objects according to their relationships and relative Musical Pressures. Together, Musical System and Montage form the Filter of a composer. This Filter is also twofold, as described before (external world versus internal world components), and the balance of the whole system is of utmost importance.

It is not too difficult to create a musical world alien to any external world conceptions of music. But this music will surely tend to ostracize the listener. On the other hand, it is very easy for a reasonably intelligent trained composer to let everything go through the Filter, indiscriminately. This composer will probably be a stranger to his own voice and his music will be of doubtful artistic value.[23] I have met musicians who could write "perfect" minuets in the style of Boccherini, sonatas in

[23] It is a modern plague to allow this indiscriminate Filter aperture to happen "purposefully" and afterwards organize the bits-of-this-bits-of-that according to extra-musical concepts. Proceed at your own risk...

classical style, Viennese waltzes, Webberian Broadway musicals, blah, blah, but were totally incompetent to conceive an Idea of Minuet, an Idea of Sonata, an Idea of a Musical. They seem to be able to reasonably mimic any musical style of the tradition they have grown in but yet, they seem to have never stopped to think about the essentials of what Composition is all about.

For now, what we said about this Filter matter shall suffice. We should just remember that the actual balance to be applied to the filter will vary from artist to artist and will ultimately stand as the artist's own signature. We have discussed the Filter's existence, the nature and consequences of its behavior. As far as its actual implementation is concerned, I can only speak for myself, for my own Filter. Artists have the obligation to figure this out for themselves. Here, we can only try to point the way, while we ourselves struggle with our own things.

2.4. Ear and Listening

From the composer's point of view, what is called the Ear will be exactly what I just defined as the Filter. Listening would then be the act of sending sound matter through that Filter, through the Ear.

This cannot be so from the listener's point of view. For him, Listening has to be something else!

2.5. The Position of the Listener

We have already commented on what would be the functions of Art (and therefore, of Music as well). By now I am convinced that the honest person that looks for a work of Art is definitely in search of something important for him, something that can cause a transubstantiation of some sort inside him.

Nonetheless, there are still some things to be analyzed from the point of view of this external observer, namely, his willingness to surrender himself to the hands of the artist and in which degree he (the observer) allows that to happen, thus accepting the integrity of the artist's Filter in some capacity and opening himself to what the artist has to show. Here I want just to comment quickly on the profile of the Honest Listener (or Honest Art onlooker), to localize the most profitable position for his point of departure as a Listener.

The transubstantiation, the Epiphany that Art makes possible, is closely connected with the fact that one observes an universe through the artist's lenses, his Filter. The very same subject cannot (and if it could, should not) be seen in the same manner by two different artists. This is why upon entering a work of Art, the onlooker should leave at the door all expectations. He has to trust the artist's hand and permit his guidance in full, without reserves. I know, bad drivers certainly make for the most of our fears of this kind of surrendering, but there are those magical rare occasions when one feels that indeed there is really someone at the steering wheel, and we just relax and enjoy the ride. And we are so happy afterwards ...

2.6. Pause: Tarkovsky

"I cannot in fact understand the problem of an artist's so-called 'freedom' or 'lack of freedom'. An artist is never free. No group of people lacks freedom more. An artist is bound by his gift, his vocation.

On the other hand he is at liberty to choose between realizing his talent as fully as he can, or selling his soul for thirty pieces of silver. (...)

I am also convinced that no artist would work to fulfil his personal spiritual mission if he knew that no one was ever going to see his work. Yet at the same time, when he is working he must put a screen between himself and the other people, in order to be shielded from empty, trivial topicality. For only total honesty and sincerity, compounded by the knowledge of his own responsibility towards others, can ensure the fulfillment of an artist's creative destiny."[24]

2.7. Musical Object

A musical object is a complete musical idea. It is a collection of sounds of any size, small or big, that encloses in itself a single and recognizable complete thought. Because it represents a complete thought, it has a definite beginning and an end, its boundaries can be assessed. Because it is recognizable, it can be repeated, varied,

[24] A. Tarkovsky : "Sculpting Time", chapter VI.

transmutated, combined with other objects, traced by our memory.

According to its "main course", to its foreground main ideas, a musical object can be said to gravitate between two poles: static or dynamic.

In the "static" musical object the spotlight is focused on the constituent sound elements themselves. Here the object always presents its internal elements in an arrangement, a snapshot. This "frozen" arrangement of sounds obviously can be broken down, varied, recombined, etc. One could say that here the sounds always appear in "bouquets". Western tradition musical themes in general could be said to be musical objects revolving around this "static" orbit. Here are some random examples: the "idée fixe" in Berlioz's "Symphonie Fantastique", the famous two chords from the beginning of the Coronation scene of Mussorgsky's "Boris Godunov", the opening bassoon solo melody in Stravinsky's "Rite of Spring". Still within western tradition, sometimes a single motif can acquire so much significative weight that it becomes an object in itself, for example, the famous four notes of Beethoven's fifth symphony.

In the dynamic musical object the spotlight is focused on the internal evolution of the constituent sound elements. A "dynamic" musical object presents itself as a recognizable set of sounds in constant movement, constant peregrination. Some random examples of objects revolving around the "dynamic" orbit could be the single note unison voyages in Giacinto Scelsi's "Anahit", the notorious repeated chords in the "Augures Printaniers" of Stravinsky's "Rite of Spring", the thematic clouds of chords in La Monte Young's "The Well-Tuned Piano", the upwards voice

glissandi in the "Six coupes de colère" in Pierre Henry's "L'Apocalypse".

In reality, all musical objects fluctuate somewhere between these two antipodes. The "static" nature refers to operations in Musical Space, the "dynamic" nature, to operations in Musical Time.

2.8. Musical Instrument and Pseudo Musical Instrument

Pierre Schaeffer defined a musical instrument as being a sound producing device endowed with three characteristics. First, the device has the property of endowing its sounds with a particular timbre, a *"marque d'origine"* that allows us to recognize all the sounds as coming from the same source. Second, the device possesses a gamut of possible physical manipulations that, when applied, produce the gamut of available sounds. Third, it possesses a collection of playing modes, of manners of playing, in other words, a playing style.[25]

Although the devices used to manufacture Electroacoustic Music (including the computer) in themselves do not constitute musical instruments, they can be used to produce pseudo musical instruments, that is, virtual instruments that do not exist in the real world but nonetheless possess the same three characteristics of a musical instrument: an origin mark (timbre), a gamut of possible sounds and a style of playing.

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[25] Pierre Schaeffer, "Traité des Objets Musicaux", 2,4 to 2,5 .

From works by Pierre Henry, the master-inventor of pseudo musical instruments "*par excellence*", I can cite as examples of virtual instruments the door in *"Variations pour une porte et un soupir"*, the voice of François Dufrêne in *"Granulometrie"*, and the furious "bird" cries in the *"Divinités Irritées"* movement of *"Le Voyage"* (as a matter of fact, also constructed out of Dufrêne's voice), among countless others.

2.9. Montage

Although we are accustomed to seeing this word more in the context of Film technique, the concept of Montage is hardly a purely cinematographic one. Eisenstein defined it as being the process in which two elements are deliberately put together so that from their juxtaposition a third idea is formed, one that is not the sum, but a multiplication of its constituent elements:

" (...)Two pieces of film of any kind, when put together, inevitably create a new concept, a new quality, that rises from the juxtaposition. This is not, in any way, a characteristic of cinema alone, but a phenomenon found every time we deal with the juxtaposition of two facts, two phenomena, two objects." [26]

[26] S. Eisenstein : "Word and Image", in "Film Sense".

And he goes further to define Montage as a "chemical reaction" between Representations with the end result of an Image:

"The representation A and the representation B must be selected among all the possible aspects of the subject that is being developed, they must be searched for so that their juxtaposition - that is, the juxtaposition of these very elements and not of others, alternative ones - produce in the perception and in the feelings of the spectator the most complete image of the subject itself." [27]

You here notice how myopic is the general understanding of the word Montage (the fast cut between different image planes in film, the fast cut between different musical sections in music, for example). The definition given by the Webster Dictionary, for example, further helps to increase the short-sightedness:

*"**montage**, n. a composite photograph made by combining several separate pictures ; an artistic composition made up of several different kinds of items (as strips of newspaper, pictures, bits of wood) arranged together."* [28]

Of course, this is nothing but the instance of one of the infinite shapes that

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[27] S. Eisenstein, Ibid.

[28] A far more successful definition is given by the French Larousse dictionary, isolating correctly the germ of the idea: *"montage: Action de disposer les parties d'un ensemble."*

Montage can assume. Montage goes way beyond this simple definition and its consequences are much more far-reaching.

Even in Eisenstein's ideas there is an essential element missing. Tarkovsky pointed this out when he wrote that Eisenstein *"allowed the construction of the image to become an end in itself"*, presenting the audience *"with puzzles and riddles, making them decipher symbols, take pleasure in allegories, appealing all the time to their intellectual experience."* [29]

This is probably what happens when an artist starts turning his art into the proof of a theoretical concept. The artist loses touch with the basic principles of Art itself and allows his theories to corrupt his products.

Back to Tarkovsky, he goes on and describes the nature of the missing element:

"*Editing* [montage] *has to do with stretches of time, and the degree of intensity with which these exist, as recorded by the camera; not with abstract symbols, picturesque physical realia, carefully arranged compositions judiciously dotted about the scene."* [30]

And Tarkovsky then localizes the source of Eisenstein's mistake saying that

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[29] A. Tarkovsky, in his book "Sculpting Time".

[30] A. Tarkovsky. Ibid.

"he failed to put into the edited pieces the time-pressure required by that particular assembly", he ignored the *"need to fill the frames with the appropriate time-pressure"*.

Agreeing with Tarkovsky, I believe that Eisenstein did allow himself to be blinded by his own theories and, too busy occupied with the "chemical reactions" themselves, he forgot to consider controlling the intensity and speed in which the reactions propagate.

Paying attention to Time is far from being an easy task and even if you can localize the question itself, even if you can pose to yourself the problématique of Time's existence, it is a long, long road to actually be able to control its dramatic possibilities in expressive terms. Even the greatest artists can be found sometimes bruised struggling with this concept. I watched recently Mikhail Kalatozov's 1964 film "I am Cuba" and noticed the same problematic questions. The cinematography possesses a supreme beauty, the images and camera movements soar, but you can't help but notice Time getting stuck in the frames, you feel that the scenes are somehow chained to an iron ball. The amount of calculated energy you see in each image doesn't seem to inform the whole ensemble of images in a way that sets everything in an irresistible motion towards a north.

Examples of successful pieces are extremely rare (and therefore, precious). Among my favorites are the silents "Arsenal" (1929) and "Earth" (1930) by Alexander Dovzhenko (1894-1956), a contemporary of Eisenstein. He worked with a similar concept of Montage but he seems to have understood in exact terms the

nature and implications of what both Eisenstein and Tarkovsky were talking about, and he was able to apply them with mastery in the most expressive way. A curiosity is that, in these films, the pace, the rhythm in which the images evolve is so powerful that it tends to reveal blatantly the poor hand of the movie release companies and their bad musical judgement. The clash between their added music and Dovzhenko's images is so strong that it forces you either to quit the film altogether or to turn the sound totally down. The music and the images seem so uncoordinated from each other that at the end one thing rejects the other in the most painful way.

Back to Music, I strongly believe that Time in Film and Musical Time have the same nature. Maybe I can see this more clearly now, after several years working intensively with electroacoustic music, a medium where the closeness to Cinema can be much more easily felt. Anyway, I think it is the visual aspect of Cinema, its closeness to real life, that makes it easier to comprehend the idea of the passage of Time. The matter seems clearer when we are dealing with images rather than with sounds. A musician can make use of Cinema as a means to catch a glimpse of what Time is and can be, and to certify himself of its existence. With his ears fine-tuned to the perception of Musical Time, a musician is now in the position of thinking about its manipulation.

2.10. How does a composer approach Montage ?

It is very easy to succumb to the temptation to think of Montage as being

one single monolithic entity. Montage is effectively like the atom: you first think it is indivisible and then, as you probe it further, it opens and splits itself into several smaller parts that, in their turn, further subdivide more and more, and the process goes like this, perhaps infinitely. Therefore, there will be microscopic and macroscopic montages. They start at the very "atomic" level of the sounds (pitches, durations, timbres, or even more microscopic, frequencies, decibels, envelopes), they escalate to measure-to-measure, object-to-object montages, and proceed all the way up to the very Form of the piece, the grand montage of all montages.[31]

Because we are dealing with an art form, there will be infinite ways of tackling the problem of Montage. Every artist will have an individual way of approaching it and here I can only speak for myself. Nonetheless, I will, through the description of how I myself face this question, try to see if there is a general, more universal point of departure for this task.

So, how do I tackle Montage ?

I first remind myself of my initial objectives, the subject of the particular work I'm composing, my motivation to write it, whatever it is, and I spend some time creating musical objects with that motivation in mind. Then, I take every one of the objects I created for the piece and I attentively Listen to them, one by one, paying attention to the Musical Pressure they create. When I believe I am properly

[31] The idea of Musical System here reveals itself as an element inside the Montage process, it appears as a systematic way of handling some of the microscopic montages, maybe even some of the macroscopic ones (but definitely not all of them).

understanding their Pressures, I proceed to study the effects of the juxtaposition of those objects, evaluating the possibilities that rise from the clash of the different Pressures and their relevance and application according to my initial objectives.

I am then able to propose a sketch for the flow of Pressure, according to the final effect (the Eisensteinian Image) I'm after. With a clearer idea in mind for a shape of Musical Time, I try to consider what would make its internal elements work at maximum efficiency to promote the desired shape. This tells me if there is need for additional musical objects (custom-made to the assessed specifications) and I start reconsidering the already possessed musical objects. If needed, I rework the older objects adapting them to the new specifications. At this point, having all the construction materials I need and the schematics of the project, the puzzle is solved.

And here is when I notice that there is something that probably holds true universally as the main guideline for Montage: the process of assemblage (Montage) begins as a process of disassemblage, of disarticulation, of "découpage"[32] of the Subject. We could have already deducted this from Eisenstein's definition of Montage described in 2.9. If Montage is the process of a collection of Representations generating an Image, in order to create an Image the artist has to go the opposite way, he first has to break down the Image ("*il découpe l'Image*") into its Representations

[32] The French word "Découpage" marvellously describes this disassemblage process. The best translation for it could be the act of breaking down a bigger entity into smaller units. In English there is the word *decoupage* that, hopefully, holds more or less the same sense.

and then he proceeds by putting them together so that an onlooker can, in his turn and in his own way, reconstruct that original Image.

To exercise Montage, we first disintegrate and then re-integrate the Subject, the final Image that we are after with the particular work of Art we are creating.

2.11. The Musical System

The problématique of the Musical System has already been assessed, as well as the issues of its causes and consequences. We should now go further and define its internals with a little bit more precision.

As it would be expected from "experimental" composers, we are here looking for basic and universal definitions for a Musical System, definitions disconnected from a particular tradition. As always, the purpose of such basic definitions is to localize "archetypical questions" that arise from the conflict Purpose vs. Sound Material. The actual proposition of answers to those problems is certainly beyond the scope of these definitions. The whole point is that because they only point the way, such definitions will allow for an infinite number of possible answers and this is the type of soil an artist should want for himself.

A Musical System is any set of rules that directly restricts the choices of sound possibilities. In other words, it is a set of constraints. I like to think that such rules do not dictate what is possible directly, instead, they do it indirectly, by establishing what is impossible, what cannot happen.

We shall investigate this. Imagine the scenario of someone trying to send a message through the medium of an established code. The variety of information that can be transmitted through a given code is, at least in a first moment, directly proportional to the number of combinatorial possibilities given by the vehicle of that transmission. By vehicle I mean the physical material "modulated" by the code, like the human hand for deaf sign language, "beeps" for Morse code, colored flags for naval codes, vocal sounds for spoken language, etc. According to Information Theory, if the combinatorial possibilities of the given code are too small or if the combinatorial possibilities of the code are too big, the possibility of success in the transmission of the message decreases.[33]

Why is that? Well, every vehicle of transmission can be said to have an infinite number of states, a continuum of positions. For example, in a luminous sign that uses a color based code, the continuum is the whole spectrum of visible light. In spoken language, the continuum is the whole collection of possible human vocal sounds. In a clock, the continuum is the infinite number of positions of its arms along its circumference. We shall continue this clock idea as an example of a vehicle transmitting messages through the means of a code.

Let us consider that if a clock sends a message, it is not exactly "what time it is" but rather "when our scheduled affairs are due". With this in mind, imagine a clock with absolutely no markings on the dial and only one arm that takes a whole day to travel 360 degrees. If we want the clock to tell us successfully when a specific

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[33] See, Eco, Umberto : "A Theory of Semiotics".

appointment of ours is, without mistake, we cannot deal with such a naked dial, we have to make a marking somewhere in its circumference, either physically or mentally. By selecting specific positions inside the continuum, we create a framework for coding messages, because when you can recognize without ambiguity the precise state in which a vehicle finds itself at a given moment, you can create a rule that equates that position to a specific meaning.

Back to our clock: with one single mark on the dial we create four positions: on the mark, right before the mark, right after the mark, and far away from the mark. In this manner, our clock is already set to communicate a few number of simple messages that interpreted by the clock owner can elicit the comprehension of a meaning. Just a possibility: imagine that we are "on the run" for a very important appointment (which is due when the clock arm reaches the mark) and we look at our clock. We see the vehicle, the clock itself, and we perceive its present position inside its continuum, its circumference. If the arm is far away from the mark, the message is probably understood as "Nothing to do, I can be doing something else right now". If the arm is positioned right before the mark, the message means something like "I still have time, but I'd better go". If the arm is at the very mark, we know that we are going to be late, and with the arm positioned after the mark we know that we are already late and we start assessing the consequences to be faced.

With a couple more of markings, more messages can be transmitted (for example, we could add a marking for "lunch time"). As the number of markings increases and nears the continuum itself, the number of rules necessary to decode the

messages will also increase, approaching infinity. You can probably imagine the mnemonic implications. You start not being able to transmit information.

A "code" is therefore a twofold idea. On one hand, it operates a filtration of the vehicle's continuum and, on the other hand, it establishes a meaning for every one of the selected continuum positions. For optimal efficiency, a code should balance the number of possible continuum gradations to the required level of complexity for the messages. The good inventor of codes is the one who can devise efficient and effective lists of combinatorial permissions that are specifically tailored to the characteristics of the messages to be sent and to the characteristics of the code vehicle.

Now, very important: because of Music's abstract nature (it transmits no concrete message), a "musical code" does not go all the way to stipulate the actual content of the messages. If it did, the sounds would revert to a semantical language like speech or traffic signs and cease to be Music. Instead, a musical code can only revolve around defining the gradations in the continuum.

A Musical System is this "half baked" version of a code, a code that only deals with half of the pair "gradation of the material continuum" vs. "associated meaning". This is not surprising. In a semantical system, the actual physical elements of the vehicle are forgotten for the advantage of a concrete meaning. The second half of a full fledged code exists exactly to take care of this task. In Music, the physical elements of the vehicle and the imprinted shapes are all you get of concrete, they are

your "main course".[34] Meaning in Music is found elsewhere and for that to happen we cannot have the establishment of meanings at this level. From all this, we conclude that the "meaning" of Music is not (and cannot be) defined by its code.

Then, why would we ever bother to create a musical code?

Because we are precisely after those very "sound shapes". The "meaning" we extract from Music is derived from the subjective interpretations of a listener after his observations of the sound shapes living in Time. If the listener noticed sound shapes in the first place, it was because he was able to perceive relationships between the sounds. The "filtration" of the sound continuum is the very thing that enables our perception to notice a network of relationships. Without these relationships, the collections of sound will crumble, will disintegrate, and no shape can be imprinted on them.

Without a Musical System, there can be no Music. But to complete the musical code by adding a semantical level to it kills Music as well.

Therefore, to invent a Musical System is to create a set of rules that restricts the use of the continuum of the characteristics of sound (a microscopic restriction level) and that restricts the universe of manipulations possible (a macroscopic restriction level). Any collection of prescriptions that operate those tasks qualifies as a Musical System. The two main guidelines to be considered are, first, the function of the music to be composed, that is, the composer's particular motives to write the music, his purpose, and second, the possibilities provided by the material (the

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[34] See again Pierre Schaeffer's "Traité des Objets Musicaux", paragraphs 17,8 to 17,11.

available sounds).

In Western civilization classical tonality, for example, there are very well defined laws that prescribe pitch organization, that restrict the pitch continuum. Just as a brief illustration, all intervals used are prescribed as being multiples of an indivisible semitone unit, thus the choice of pitches is restricted to twelve positions that recur in octaves. These are further organized into diatonic scales of seven notes. A system of hierarchies establish the way each diatonic note relates to each other and the way each diatonic scale relates to one another. To assemble musical objects in classical tonality there are strict rules to develop the pitches horizontally (melodic rules) and vertically (harmonic rules).[35]

The number of continuums of qualities of sound is immense. The classic concept of four sound parameters (pitch, duration, intensity and timbre) only gives you a very generalized idea of what sound really is. Each of those four items is an amalgam of several different vibration properties of sound and all of them intersect in such close ways that it is impossible to speak of one of those four qualities without stumbling into the others. Just to mention a few of these sound characteristics, each sound has an attack (and the attack is full of complex transients), a body evolution (the so-called "*allures*"), a decay, a frequency spectra that evolves microscopically in time, etc, etc, etc. It is a mad house.[36] But we would not settle for less.

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[35] Rules that I painfully try to explain to my Harmony and Counterpoint students every week.

[36] Just remember that the 700 pages of Pierre Schaeffer's "Traité des Objets Musicaux" are the result of his entire life of listening to sounds and thinking about them.

To propose a Musical System does not mean that you will have to address every single quality of sound. There would be no reason for that. The creator of a musical code focuses his action only to the portions of the continuum that are relevant to his purpose.

"One reservation: making rules is not in itself the purpose of poetry, otherwise the poet degenerates into a pedant, practicing how to formulate precepts for non-existent or unnecessary objects and situations. For instance, it would be pointless to invent rules for counting the stars while riding a bicycle at full speed.

Situations demanding formulae, or rules, are created by life. The means of formulation and the purpose of the rules are determined by the exigencies of the class struggle." [37]

Dealing with an experimental music, I believe that a Musical System should be conceived differently for every piece of music, according to the individual purposes of each piece. An Artist should never passively settle for a standardized way of resolving the problems risen from the conflict Purpose vs. Material. Every situation will demand a unique particular solution.

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[37] Vladimir Maiakovsky, "How Verses are to be Made".

3. Illustrations of Musical Systems

3.1. Lisboa

Just as an illustration of the "one-thousand-and-one" ways of conceiving a Musical System, I will give you a quick account of some of the very different procedures I used in my *"Lisboa"* piano pieces. Each of the 16 movements that integrate this *"Travel Notebook"* is a kind of an illustration, a "photograph" of a particular moment, site, person or happening of the week I spent in Lisboa in 1998. Every single piece was constructed according to a unique set of rules. I will not bore the reader (and myself) giving complete analyses of these pieces. Such a task would be somewhat irrelevant to my purposes here. I don't intend to repeat those procedures again[38] and I don't see how and why anyone would understand those pieces better or worse if they had the knowledge of the manufacturing rules. Nonetheless, without their Musical Systems, the "Lisboa" pieces would not possess the unity they display and each piece would not bear such specific unique aromas as they do.

The use of the piano (obviously shared by all pieces) is itself the first continuum filtering (the choice of instruments here is already the beginnings of a Musical System). My first rule was that the piano had to be played "hands-on-the-

[38] Except my procedure of never repeating a procedure.

keyboard", that is, no extended techniques were allowed, like playing inside the strings of the piano or hitting the wood frame with a hammer. In this manner, I was left with what two five fingered hands are able to do pressing the 88 keys of the piano keyboard, using the twelve octavated pitches in equal temperament tuning inherited by the western tradition. Of course, the pedals were also there to be used.

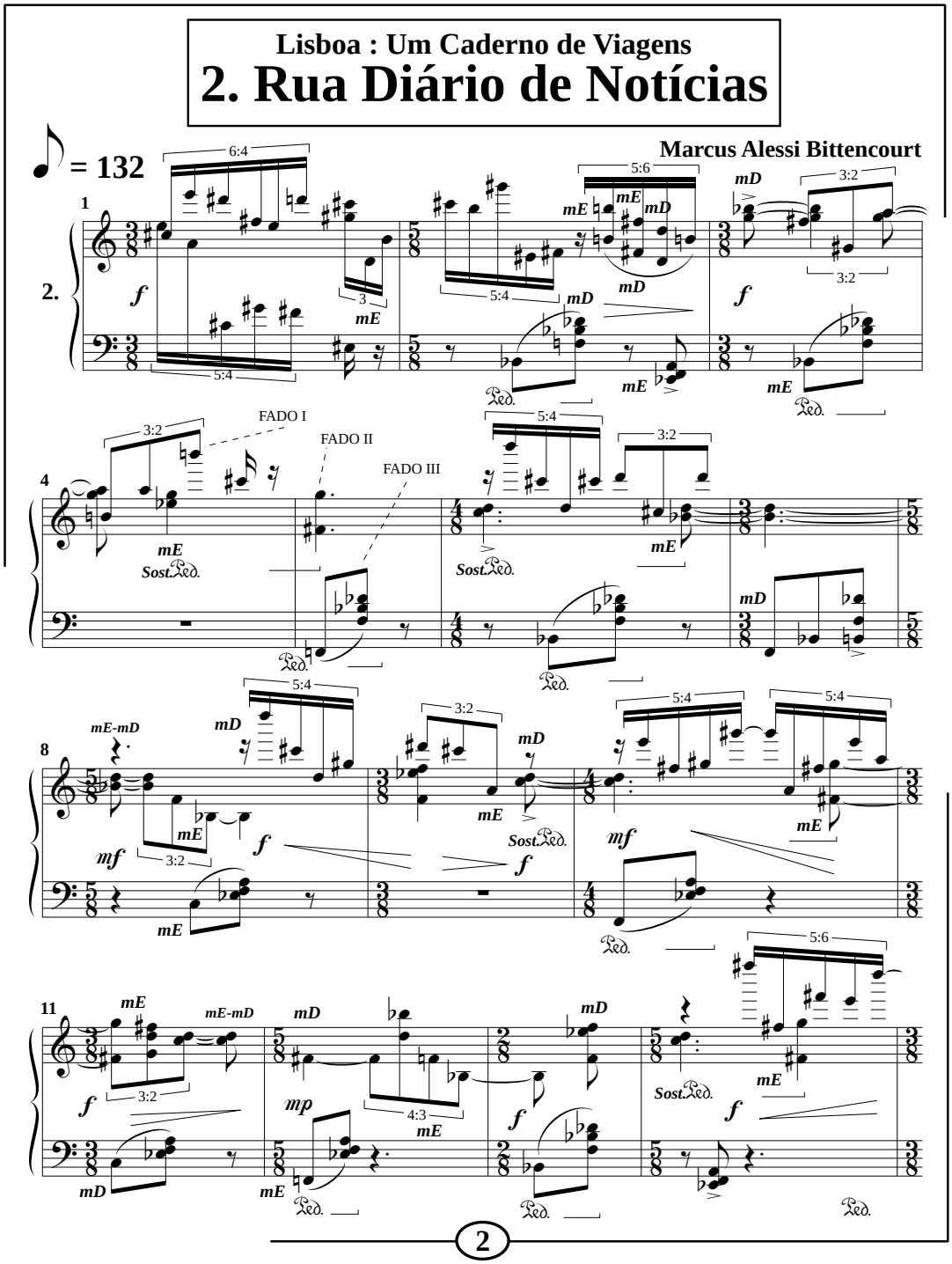
Most of the "Lisboa" pieces were constructed after an idea of a tapestry of independent musical objects. These objects were supposed to be coded with very defined rules of behavior. The main idea here is that once one of these objects is started, it is programmed to move in a particular fashion towards a specific destination. The piece itself becomes the observation of the interaction of the objects as they unfurl and cross each other's paths. What will now follow is a quick enumeration of the prescriptions used in the construction of some of those pieces.

3.1.1

In "Rua Diário de Notícias", we have the superimposition of three independent layers of constructs, each unfurling a specific abstraction of a known Portuguese fado. The first of the constructs, in F# minor, occupies the high register of the piano and it is a pointillistic simplified version of a famous fado tune. The second construct, in G minor and occupying the middle register of the piano, is the harmonic progression of another fado reduced to a minimum, to a skeleton. The third, in Bb minor, works as the traditional fado bass (the classical guitar) and comes in the form of a simple tonic and dominant piano stride with asymmetrical rests in between.

The internal cycles of these constructs are set so that they seldom coincide and the result is a polyrhythmic polyphony of objects.

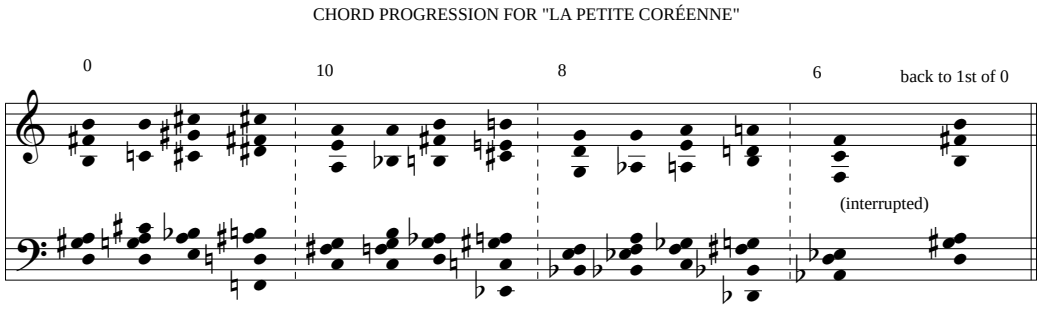
Fig. 1. First page from ÒRua Diário de NotíciasÓ



3.1.2

Very similarly, "La Petite Coréenne" was also devised in three independent threads. Two of them are Korean folk tunes, each in its own pentatonic key. Each of the original melodies contains a different number of measures and the idea was that the tunes had to be presented in their entirety but they had to start and finish together. To accomplish that, the rhythmical durations of the tunes were converted into short, medium and long values and blown up by a certain proportion so that they would all fill the same Musical Space (the proportions that perform this trick for these particular melodies are 7/6 and 6/7). To these melodies I added an atonal chord progression that goes through 3 (and 1/4) modulatory cycles, always of a -2, one major second down.

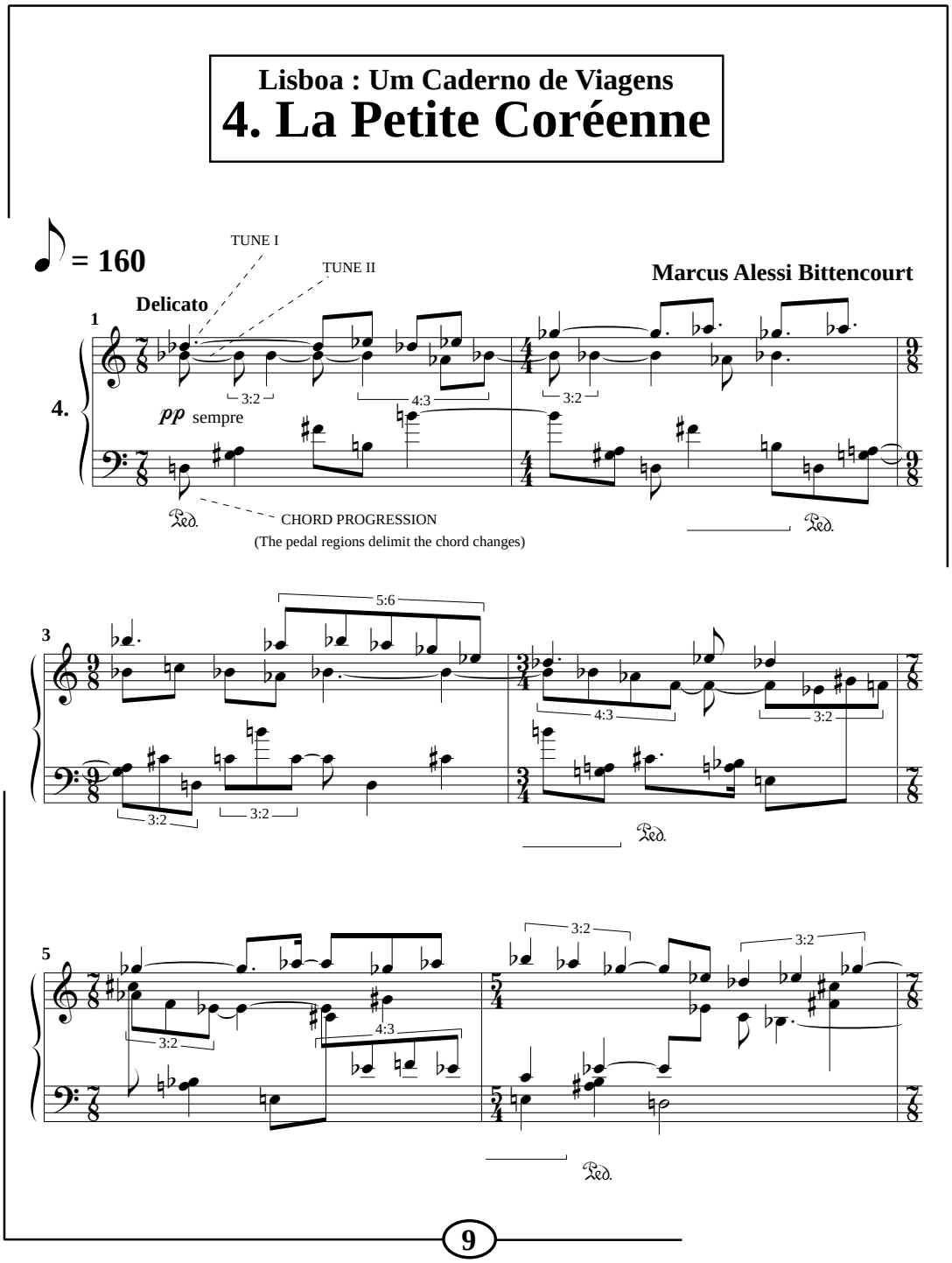
Fig. 2.



Each chord in this progression was set to areas of equal length and these areas could not coincide with the articulation points of the other layers. Inside its area, each chord had to be presented in an arpeggiated form, mostly in single notes, with rules for special occasions where the pitches had to be grouped in dyads of seconds or fifths. The difficulty here was to select the exact pentatonic keys and the exact

modulatory cycles for the chord progression so that the combined result of all the elements possessed the delicate harmonic coloration required.

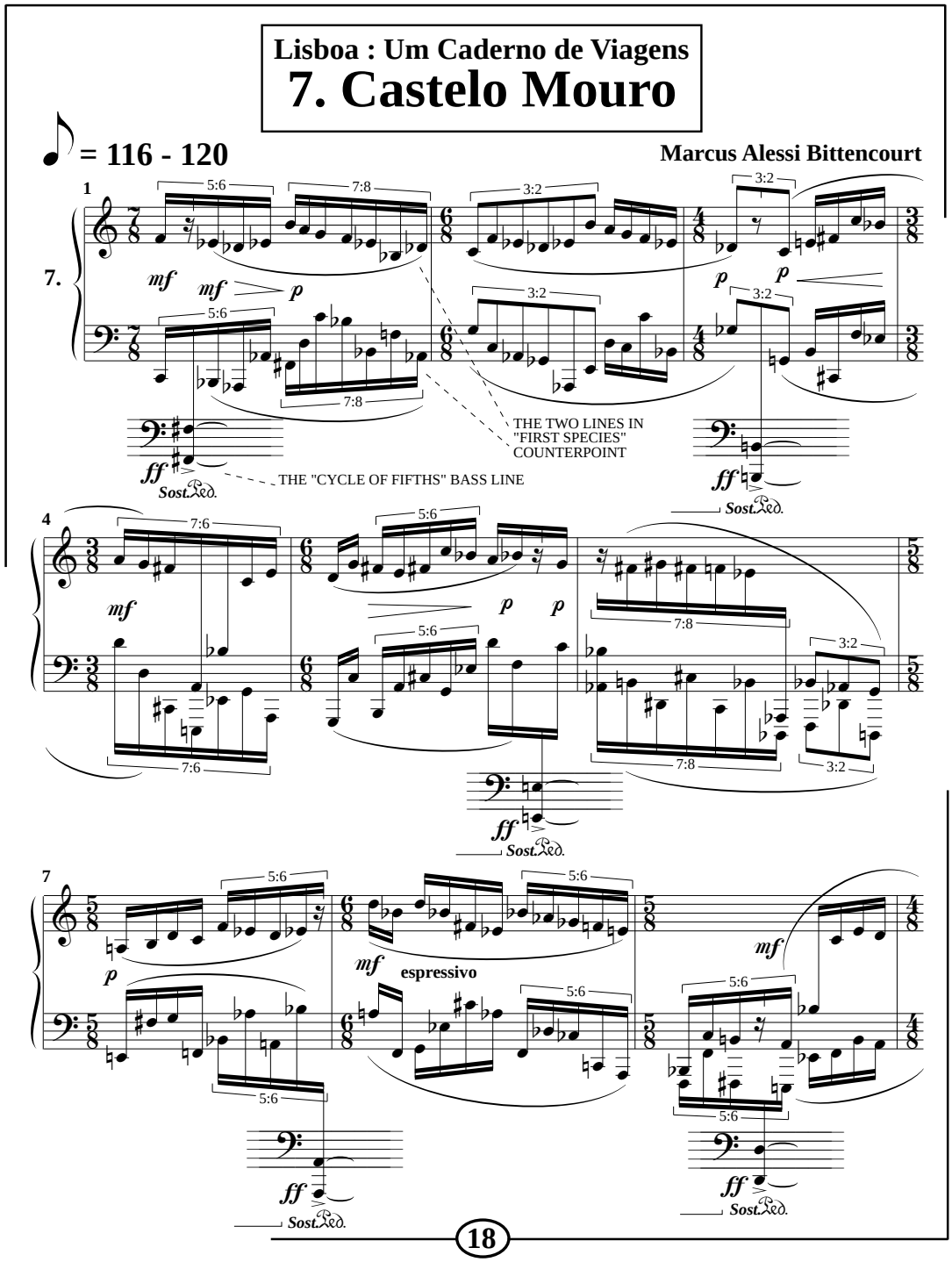
Fig. 3. First page from ÒLa Petite CoréenneÓ



3.1.3

"Castelo Mouro" is a construction in huge stone blocks of perfect fifths and fourths. First, an arbitrary atonal "diatonic" scale spanning three octaves was chosen and a cantus firmus was constructed from it. Second, a strange set of mathematical operations was put in action to modulate the evolution of the shape of the cantus firmus and the transpositions of the scale. The result of these operations is a single pointillistic melodic line. Third, a second melodic line in "first species counterpoint" was added underneath, and only harmonic intervals of perfect fifths and fourths (simple or compound) were allowed, except in the eventuality that the mathematical operations created a repeating tone in the top melody. In that case, the repeated tone and its counterpoint was always changed to the same major ninth Ab-Bb. To this monolithical construction was added a bass line in octaves playing a simple cycle of fifths. It spans the entire duration of the piece and proceeds always fifth down, fourth up, fifth down, fourth up, till it reaches the lower end of the piano keyboard and when that happens, the pitch is supposed to get stuck and is repeated till the end of the piece.

Fig. 4. First page from ÒCastelo MouroÓ

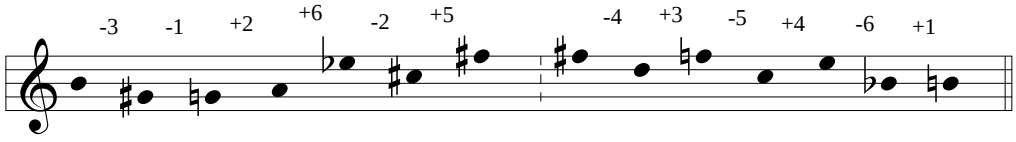


3.1.4

"Barroquismo" is a homage to my favorite Brazilian, Portuguese and Spanish baroque artists. It was inspired by my fascination with Antonio Soler's "La Llave de la Modulacion" (1762), were he explains how to perform all possible modulations. The piece recreates the binary form of the Iberic baroque keyboard sonatas interpreting them as lists of musical objects that pile up in the first half of the sonata and reappear transmutated, reordered, modulated and re-interpreted in the second half of the sonata. An all-interval twelve tone row was devised as a modulatory scheme so that the piece would go through all twelve keys and apply all the possible modulatory cases described in Soler's treatise (or almost). The keys were separated in halves, each half going to one of the two sections of the piece. As I could not resist it, the transposition row had to allow for the first section to end on a key a perfect fifth higher then the key first heard in the piece. The second half would proceed from this "dominant" region back to the opening key (the thirteenth key).

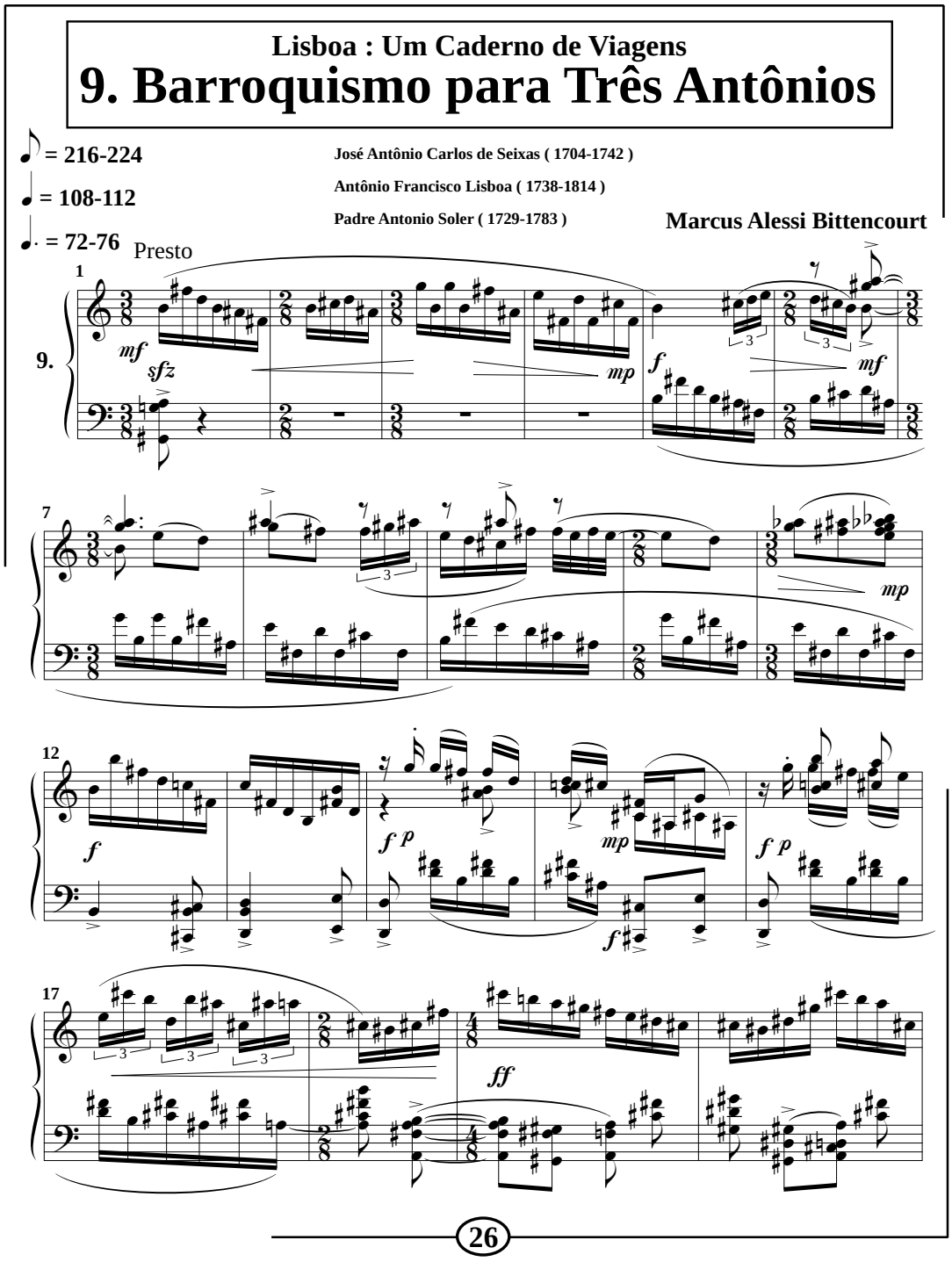
Fig. 5.

ROW OF KEYS FOR "BARROQUISMO"



The musical objects had to resemble baroque motives, but they were supposed to be consistently distorted through insistent cluster "acciaccaturas", calculated "wrong" notes, and irregular measure lengths.

Fig. 6. First page from ÒBarroquismoÓ

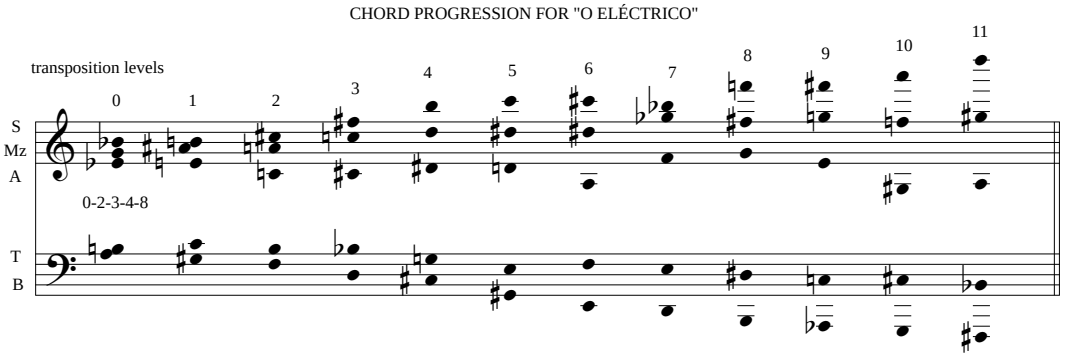


3.1.5

"O Eléctrico" is a complex collage of musical objects. It is supposed to be a trolley trip with glances of this and that, people and political propaganda on the narrow street walls. Each musical element in this piece belongs to one of seven musical groups. Each group had specific rules to be applied in the construction of their musical objects.

Three of the main musical groups were constructed out of the same five voice progression of twelve chords that are nothing more than different rotations of the same pitch collection in all its twelve transpositions, ordered according to a formula (here, the transpositions always proceed going up a semitone). The distance between the voices increases continuously throughout the progression. The voices in the first chord are in very close position and happen at the middle of the keyboard. The last chord was set to span practically the whole keyboard.

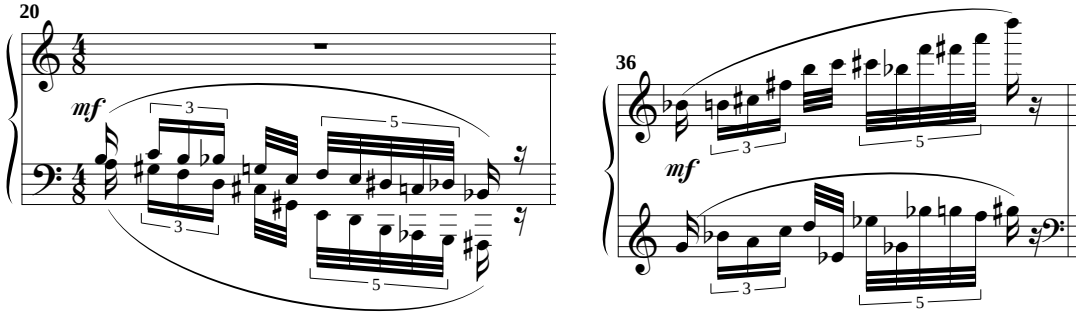
Fig. 7.



Each of these three musical groups have specific formulas for the rhythmical and dynamical arrangements (intensities) of their pitch material.

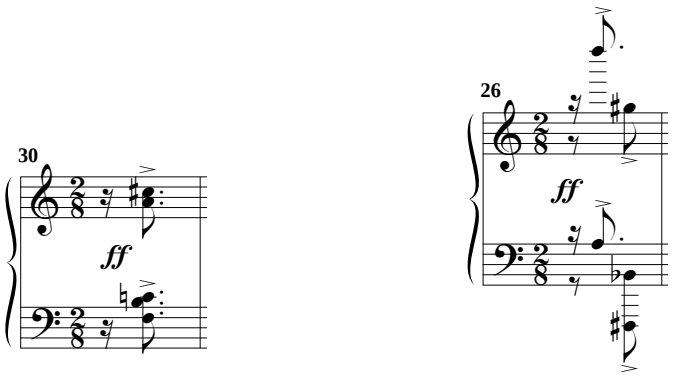
The first group of musical objects is the collection of all the permutations, two voices at a time, of the individual voices of the progression, separated to form fast scalar/arpeggiated gliding passages.

Fig. 8. Examples of objects from the first group of ÒD EléctricoÓ



The objects of the second group are the individual chords of the progression with the notes played either simultaneously, if two hands could take them or, if otherwise, slightly arpeggiated according to a formula.

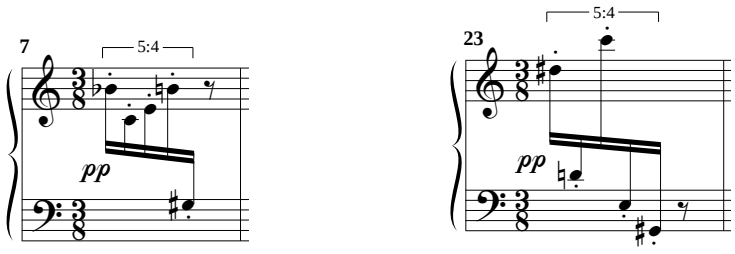
Fig. 9. Examples of objects from the second group of ÒD EléctricoÓ



The objects of the third group are also the individual chords of the

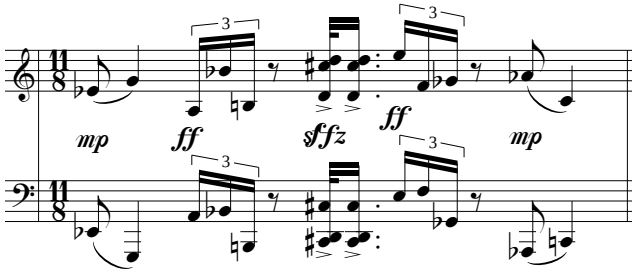
progression, but with the notes always arpeggiated in a pointillistic manner.

Fig. 10. Examples of objects from the third group of ÒEléctricoÓ



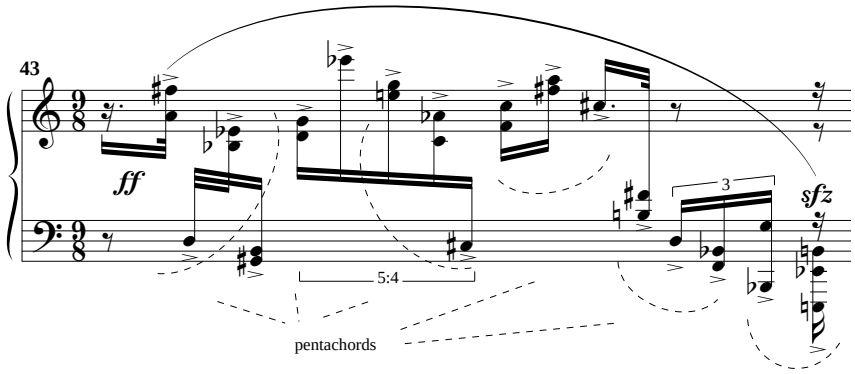
The fourth group of musical elements is based on a phrase in non-parallel octaves constructed using a twelve tone row where the intervals of its second half are the retrograded form of the intervals of its first half. The objects here are six: each one of the five individual blocks that form the phrase and the phrase itself.

Fig. 11. The fourth group of ÒEléctricoÓ



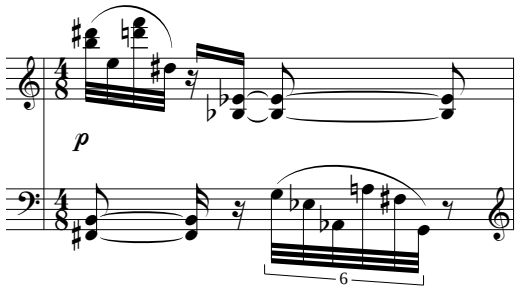
The fifth group contains three objects and all of them are "meteor showers" of dyads constructed on the same pentachord 0-1-4-7-8. The pentachords will be always transposed by a + 5 or -7 (cycle of fifths).

Fig. 12. Third object from the fifth group of ÒD EléctricoÓ



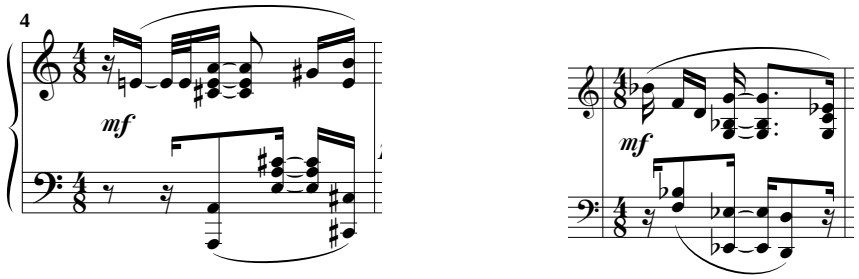
The sixth group has only two objects and they are based on the same ordered pitch set of eight notes.

Fig. 13. Object from the sixth group of ÒD EléctricoÓ



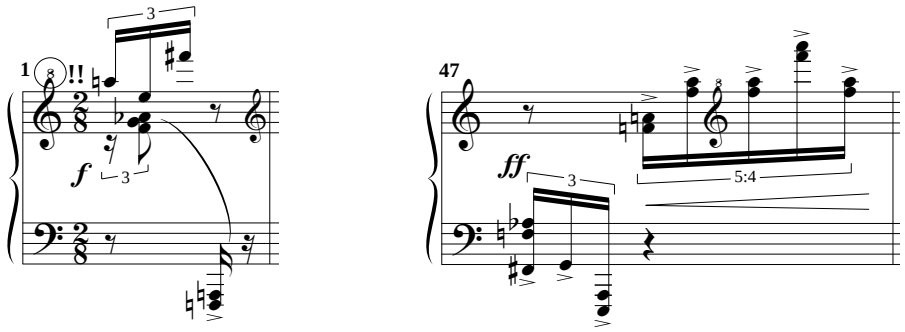
The last group is the "International Communist" anthem, separated in blocks, each block set on a different transposition level.

Fig. 14. Two adjacent objects from the seventh group of ÒD EléctricoÓ



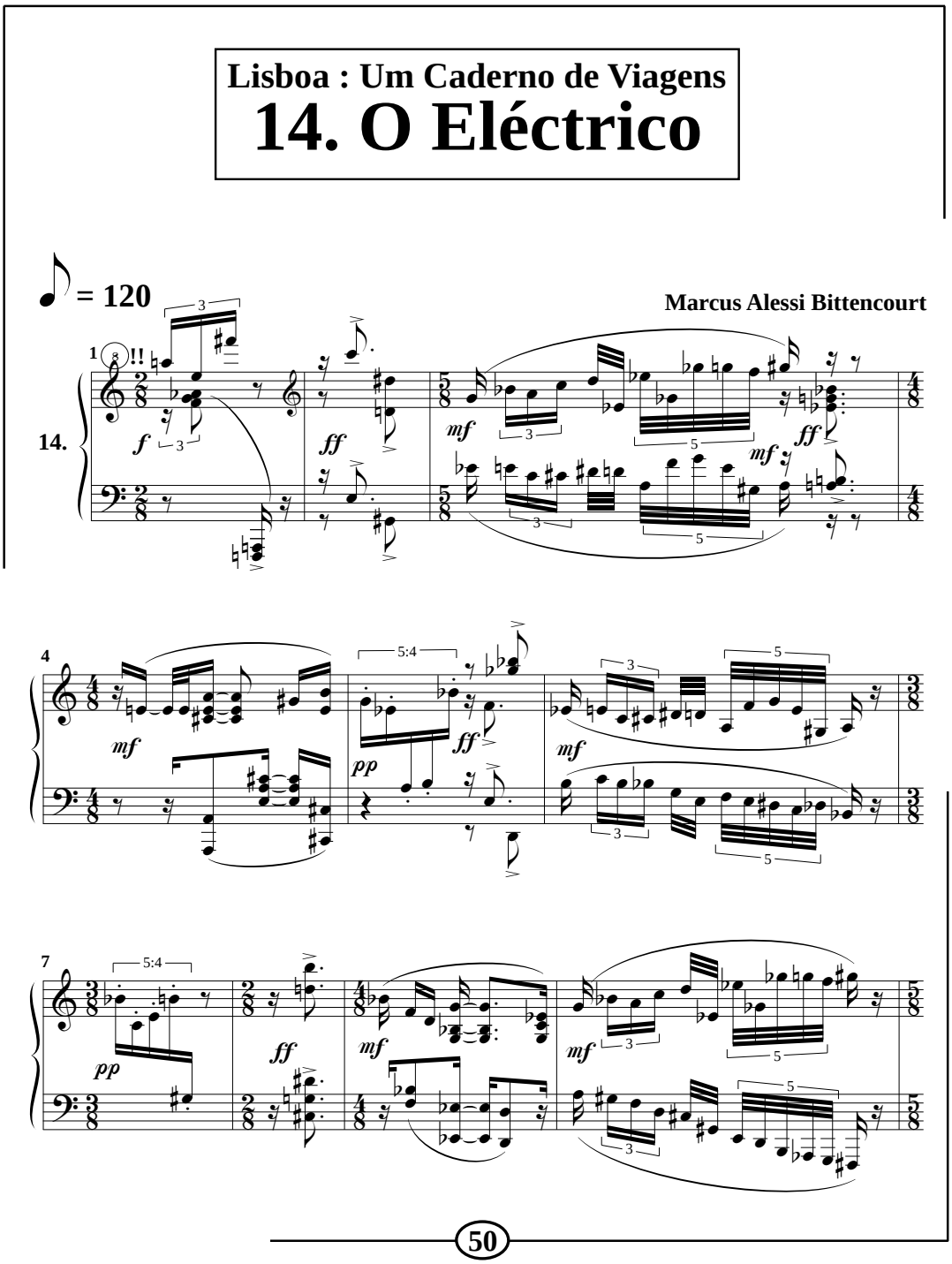
To complete the collection, an opening and a closing gestures were manufactured out of the same little cluster.

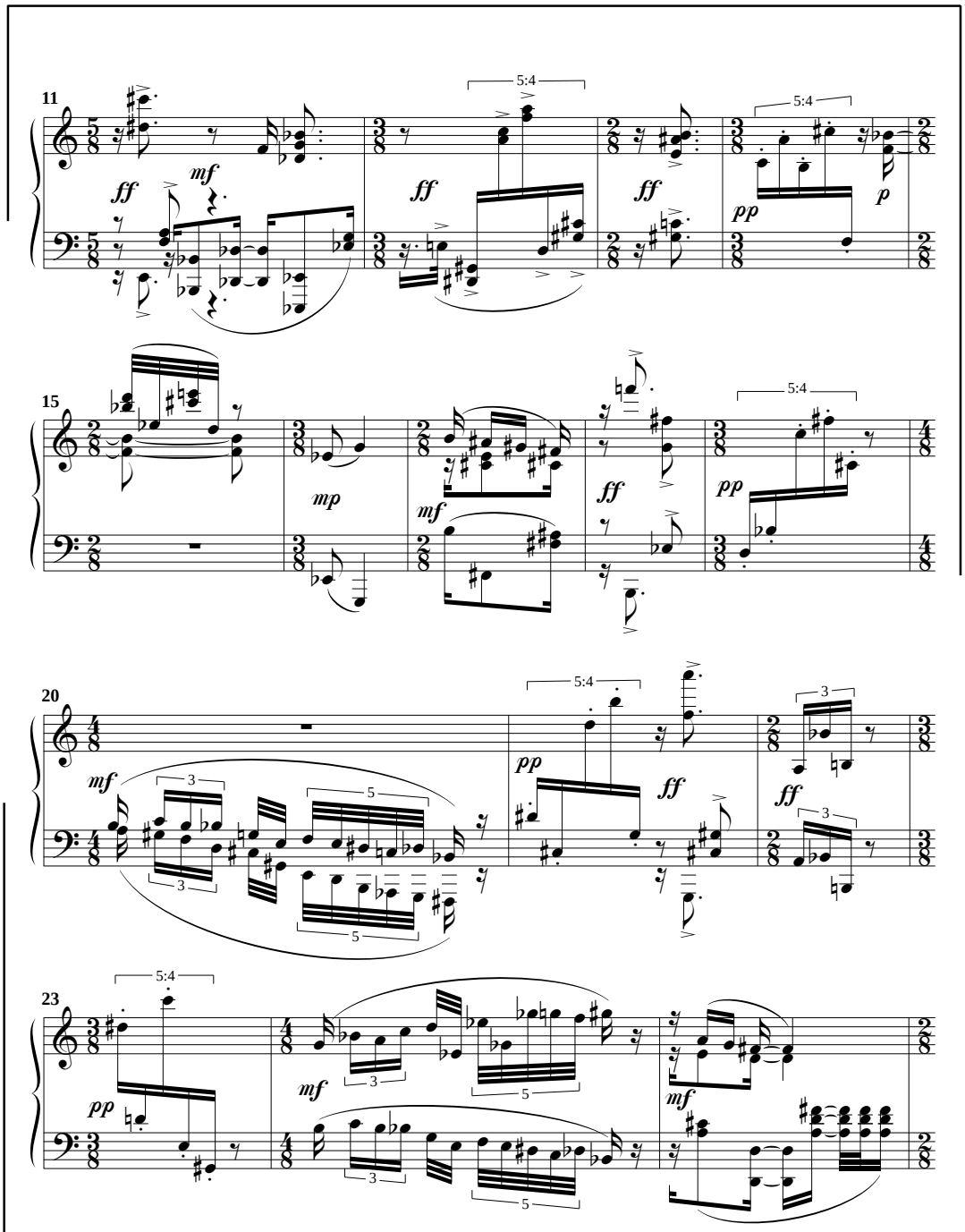
Fig. 15. Opening and closing gestures from ÒO EléctricoÓ



Each musical object in the piece was created according to the rules of its own "clan" and was individually placed on a card. To assemble the piece I was supposed to order the whole stack of cards into a linear development (no superimpositions were allowed). Two more constraints prescribed that group three and the fragments of the anthem (group seven) had always to be presented in chronological order and that the "meteor showers" had to be ordered according to their duration, beginning with the shortest. All the other objects could be shuffled freely. The act of ordering the materials is then left to the guiding hand of Listening.

Fig. 16. Complete score of ÒO EléctricoÓ




11
ff
mf
ff
ff
pp
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5:4
5:4
15
mp
mf
ff
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23
pp
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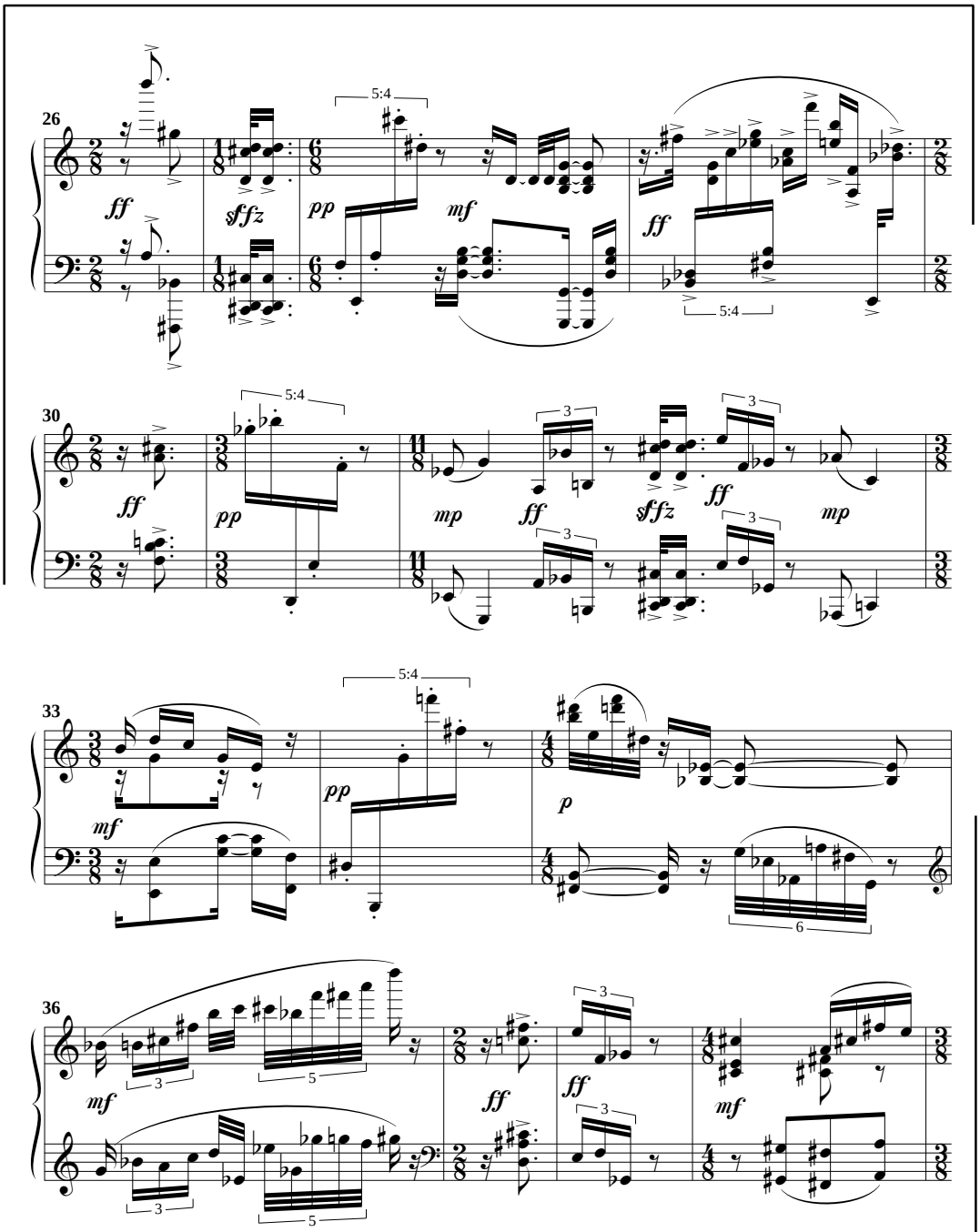
5:4


26
ff
sffz
pp
mf
ff
5:4
5:4
30
ff
pp
mp
ff
sffz
ff
mp
5:4
3
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3
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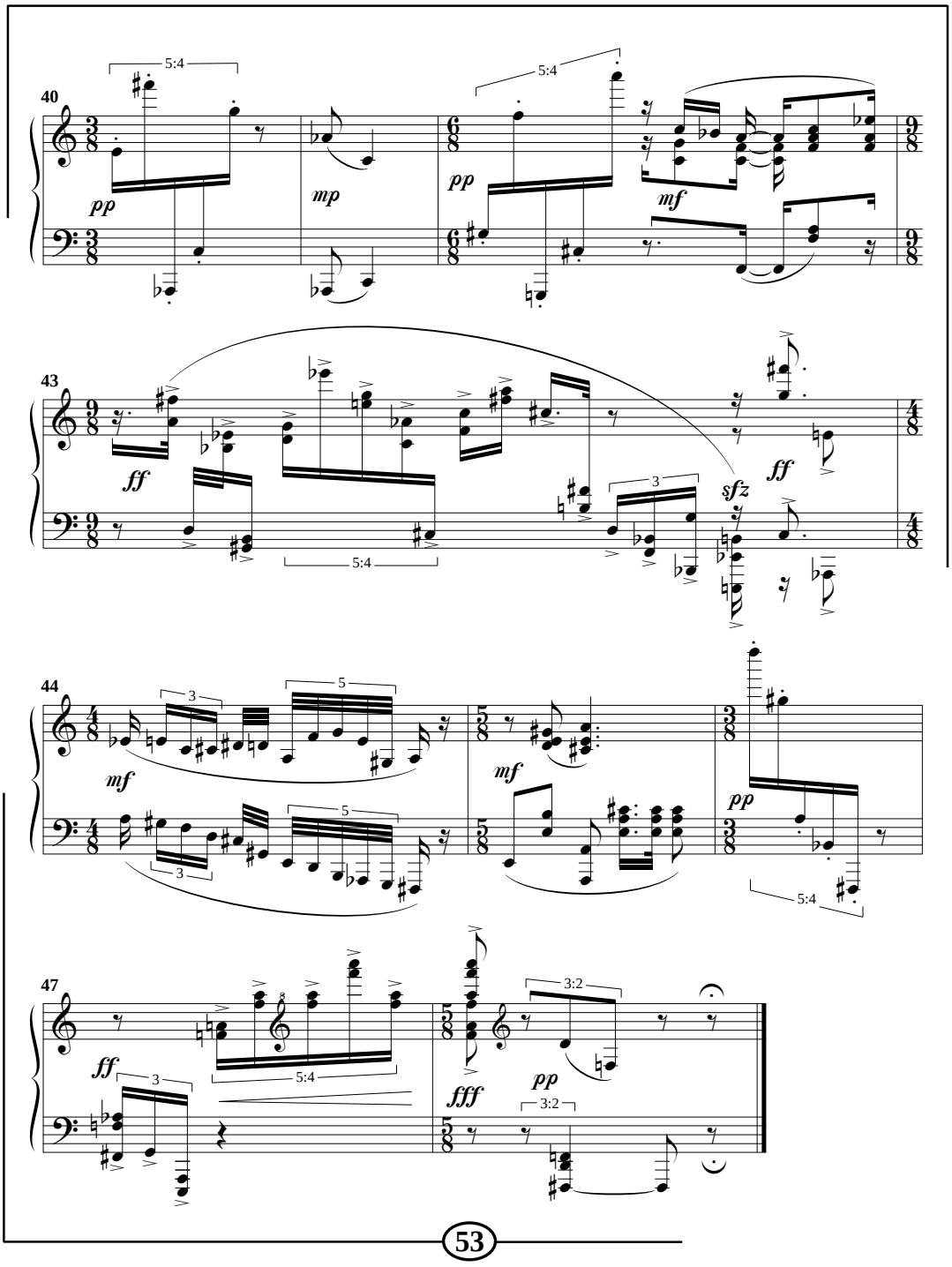
3



I shall stop here. I have probably already demonstrated my fondness for rules of construction. Nonetheless, listening to the "Lisboa" pieces you may never hear in

them the explanations I just gave. I believe it is irrelevant for the listener to comprehend the exact rules operated by the musical code. And, most important of all, even if the listener can figure them all out, he will have gained nothing possessing that knowledge: the meaning, as we have already seen, escapes the code.

3.2. Conclusions on the Musical System

I would say that the function of the Musical System is similar to the function of those poles we sometimes place near growing trees: to give the growing matter support, shape, coloration. The goal of a Musical System is not to make the listener perceive the exact "atomic" nature of the sounds, but it is to lead the listener to believe that there is some "unknown" force connecting all the sound elements together. In this way, the listener's objective perception is allowed to fly towards a more important goal: the apprehension of the Montage.

Even from the point of view of the composer, the Musical System is a vassal of the Montage. And Montage cannot be controlled by anything else other than the composer's own Listening. If you consider that the composer's Ear is nothing more than the composer's Filter itself, the act of "Listening" can be seen as the act in which the composer sends the selected sound materials through his artistic Filter.

I would even say that a composer exercises his Listening not only at the time of the assemblage of the materials, but even at those initial steps of the selection of a sound universe. Maybe even prior to it. As Carlos Drummond de Andrade once

wrote, the poet is someone who stops, filters out the landscape and conceives a rose out of pure absence, ample emptiness.[39]

For example, back to my "Lisbon" pieces, why did I choose those very rules and not different ones ?

Speaking of my own personal methods, when I have an understanding of the purpose of a piece, when I have accessed through several points of view the nature of what I want to say, I send this purpose, in all its constituent facets, through my Filter (in other words, through my Ear: I Listen to it) and the result is a "vision", sometimes blurred, sometimes perfectly clear, of what my universe of sounds should be and, most of all, how it should behave. The rules I invent to manufacture and assemble my musical objects appear out of this "vision". Here it is important to mention that I am faithful to my rules insofar as they succeed in giving me musical material with the characteristics I envisioned. If the rules fail to give me what my Ear needs, they will be adjusted (or eliminated) accordingly.

Once the composer has at his disposal all the appropriate materials he needs (materials formatted by a suitable Musical System according to the requirements of his purpose), the assemblage of all materials will be a task outside the aegis of a Musical System. Montage takes over.

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[39] Carlos Drummond de Andrade (1902-1987), Brazilian poet. The quoted lines come from his poem "Announcement of the Rose", in his book *"A Rosa do Povo"*:

> *"Autor da rosa, não me revelo, sou eu, quem sou ?*
> *Deus me ajudara, mas ele é neutro, e mesmo duvido*
> *que em outro mundo alguém se curve, filtre a paisagem,*
> *pense uma rosa na pura ausência, no amplo vazio."*

4. And finally, yours truly, Doctor Frankenstein.

4.1. Some notes on me

My basic training was originally as a traditional classical musician. The only contact with Electroacoustic Music I had during my early training days came from a LP I owned in my teenager years that contained concrete and electronic pieces by Berio, Xenakis, Ligeti and Kagel.[40] My first real contact with Electroacoustic Music happened seven years ago at Columbia University when I started my Master-Doctoral studies (1996). The historical importance of Columbia's electronic studio and my notorious fondness for mathematics, physics and computers were the obvious ingredients that originally attracted me to register for those courses. At the time, I had no idea of the philosophies of Electroacoustic Music. By the time when I was able to catch a glimpse of what it really meant to be dealing with such type of Music, I realized that my artistic Norths had already changed dramatically and irrevocably towards it.

First of all, working with sound itself changes your conception of solfege completely. By solfege I mean the relationship of understanding, of comprehension,

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[40] As a curiosity, last year I succeeded in localizing this particular LP among my belongings at my parents' in Brazil. I was amazed to find out that all the pieces in the record were realizations by Pierre Henry.

of intimacy between "sculptor" and "stone-matter".[41] Originally, the first impulse of a traditionally trained composer that first tries his hand on the Electroacoustic field is to transpose an instrumental solfege to the electroacoustic world. This is a short-sightedness that I myself committed. But the recorded medium possesses the same properties that Film has for freezing Time. The concept of Musical Time becomes extremely more palpable in an electroacoustic piece than in a traditional instrumental one. Instead of a latent Musical Time, to be recreated by interpreters, you have Musical Time in a materialized state, a concrete form. You also start to think of musical materials disconnected from considerations of instrumental execution, the musical materials are free from practicalities, from concerns of "playability", of feasibility. Electroacoustic sounds live in a reality of their own, their sonic properties are independent of external considerations.

Back to my story, I intuitively started working with the original concepts of Electronic Music and, accordingly, my first electronic pieces were made exclusively with synthetic sounds. The first thing one finds out dealing with sound synthesis is that the theory of additive synthesis, although true in theory, is in practice unmanageable and unsatisfactory. This is why I immediately got attracted to what is known as polygonal wave forms (a favorite of Xenakis's), wave forms where the sound vibrations don't follow sinusoidal patterns but geometrical constructions of

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[41] I tend to see what is traditionally known as "solfege" as being a specific subset of this larger idea, a subset that deals exclusively with "stone-matter" of instrumental/vocal quality according to the Western musical tradition.

mixtures of triangles, squares and rectangles. These sounds are marvelously expressive in their crude, monstrous own way and I assembled three little pieces out of these sounds: "Scorching Sun", "Processional", and "Embroidery".

Without realizing it I was a truly electronic composer, with my concerns for total mathematical control over all the aspects of the composition. In the first version of "Processional", I submitted the musical materials to absolute algorithmical control. Everything in the piece was derived from a collection of five proportions, from the tuning system to the profile of the polygonal waves, from the pitch vibrato to the musical form. Really, everything. At the end, I had a huge computer program that required only the input of the total length for the piece. The algorithm would take thirty minutes to calculate and manufacture always the same piece, only scaled according to the given length. I can proudly say that the result was a disaster. I gave to the algorithms the tasks that could only be given to my Ear. My Ear was enslaved by my mathematical intellect, when the exact opposite has to be the truth. "Processional" was the turning point where I noticed that my views on the electroacoustic subject were mistaken, and that I was missing the whole point. "Embroidery" and the second version of "Processional" are tentatives to move in another direction, although I was still struggling too much with the technical means to be able to focus on the more aesthetical and philosophical issues at hand.

At the same time, I was taking my first baby-steps working with organic sounds, that is, recordings of natural sounds. My first big project was to manufacture a mock up version of my piano concerto just as a proof of concept, out of curiosity.

For this I wrote my own primitive orchestral sampler. I gathered my first collections of instrumental sounds and programmed algorithms in Minc (the script language used by Rtcmix) that would read MIDI files of the instrumental parts of my concerto (generated from the Finale score) and assemble soundfiles sticking into the appropriate time locations sound chunks taken from my instrumental collections. This rudimentary sampler was in some sense the Neanderthal predecessor of the C++ automatons that I now conjure to assemble my electroacoustic pieces.

When I was working with the instrumental samples for the Concerto demo, I noticed that with additions here and there I could make my "virtual" instruments, among other things, play any microtonal pitch. After a couple of semesters taking every single programming course at my disposal at the Computer Sciences department (C, C++, Java), I was able to assemble some of these improved "instrumental" engines and the result of this exploration was the piece "Chimæra". In this piece I used the same instrumental samples I used for the concerto project (basically, orchestral instruments), but instead of trying to reproduce a symphonic orchestra, I started to think more in alchemical terms, I wanted to blend the "organic flesh" and transform it into something else, unheard of. Hence the title of the piece. Having intuitively started in the "Electronic" field, I naturally stumbled into the "Concrete" field, practically as a personal discovery.

My delirium was (and still is) that I could over a lifetime assemble a huge collection of "flesh" that I could use to manufacture chimaeras, like an alchemist blending potions out of thousands of bottles of colored substances of all sorts, a

Doctor Frankenstein or a Dr. Moreau, the vivisectionist. Some time after this, I started to discover the fantastic works of Pierre Henry and learned that he had not only had more or less the same ideas, but that he has been intensely and steadily developing those concepts for more than fifty years!

Anyway, I had enough knowledge of C++ so that I could think of programming a series of libraries that could handle requests of sound samples from a collection, a sound bank. The idea was to program C++ classes that would act as managers to particular collections of sounds. In this way, if I needed a particular sound from a collection, the only thing I would need to do is to instantiate its C++ object and call up its "Play" method with the appropriate parameters.

I implemented these C++ classes so that they can not only plainly relay the contents of the collections but, if they receive requests for samples whose specifications do not match anything in its database, the classes are prepared to find the most suitable item in its database and apply special algorithms to it, thus delivering the request with absolute precision to its specifications.

I also coded the libraries so that they can be indefinitely expanded and improved. The first step for this was to find a good architecture of class inheritance. Characteristics that would be useful for all the objects to have were defined inside a parent class. Whenever a new capability is envisioned that I would like to see extended to all my objects, I just have to add it in the parent class and all of its children immediately acquire the new properties. Since the original 32 instruments programmed in the semester right before I started working on KA, I have

continuously been making additions to this library. I lost count of how many little classes I have programmed so far, from instrumental sources of all sorts like western orchestral instruments and ethnic "exotic" ones, to vocalizations of animals and sound effects like war sounds, machinery of all sorts, etc, etc, etc.

I became the "king of the dried soup". Before a sound is put inside a collection, the idea is to atomize it into its smallest significant particles, and each fragment has all its pertinent information qualified, quantified and classified. With all this information coded into a C++ class, I can reintegrate those atoms, "rehydrate the soup powder" so to speak, into different shapes in an infinite number of variations. For example, I have a collection of sounds of birds that I used on the Huris/Mohammed section of scene three of KA. Instead of collecting whole phrases of bird song, I selected 65 different individual little chirps, most of the time not bigger than 0.2 seconds. Every chirp was classified according to its duration and its pitch was carefully assessed. In this manner, the C++ manager of this collection can automatically transform the sounds of its database according to the requests it receives. To request a sound from this class, I have to specify which chirp sample I want, when it should play, a desired duration, a desired frequency (in Hz), an amplitude, and a stereo spread. The C++ class automatically takes care of all the precise microscopic transformations necessary to deliver the wanted goods to the specified "addresses" (the correct positions in the output soundfile).

This gives me the freedom to design and build with precision constructions of great complexity. For example, I can instantiate as many of these "birds" as I want

and get them to sing precise musical materials at precise moments and stereophonic positions. It is also an effective way to generate a huge number of different sounds out of a very few number of them. It would be correct to say that instead of having a "bird collection", I rather have a "bird-machine" that can be conjured at any time to speak.

With all this programming work, painfully and meticulously realized during a period of almost three years, I became technically able to realize my compositional ideas without hindrance using the computer, what was not the case with my pieces up to "Embroidery". At that time, the difficulties to assemble a single sound object were so intense that the compositional structures were impaired, they could not "take off". Basically, it was very difficult to give "life" to a musical object and to set it in movement expressively. With my new algorithms, I find myself not only able to generate musical objects with fluidity, but I can get the same objects to be materialized always differently: the solemn almighty concept of variation.

With this I discovered that computer algorithms, instead of mechanizing their musical output (remember "Processional"), could be used to "humanize", to "naturalize" their output. A well-thought algorithm can endow a musical object with a behavior, with a character of almost "psychological" nature, in short, with such life that it seems there is a soul in it, and it speaks.

The legend some more traditional musicians believe in that non-live Electroacoustic Music lacks "human touch", "human sensitivity", has never sounded more ridiculous to me. To read the young Pierre Henry saying *"Si nous voulons lutter*

contre la mécanique, il faut employer de méthodes méchaniques, ainsi la machine se retournera contre elle-même"[42] just gives me more conviction that I am not mad, after all. With computer virtuosity, the sounds become the puppets, the computer becomes the strings, and the composer, of course, the puppetmaster.

The more artisanal the means, the better. I can not even imagine myself releasing my sound collections to anyone. I am extremely happy to share the technical knowledge and the architectural designs of my sound engines, but I believe that the sounds themselves are too personal belongings of mine. Anyway, I have tainted all my sounds with my Filter (my Ear) and they are unusable for another artist (and I have to protect myself and my work against the non-artists). At the end, if my electroacoustic music is to acquire a personal touch and reveal my individuality through all its pores, I have to continue on this "artisanal" track, away from industrially produced, commercial "brand" products.

Like Pierre Henry with his notorious *"Sonothéque"*, I believe an Electroacoustic composer should engage on a personal lifetime journey of accumulation of sounds. I have just begun my own library. If life allows me to keep in this track, I shall investigate more the mysteries of the sound pick-up, *"la prise du son"*, now that I have some good operational solutions for the technical problems concerning assemblage and manipulation of concrete musical materials.

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[42] Quote taken from Michel Chion's book "Pierre Henry".

4.2. The Nature of Computer Music

The culture of our time is famous for its irresistible vice of labeling everything, from art, to science, to people, to anything. Everything has to belong inside some drawer completely, neatly filed under the appropriate letter. Although this may serve some purpose, providing organization for the work of scientists, scholars, bureaucrats, politicians, etc., from the artist's point of view, this is an extremely hazardous idea. An artist only needs a label if it gives him a well defined explanation for a concept capable of enlightening and facilitating the artist's understanding of the very internals of his art.

It is not uncommon for people to navigate through labels only skin deep, superficially and without a real understanding of the concepts vehiculated. "Concrete Music", "Electroacoustic Music", "Electronic Music", "Acousmatic Music", "Computer Music", are examples of these half understood terminologies. If I am to put my hands on a computer and use it for music production, the term "Computer Music" has to be examined closely. Most people believe that it is a musical genre in itself, "music made by computers". Of course it is made by computers! But this fact alone doesn't say anything about what type of music it is. It doesn't shed any light on its musical content.

Going down the tree, it would be quite correct to say that Computer Music is a branch of Electroacoustic Music. In its turn, Electroacoustic Music, like Acousmatic Music, seems to be the union of the two pioneers: Concrete Music and

Electronic Music. Bottom of the tree. Going up again, we shall try to purge each concept of the petty aestheticism that was miserably glued to it. Don't get me wrong, an artist is obviously not against "aesthetics", but the relationship between an artist and his materials is sacred. When aesthetes fight and enlist their hordes of boxers, concepts like those often end up emptied of their original enlightening ideas and only a generalized shadow of their meaning remains.

Take Musique Concrète and Electronic music, for example. Apart from the fact that both exist only through the projection by loudspeakers of a recording, they are usually considered to be two opposing aesthetics that diverge on the nature of the sounds they wish to utilize, among organic sounds, recorded by a microphone, processed or not in laboratory (what people usually refer to as "concrete" sounds) and artificial sounds, sounds synthetically generated in laboratory (usually referred to as "electronic" sounds).

It is not exactly as simple as that. You just have to read Pierre Schaeffer to understand that what he meant by "Musique Concrète" was a music that worked with sound itself in such a concrete way that it couldn't be written down on a paper in abstract terms, like traditional instrumental music can.[43] This music could only be physically registered and reproduced, through the medium of a sound recording. Here you have it, precisely delineated, the germ of the idea people like Schaeffer and Henry were after. Seen like this, the term Concrete Music doesn't necessarily

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[43] "The abstraction of the note is substituted by the concrete creation of the sound object".
P. Schaeffer, preface to "Vers une Musique Expérimentale".

stipulate anything regarding aesthetic concerns, neither of material nor form. Instead, it only proposes a point of departure, and, by the way, a truly radical one. All of a sudden it was not enough to say to a violinist "play middle do pianissimo, pizzicato at the third beat".

In traditional music, a musical note is above all an intellectual abstraction. It can even be appreciated only in written form, without being materialized into sound. To be materialized, a musical note always needs an interpreter to translate it to a real sound. Now, the "concretes" wanted to assemble constructions with sound itself. You know, every sound is an entity in its own. Like any physical object, a sound has its texture, its coloration, its shape, like any living being, a sound has a life as well, a trajectory, an internal movement. Of course you can get any sound graphed down (like a sonogram or a simple time vs. amplitude graph) and classified according to this or that, but in the hands of an interpreter such information means nothing. It is impossible to explain to someone how to reproduce the same sound exactly twice. To work with sound in such terms, you will have to freeze sound in a recording. As a by-product of working with recordings, yet another powerful idea was discovered, opening huge possibilities: you could now freeze a slice of Musical Time, just like Cinema freezes Life out of reality. A recording of a sound captures not only the sound but its life and surroundings as well, all frozen for posterity. But unlike the frozen Time images of Cinema, a sound when recorded disincarnates from the body that produced it and starts living a life of its own, totally independent from its source. This is the basic idea of "Acousmatics".

" Un son enregistré est instantanément détruit en tant que machine. (...) Les bruits seront supprimés. Ils deviendront désincarnés, désignifiés et comme sacralisés." [44]

Originally, "acousmatic" was the name given to the disciples of Pythagoras who, for five years, had to listen to the lessons from behind a curtain, without seeing the master and in absolute silence. Resuscitated, this term is now used to define a sound that one listens without seeing the source where it comes from. A sound that disconnects from its source and becomes something else.[45]

Another important point (and also the source for the usual misconceptions regarding Concrete Music) is that, amazed by the internal complexities of sound, the "concretes" could not help noticing that natural sounds possessed an internal complexity unsurpassed by any sound produced artificially (and this remains true even in our days). Hence their fondness to make use of recorded natural sounds (that I like to call "organic"), manipulated at the laboratory.

Now, regarding Electronic Music, on one hand it is a denotation of a technique, on the other, of an aesthetic. As a technique it proposes to synthesize musical sounds artificially from scratch, beginning from the very "atoms" of sounds:

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[44] Pierre Henry, quote taken from Michel Chion's book "Pierre Henry".

[45] Schaeffer considers this concept to be the very idea of musical listening itself (as opposed to physical hearing). See his "Traité des Objets Musicaux", paragraphs 1,1 to 1,6.

vibrations, oscillations, collections of sine tones. The unfortunate aesthetic counterpart is the preaching of a total obsessive control of the materials, internally (the interior of the sound itself) and externally (the organization of the sounds).

The way Electronic Music and Musique Concrète were put one against the other was due to short-sightednesses of their own, as Schaeffer described it: *"Nous travaillions alors, les uns à construire des robots, les autres a disséquer des cadavres. La Musique vivante était ailleurs, et ne devait se donner qu'à ceux qui allaient savoir s'évader de ces modèles simplistes"*.[46]

Nonetheless, Concrete vs. Electronic will remain standing for a conflict of Material vs. Form. If the former saw form as the consequence of the manipulation of raw sound, the later had their sounds synthesized according to a pre-existent form, the sounds themselves were the realization of an abstract intellectual structure. One proposed the liberation of the concrete sound (as opposed to the abstract sound: a musical note), through its disincarnation, into the world of abstractions. The other proposed to materialize a world of abstractions into the concrete realm.

As anyone can see, there wasn't (and still there isn't) any reason why these two ideas would one exclude the other and restrict the universe of sound (the sound palette) or even the universe of ideas. Not surprisingly, composers would more often then not drink from those two sources, according to their needs. The label "Electroacoustic Music" was created to designate precisely this hybridism. It retains

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[46] P. Schaeffer: "Traité des Objets Musicaux", 2,8.

nonetheless that basic principle of Concrete Music (the use of sound itself, organic or artificial, not of an abstract musical note), and it is a music that is registered in a recording and reproduced through loudspeakers.

The use of computers for music appeared as an obvious "next-step" for the ideas of Electronic Music. As the composers searched for musical structures of an ever-increasing level of complexity never seen before, the computer's algorithmical behavior appeared as the blessed tool that could operate the otherwise prohibitive structural calculations. The "computer-assisted composition" was thus born. Also, after the invention of digital sound technology, the computer was found to facilitate immensely the task of synthesizing artificial sounds and eventually, the computer would be able to handle organic sounds just as well, as a recording, editing and processing tool. As the computer evolved, it became able not only to reproduce all the usual operations required to manufacture Concrete or Electronic Music, but it opened new technical possibilities of its own.

These days, a home computer possesses already so much processing power that it can reproduce in software format most of the hardware vital to an Electroacoustic studio. A room filled with heavy equipment now fits inside a laptop. The type of Herculean effort required to assemble, centimeter by centimeter of magnetic tape, a work like, for example, Pierre Henry's "*Variations pour une porte et un soupir*" (1963), is now, with the use of computers, an effort tamed to a much more comfortable level. It still has its difficulties, of course, but they are not mind

numbing anymore.

The computer makes it possible to get the concepts of Material and Form soldered in a way that was impracticable (or impossible) before. If the "electronics" despised the "concretes" because of the impossibility of achieving total control of the organic sounds, now the computer appears as the missing link between those two trends. With the computer, organic sounds can be modified, disintegrated and reintegrated indefinitely. The very internals of a sound can now be twisted and modified to conform to any intellectual abstract structure (arcane or not). The use of computer algorithms allows standard montage and editing of sounds to achieve details of microscopic precision. Sounds can be cut and pasted surgically, in millions of different ways.

Nonetheless, when we speak of Electroacoustic Music we speak of concrete philosophical points of departure that truly inform and determine the way composers think their sound universes, they even demand from them new types of solfege. A piece of electroacoustic music is certainly a music that reflects, in some capacity, those points of departure. The computer does not propose any new philosophical concepts. It appears only as the tool that allows the construction of Electroacoustic Music with a technical virtuosity never imagined before.

Does the fact that Computer Music is a music produced inside a computer implies that its music will sound in a certain specific way?

Practically all the music consumed worldwide has passed inside a computer one way or another. Unless one decides to use "computery" sounds on purpose, in

no way the computer taints the sounds it handles with "computery" characteristics, like a piano taints whatever you play on it with "pianoey" characteristics.

When we think of Piano music, for example, the fact that the sounds come out of a piano establishes an immediate and direct identity between the musical works performed on a piano, no matter how diverse and different these works can be. We speak here of instrumental music, of violin music, of tuba music, of vocal music. The Computer is not a musical instrument. By the way, neither is all the past and present equipment used to manufacture Electroacoustic music.[47] These equipments and the computer are tools that allow you to conceive and materialize pseudo musical instruments.[48] Whenever a technical ear detects this or that computer algorithm in action, it is not detecting something inherent to the computer itself, but only to the algorithm it instantiated.

"Computer Music" is a term that can dangerously be used as a skin-deep label to designate the most simplistic hackneyed views of the production of music through computers. Today's facility with which anyone can take sounds out of a computer ironically tends to handicap the very development of Electroacoustic Music as an Art form.

On one hand, musicians with indigent computer technique (that is, who lack computer programming skills) are forced to work with industrial mass produced

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[47] As Pierre Schaeffer brilliantly demonstrated in the paragraphs 2,1 to 2,12 in his "Traité".

[48] For the pseudo musical instrument concept, see 2,12 in Schaeffer's "Traité".

software and their work will bear the marks of that software, according to its transparency level. These composers have, in some degree, to unconditionally surrender important elements of their artistic conception to someone else. The way a person commands a computer is through an "interface". An interface, one way or another, always colors whatever passes through it. It is really dangerous for an artist to have his ideas filtered through interfaces made by others. Of course, no one, programmers or not, can escape the "computer interfaces", but there are several levels of them, each with different transparency levels and malleability. Here we have to face the problem of Passive vs. Active, of Dependent vs. Independent. To have a "virtuoso" handling of the computer as a tool is to understand and control its algorithmical mind to its fullest.

On the other hand, people with extreme facility to control the computer but an extreme lack of the most basic musical notions and training (in other words, non-musicians, amateurs), can take sounds out of the computer with profusion. This fact plus today's philosophical poverty and renowned childish fascination for technology are enough already to send the ideas of Electroacoustic Music and its precious possibilities as an Art form directly to hell upside down (head first), as the Brazilians say.

The computer's breakthrough as a tool for Electroacoustic Music comes from its algorithmical possibilities. But what is superficially referred to as "algorithmical composition" is a concept terribly misunderstood by the majority of people, musicians or laymen. There are all sorts of mistaken preconceptions about it: it is

irrelevantly intellectual, it is cold-blooded, unmusical, inhumane, machine-like. That is understandable. With the aversion that some musicians have to computer programming techniques,[49] the applications of algorithmical composition are left most of the time in the hands of scientists, programmers and mathematicians that, ignorant of the most important notions of the Musical métier, can't help to just realize one of their scientific equations using sound. And then we have all those fractals, genetic algorithms, neural nets crudely translated into sound, in the most amateurish way. I have nothing against the ideas themselves, only the musical applications people usually give to them.

For me, Algorithmical composition is not the musically barren concept of "music generated by algorithms" ("barren" because it denies the composer's Ear). Instead, it is a method of giving efficient instructions to the computer, instructions that are extremely precise even in their imprecision, instructions in the only language a computer understands: algorithms. The virtuosity in the use of the computer is the virtuosity of explaining in precise computer terms the things you want done. The computer is an automaton, a slave of the programmer's thoughts. The composer thinks, communicates his thoughts to the computer via an algorithm, and the computer deploys the hordes of sounds precisely as commanded. If the composer is incompetent, either in his musical thought or in his ability to command the computer to materialize his ideas, all is lost.

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[49] Perhaps this is the same aversion that Pierre Henry had when he was confronted with the tape recorder for the first time. But he did overcome it !

My whole point: Computer Music is not a genre of music, except for the simplists. The computer can be used to produce an infinite number of different types of music. As aesthetics, it is the extension of the ideas of Electroacoustic Music.

What draws me to it, like lamp light attracts flies, is the very fact that with the computer you can accomplish with extreme virtuosity both principles of Concrete and Electronic music. I have no interest in technology itself. I see the computer (and technology in general) as a tool to solve a human problem, to achieve a goal with more precision than bare hands could give you. I like thinking that the computer is just like the wheel and the spear, a tool, only a "little bit" smarter.

The concepts of Musique Concrète are the most dear to me, and they serve me more and more as my North. What will suffice to say here is that the music I desire to manufacture using the computer is inherently based on the principles of Musique Concrète, its ideas of acousmatics and the new horizons they point to.

" Je crois que l'appareil enregistreur est actuellement le meilleur instrument du compositeur qui veut réelement créer par l'oreille et pour l'oreille. Si nous voulons lutter contre la mécanique, il faut employer de méthodes méchaniques, ainsi la machine se retournera contre elle-même. Un son enregistré est instantanément détruit en tant que machine.

Le Mythe du Moderne n'existe plus. Les bruits seront supprimés. Ils deviendront désincarnés, désignifiés et comme sacralisés.

Alors ce sera peut-être la musique concrète, la musique du VIVANT et du

SOLEIL."[50]

4.3. Case study of pseudo musical instrument and musical system

I will here describe a reasonably successful collection of algorithms I created for the seventh scene of KA. The interest here is that these algorithms materialize at the same time a pseudo musical instrument and a Musical System with a precise collection of possible notes and timbres distributed in space, strict rules for manipulating these possibilities, and a complex rhythmical system.

4.3.1 General Description

Scene seven is supposed to contain an instrument made of an elephant tusk with five strings (later on, six), attached to the tusk by pegs of years. The five years on top show the times when the East invaded the West, and the five in the bottom, when the West invaded the East. It is also mentioned in Khlebnikov's story that each string is divided in six parts. Trying to conceive an image of this fantastic instrument, I thought of a C++ class that would "speak" through the RTcmix STRUM instrument.

First, I studied what happens when a string is divided in six equal parts. With frets positioned at those six points, your string will be set to play an inverted

[50] Pierre Henry. More quotes taken from Michel Chion's book "Pierre Henry".

harmonic series: if 1x string length produces C3, for example, (5/6)x gives Eb3, (4/6)x gives G3, (3/6)x gives C4, (2/6)x gives G4, (1/6)x gives G5, everything in the natural tuning of the harmonic series, obviously.

Because this tusk harp was supposed to accompany Laili singing, I wanted it to use the "Laili mode", so I searched for possibilities of finding six collections of six notes in this mode that could conform to that "minor chord" formation described above, with a maximum margin of error of a quarter tone, as if the strange tuning generated from the use of the Laili mode was derived from the frets being positioned slightly off from the equal string subdivisions. To prevent the instrument from playing only arpeggios, the fingers were thought to move across and not along the strings. I was supposed to imagine five virtual fingers moving across the fretboards according to strict rules of fingering.

Fig. 17.

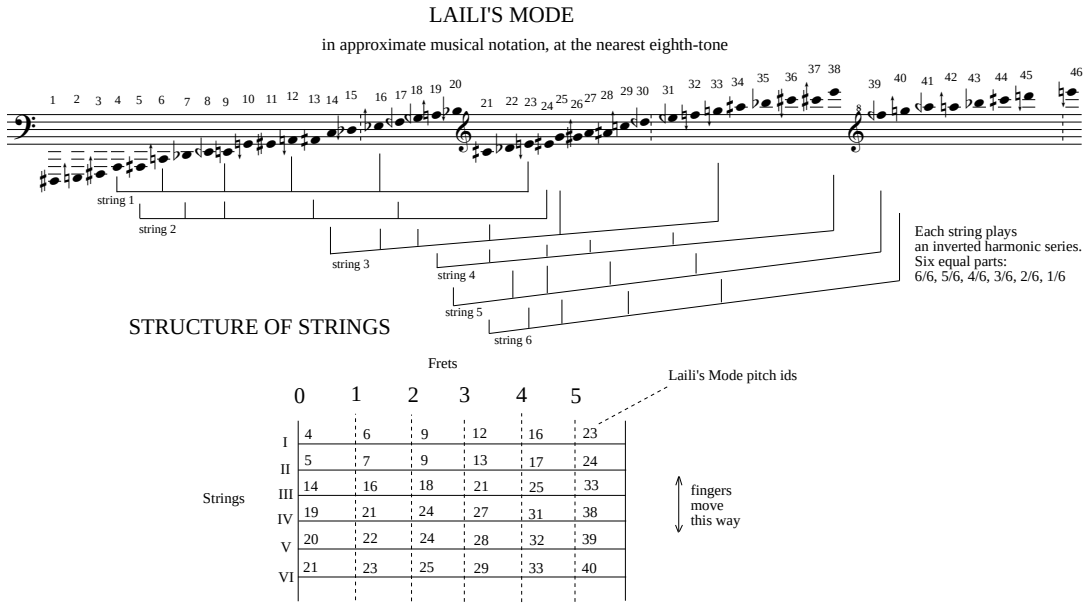
LAILI'S MODE

Based on a multiplication proportion of 1.038566 ;
it gives steps of 0.655113 semitones ;
The proportion is the result of the division of the space between
158.012253 Hz and 640.841980 Hz in 37 equal parts.

1	+ 0 step	38.961067 Hz	27.031219 midival	re#1+0.031219
2	+ 2 steps	42.024155 Hz	28.341446 midival	mi1 + 0.341446
3	+ 3 steps	47.076176 Hz	30.306786 midival	fa#1 + 0.306786
4	+ 4 steps	54.769314 Hz	32.927235 midival	la1 - 0.072765
5	+ 1 step	56.881542 Hz	33.582348 midival	la#1 - 0.417652
6	+ 4 steps	66.177086 Hz	36.202801 midival	do2 + 0.202801
7	+ 1 step	68.729248 Hz	36.857910 midival	do#2 - 0.142090
8	+ 4 steps	79.960930 Hz	39.478363 midival	re#2 + 0.478363

9	+ 1 step	83.044693 Hz	40.133476 midival	mi2 + 0.133476
10	+ 4 steps	96.615791 Hz	42.753929 midival	sol2 - 0.246071
11	+ 2 steps	104.211601 Hz	44.064148 midival	sol#2 + 0.064148
12	+ 1 step	108.230614 Hz	44.719261 midival	la2 - 0.280739
13	+ 1 step	112.404625 Hz	45.374374 midival	la2 + 0.374374
14	+ 4 steps	130.773697 Hz	47.994827 midival	do3 - 0.005173
15	+ 2 steps	141.055023 Hz	49.305054 midival	do#3 + 0.305054
16	+ 3 steps	158.012253 Hz	51.270393 midival	re#3 + 0.270393
17	+ 2 steps	170.435028 Hz	52.580620 midival	fa3 - 0.419380
18	+ 3 steps	190.924210 Hz	54.545959 midival	sol3 - 0.454041
19	+ 4 steps	222.124878 Hz	57.166409 midival	la3 + 0.166409
20	+ 1 step	230.691315 Hz	57.821522 midival	la#3 - 0.178478
21	+ 4 steps	268.390686 Hz	60.441975 midival	do4 + 0.441975
22	+ 1 step	278.741394 Hz	61.097084 midival	do#4 + 0.097084
23	+ 4 steps	324.293091 Hz	63.717537 midival	mi4 - 0.282463
24	+ 1 step	336.799713 Hz	64.372650 midival	mi4 + 0.372650
25	+ 4 steps	391.839233 Hz	66.993103 midival	sol4 - 0.006897
26	+ 2 steps	422.645264 Hz	68.303322 midival	sol#4 + 0.303322
27	+ 1 step	438.944946 Hz	68.958435 midival	la4 - 0.041565
28	+ 1 step	455.873260 Hz	69.613548 midival	la#4 - 0.386452
29	+ 4 steps	530.371643 Hz	72.234001 midival	do5 + 0.234001
30	+ 2 steps	572.068970 Hz	73.544228 midival	re5 - 0.455772
31	+ 3 steps	640.841370 Hz	75.509567 midival	mi5 - 0.490433
32	+ 2 steps	691.223877 Hz	76.819794 midival	fa5 - 0.180206
33	+ 3 steps	774.320740 Hz	78.785133 midival	sol5 - 0.214867
34	+ 4 steps	900.859680 Hz	81.405586 midival	la5 + 0.405586
35	+ 1 step	935.602112 Hz	82.060699 midival	la#5 + 0.060699
36	+ 4 steps	1088.497559 Hz	84.681152 midival	do#6 - 0.318848
37	+ 1 step	1130.475952 Hz	85.336258 midival	do#6 + 0.336258
38	+ 4 steps	1315.217407 Hz	87.956711 midival	mi6 - 0.043289
39	+ 1 step	1365.939941 Hz	88.611824 midival	fa6 - 0.388176
40	+ 4 steps	1589.160889 Hz	91.232277 midival	sol6 + 0.232277
41	+ 2 steps	1714.098511 Hz	92.542496 midival	la6 - 0.457504
42	+ 1 step	1780.204346 Hz	93.197609 midival	la6 + 0.197609
43	+ 1 step	1848.859497 Hz	93.852722 midival	la#6 - 0.147278
44	+ 4 steps	2150.998779 Hz	96.473175 midival	do7 + 0.473175
45	+ 2 steps	2320.108398 Hz	97.783401 midival	re7 - 0.216599
46	+ 3 steps	2599.024902 Hz	99.748741 midival	mi7 - 0.251259

Fig. 18.



Strings	0	1	2	3	4	5
I	4	6	9	12	16	23
II	5	7	9	13	17	24
III	14	16	18	21	25	33
IV	19	21	24	27	31	38
V	20	22	24	28	32	39
VI	21	23	25	29	33	40

Each string of the tusk harp has its own fixed stereophonic positioning and an unique set of STRUM parameters so that each string possesses a different particular timbre. Also, a string had to be prepared to never play two notes at the same time. Unless it is played again, the string has to continue vibrating till the extinction of the sound, but if a string is still vibrating when a new pluck order is given, the previous note has to be stopped accordingly.

4.3.2 Implementation

To code such an instrument in C++, I designed a system of 3 classes.

A Strumline class is used to hold a RTcmix STRUM command and keep track of its current state, if it is still alive (vibrating, that is), or not. Here are its definition, constructor and destructor methods. There are other four methods: one to set the

STRUM command line, one to recall it, one that verifies if the previous note is still vibrating, and one that adjusts the length of the previous note (i.e. turns it off).

```
class Strumline
{

private:

        char strumstring[500], inst_name[50];
        float start, dur, pitch, fundprop,nyquist,amp, squish, spread  ;

public:

        void set_strumline(char * xinst_name , float xstart, float xdur, float xpitch, float
xfundprop,float xnyquist,float xamp, float xsquish, float xspread ) ;
        float get_border();
        void adjust_border(float time);
        char* get_strumstring();

Strumline::Strumline()
{
        start = 0.0 ;
        dur = 0.0 ;
        pitch = 0.0 ;
        fundprop = 0.0 ;
        nyquist = 0.0 ;
        amp = 0.0 ;
        squish = 0.0 ;
        spread = 0.0 ;
        strcpy(strumstring,"\0");
        strcpy(inst_name,"\0");
}
        ~Strumline(){}
};

void Strumline::set_strumline(char * xinst_name , float xstart, float xdur, float xpitch,
float xfundprop,float xnyquist,float xamp, float xsquish, float xspread )
{
        strcpy(inst_name,xinst_name);
        start = xstart ;
        dur = xdur ;
        pitch = xpitch ;
        fundprop = xfundprop ;
        nyquist = xnyquist ;
        amp = xamp ;
        squish = xsquish ;
        spread = xspread ;
}
```

```
float Strumline::get_border()
{
        return (  start + dur ) ;
}

void Strumline::adjust_border(float border)
{
        dur = border - start ;
}

char* Strumline::get_strumstring()
{
        strcpy(strumstring,"\0");
        sprintf(strumstring,"%s(%f,%f,%f,%f,%f,%f,%f,1)\0",inst_name,start,
dur,
pitch,fundprop,nyquist,amp,squish,spread);

        return strumstring ;
}
```

Next, we have a Tusk_String class that contains one Strumline class and is used to control all the operations necessary for a string to play. This class prints STRUM commands to the stream defined as TARGET_file. A higher level program will later use this Cmix script to produce the sounds. Because this process does not occur in real time, we can control the duration of the notes by holding the printing of the STRUM command line until another note is requested from the string. When this occurs, before the previous STRUM command is flushed, the elapsed time between the old and the new notes are calculated and compared with the maximum vibration time set for the string. If the previous string would still be vibrating at that time, the duration of the previous STRUM line is adjusted accordingly. Because of this, we have to add a flush() method at the end otherwise the last note requested would never be played (as it always waits for the next note to be flushed). Basically, other than the constructor and destructor, we have five methods: one to set the output stream,

one to set the pitches (in Hz) for each of the six positions along the string (five frets plus the open string), one to set the STRUM timbral parameters and the stereophonic positioning for the string, one to receive and realize playing commands, and finally, one method to flush the last Strumline class buffer, as we discussed above.

```
class Tusk_String
{

private :

        FILE * TARGET_file ;
        int first_time_flag ;
        float pitch_Hz[6] ;
        float base_amp, base_dur, fundprop, nyquist, squish, spread ;
        char inst_name[50];

        Tools t ;
        Strumline strum_buffer ;

public :

        void redirect_printing(FILE * file);
        void set_pitch_Hz(float a, float b,float c,float d,float e, float f );
        void set_params(char * xinst_name, float xbase_amp, float xbase_dur, float
xfundprop, float xnyquist, float xsquish, float xspread );
        void receive_command(int pitch_id, float start_time, float amp );
        void flush_buffer();

Tusk_String::Tusk_String()
{
        first_time_flag = 1 ;
        TARGET_file = stdout ;
        base_amp = 0.0 ;
        base_dur = 0.0 ;
        fundprop= 0.0 ;
        nyquist = 0.0 ;
        squish = 0.0 ;
        spread = 0.0 ;
        strcpy(inst_name,"\0");

}
        ~Tusk_String(){}

};
```

```
void Tusk_String::redirect_printing(FILE * file)
{
	TARGET_file = file ;
}

void Tusk_String::set_pitch_Hz(float a, float b,float c,float d,float e,float f )
{
	pitch_Hz[0]= a ;
	pitch_Hz[1]= b ;
	pitch_Hz[2]= c ;
	pitch_Hz[3]= d ;
	pitch_Hz[4]= e ;
	pitch_Hz[5]= f ;
}

void Tusk_String::set_params(char * xinst_name, float xbase_amp, float xbase_dur,
float xfundprop, float xnyquist, float xsquish, float xspread )
{
	base_amp = xbase_amp ;
	base_dur = xbase_dur ;
	fundprop= xfundprop ;
	nyquist = xnyquist ;
	squish = xsquish ;
	spread = xspread ;

	if ( strcmp(xinst_name,"strum\0")== 0 ) strcpy(inst_name,"start\0");
	if ( strcmp(xinst_name,"STRUM\0")== 0 ) strcpy(inst_name,"START\0");
}


void Tusk_String::receive_command(int pitch_id, float start_time, float amp )
{
	if ( first_time_flag == 1)
	{
		strum_buffer.set_strumline(inst_name,start_time,base_dur,
t.hertz_to_octpc(pitch_Hz[pitch_id],0.003),fundprop,nyquist,amp*base_amp,squish,
spread);
		first_time_flag = 0 ;
		return ;
	}
	if ( first_time_flag != 1)
	{
		if (start_time < strum_buffer.get_border() ) {
			strum_buffer.adjust_border(start_time) ; }

		fprintf(TARGET_file,"setline ( 0.0,0.0 , 0.01,1.0 , 0.99,1.0 , 1.0,0.0)\n");
		fprintf(TARGET_file,"%s\n",strum_buffer.get_strumstring() ) ;
		strum_buffer.set_strumline(inst_name,start_time,base_dur,
t.hertz_to_octpc(pitch_Hz[pitch_id],0.003),fundprop,nyquist,amp*base_amp,squish,
spread);
		return ;
	}
}
```

```
void Tusk_String::flush_buffer()
{
        if ( first_time_flag != 1 )
        {
                fprintf(TARGET_file,"setline ( 0.0,0.0 , 0.01,1.0 , 0.99,1.0 , 1.0,0.0)\n");
                fprintf(TARGET_file,"%s\n",strum_buffer.get_strumstring() ) ;
        }
}
```

Finally, we have the Tusk_Harp class, that contains six Tusk_String classes (one for each string, of course). There are two constructors, so that the strings can be set to play either together or in individual soundfiles. The constructors initialize the strings with the STRUM timbral parameters I selected, their stereophonic positioning, and the pitches the string frets are supposed to play. The class KA_modes holds all the specifications of the tuning systems and modes used in KA. The Play() method, the one used inside another program to actually play the harp, receives only the parameters string, fret, point in time to start playing and amplitude (linear, from .0 to 1.0). It functions basically as a routing system, relaying the information to the appropriate string. The method prepare() realizes the formalities of setting the STRUM instrument to play in real time or to play writing a soundfile and terminate() wraps up the string operations at the end by flushing their Strumline buffers. The get_pitch() method just provides the convenience of recalling the note associated to a particular string fret.

```
class Tusk_Harp
{

private:
        FILE * file_A ;
        FILE * file_B ;
        FILE * file_C ;
        FILE * file_D ;
        FILE * file_E ;
        FILE * file_F ;

        int p_grid[6][6];
        char inst_name[50];

        Tusk_String string_A ;
        Tusk_String string_B ;
        Tusk_String string_C ;
        Tusk_String string_D ;
        Tusk_String string_E ;
        Tusk_String string_F ;
        KA_modes km ;

public:

        void prepare();
        void play( int string, int fret, float start_time, float amp );
        void terminate();
        int get_pitch(int a_string,int a_fret);


Tusk_Harp::Tusk_Harp(char * xinst_name, FILE* a)
{
        km.set_mode("laili");

        file_A = a ;
        file_B = a ;
        file_C = a  ;
        file_D = a ;
        file_E = a ;
        file_F = a ;

        strcpy(inst_name,xinst_name);

        string_A.redirect_printing(file_A);
        string_B.redirect_printing(file_B);
        string_C.redirect_printing(file_C);
        string_D.redirect_printing(file_D);
        string_E.redirect_printing(file_E);
        string_F.redirect_printing(file_F);

        string_A.set_params(inst_name,60000.0,3.0,1.0,0.0,50.0,.25) ;
        string_B.set_params(inst_name,30000.0,4.5,(4.5*1/3),0.0,13.0,.35) ;
        string_C.set_params(inst_name,25000.0,2.0,(2.0/3.0),0.0,8.0,.45) ;
```

```
        string_D.set_params(inst_name,7500.0,3.0,1.0,0.1,2.0,.55) ;
        string_E.set_params(inst_name,22000.0,4.5,(4.5*0.3),0.3,10.0,.65) ;
        string_F.set_params(inst_name,6000.0,3.0,(3.0*0.44),0.0,0.05,.75) ;

        string_A.set_pitch_Hz(km.get_pitch_Hz(4),km.get_pitch_Hz(6),
        km.get_pitch_Hz(9),km.get_pitch_Hz(12),km.get_pitch_Hz(16),
        km.get_pitch_Hz(23) );

        string_B.set_pitch_Hz(km.get_pitch_Hz(5),km.get_pitch_Hz(7),
        km.get_pitch_Hz(9),km.get_pitch_Hz(13),km.get_pitch_Hz(17),
        km.get_pitch_Hz(24) );

        string_C.set_pitch_Hz(km.get_pitch_Hz(14),km.get_pitch_Hz(16),
        km.get_pitch_Hz(18),km.get_pitch_Hz(21),km.get_pitch_Hz(25),
        km.get_pitch_Hz(33) );

        string_D.set_pitch_Hz(km.get_pitch_Hz(19),km.get_pitch_Hz(21),
        km.get_pitch_Hz(24),km.get_pitch_Hz(27),km.get_pitch_Hz(31),
        km.get_pitch_Hz(38) );

        string_E.set_pitch_Hz(km.get_pitch_Hz(20),km.get_pitch_Hz(22),
        km.get_pitch_Hz(24),km.get_pitch_Hz(28),km.get_pitch_Hz(32),
        km.get_pitch_Hz(39) );

        string_F.set_pitch_Hz(km.get_pitch_Hz(21),km.get_pitch_Hz(23),
        km.get_pitch_Hz(25),km.get_pitch_Hz(29),km.get_pitch_Hz(33),
        km.get_pitch_Hz(40) );


p_grid[0][0]= 4 ; p_grid[0][1]= 6 ; p_grid[0][2]=9 ; p_grid[0][3]=12 ;
p_grid[0][4]= 16; p_grid[0][5]=23 ;

p_grid[1][0]= 5; p_grid[1][1]=7 ; p_grid[1][2]=9 ; p_grid[1][3]= 13;
p_grid[1][4]= 17; p_grid[1][5]= 24;

p_grid[2][0]=14 ; p_grid[2][1]= 16; p_grid[2][2]=18 ; p_grid[2][3]= 21;
p_grid[2][4]= 25; p_grid[2][5]= 33;

p_grid[3][0]= 19; p_grid[3][1]=21 ; p_grid[3][2]= 24; p_grid[3][3]=27 ;
p_grid[3][4]= 31; p_grid[3][5]= 38;

p_grid[4][0]=20 ; p_grid[4][1]= 22; p_grid[4][2]=24 ; p_grid[4][3]= 28;
p_grid[4][4]= 32; p_grid[4][5]=39 ;

p_grid[5][0]= 21; p_grid[5][1]=23 ; p_grid[5][2]= 25; p_grid[5][3]=29 ;
p_grid[5][4]= 33; p_grid[5][5]= 40;


}
```

```
Tusk_Harp::Tusk_Harp(char * xinst_name, FILE* a, FILE* b, FILE* c, FILE* d,
FILE* e, FILE* f)
{
        km.set_mode("laili");

        file_A = a ;
        file_B = b ;
        file_C = c  ;
        file_D = d ;
        file_E = e ;
        file_F = f ;

        strcpy(inst_name,xinst_name);

        string_A.redirect_printing(file_A);
        string_B.redirect_printing(file_B);
        string_C.redirect_printing(file_C);
        string_D.redirect_printing(file_D);
        string_E.redirect_printing(file_E);
        string_F.redirect_printing(file_F);

        string_A.set_params(inst_name,60000.0,3.0,1.0,0.0,50.0,.25) ;
        string_B.set_params(inst_name,15000.0,3.0,2.0,0.0,4.0,.35) ;
        string_C.set_params(inst_name,25000.0,2.0,(2.0/3.0),0.0,8.0,.45) ;
        string_D.set_params(inst_name,15000.0,3.0,1.0,0.1,2.0,.55) ;
        string_E.set_params(inst_name,22000.0,4.5,(4.5*0.3),0.3,10.0,.65) ;
        string_F.set_params(inst_name,12000.0,3.0,(3.0*0.44),0.0,0.05,.75) ;

        string_A.set_pitch_Hz(km.get_pitch_Hz(4),km.get_pitch_Hz(6),
        km.get_pitch_Hz(9),km.get_pitch_Hz(12),km.get_pitch_Hz(16),
        km.get_pitch_Hz(23) );

        string_B.set_pitch_Hz(km.get_pitch_Hz(5),km.get_pitch_Hz(7),
        km.get_pitch_Hz(9),km.get_pitch_Hz(13),km.get_pitch_Hz(17),
        km.get_pitch_Hz(24) );

        string_C.set_pitch_Hz(km.get_pitch_Hz(14),km.get_pitch_Hz(16),
        km.get_pitch_Hz(18),km.get_pitch_Hz(21),km.get_pitch_Hz(25),
        km.get_pitch_Hz(33) );

        string_D.set_pitch_Hz(km.get_pitch_Hz(19),km.get_pitch_Hz(21),
        km.get_pitch_Hz(24),km.get_pitch_Hz(27),km.get_pitch_Hz(31),
        km.get_pitch_Hz(38) );

        string_E.set_pitch_Hz(km.get_pitch_Hz(20),km.get_pitch_Hz(22),
        km.get_pitch_Hz(24),km.get_pitch_Hz(28),km.get_pitch_Hz(32),
        km.get_pitch_Hz(39) );

        string_F.set_pitch_Hz(km.get_pitch_Hz(21),km.get_pitch_Hz(23),
        km.get_pitch_Hz(25),km.get_pitch_Hz(29),km.get_pitch_Hz(33),
        km.get_pitch_Hz(40) );
```

```
p_grid[0][0]= 4 ; p_grid[0][1]= 6 ; p_grid[0][2]=9 ; p_grid[0][3]=12 ;
p_grid[0][4]= 16; p_grid[0][5]=23 ;

p_grid[1][0]= 5; p_grid[1][1]=7 ; p_grid[1][2]=9 ; p_grid[1][3]= 13;
p_grid[1][4]= 17; p_grid[1][5]= 24;

p_grid[2][0]=14 ; p_grid[2][1]= 16; p_grid[2][2]=18 ; p_grid[2][3]= 21;
p_grid[2][4]= 25; p_grid[2][5]= 33;

p_grid[3][0]= 19; p_grid[3][1]=21 ; p_grid[3][2]= 24; p_grid[3][3]=27 ;
p_grid[3][4]= 31; p_grid[3][5]= 38;

p_grid[4][0]=20 ; p_grid[4][1]= 22; p_grid[4][2]=24 ; p_grid[4][3]= 28;
p_grid[4][4]= 32; p_grid[4][5]=39 ;

p_grid[5][0]= 21; p_grid[5][1]=23 ; p_grid[5][2]= 25; p_grid[5][3]=29 ;
p_grid[5][4]= 33; p_grid[5][5]= 40;

}
        ~Tusk_Harp(){}

};

void Tusk_Harp::prepare()
{
        if ( strcmp(inst_name,"strum\0")== 0 )
        {
                fprintf(file_A,"reset(44100)\n");
                fprintf(file_B,"reset(44100)\n");
                fprintf(file_C,"reset(44100)\n");
                fprintf(file_D,"reset(44100)\n");
                fprintf(file_E,"reset(44100)\n");
                fprintf(file_F,"reset(44100)\n");
        }
        if ( strcmp(inst_name,"STRUM\0")== 0 )
        {
                fprintf(file_A,"rtsetparams(44100,2)\n");
                fprintf(file_B,"rtsetparams(44100,2)\n");
                fprintf(file_C,"rtsetparams(44100,2)\n");
                fprintf(file_D,"rtsetparams(44100,2)\n");
                fprintf(file_E,"rtsetparams(44100,2)\n");
                fprintf(file_F,"rtsetparams(44100,2)\n");
        }
}


void Tusk_Harp::play( int string, int fret, float start_time, float amp )
{

        if ( string == 1 )
        {
                string_A.receive_command(fret,start_time,amp);
        }
```

```
        if ( string == 2 )
        {
                string_B.receive_command(fret,start_time,amp);
        }
        if ( string == 3 )
        {
                string_C.receive_command(fret,start_time,amp);
        }
        if ( string == 4 )
        {
                string_D.receive_command(fret,start_time,amp);
        }
        if ( string == 5 )
        {
                string_E.receive_command(fret,start_time,amp);
        }
        if ( string == 6 )
        {
                string_F.receive_command(fret,start_time,amp);
        }
}

void Tusk_Harp::terminate()
{
        string_A.flush_buffer();
        string_B.flush_buffer();
        string_C.flush_buffer();
        string_D.flush_buffer();
        string_E.flush_buffer();
        string_F.flush_buffer();
}

int Tusk_Harp::get_pitch(int a_string,int a_fret)
{
            if ( a_string < 1 || a_string > 6 ) return 0 ;
            if ( a_fret < 0 || a_fret > 5 ) return 0 ;

        return ( p_grid[a_string-1][a_fret] ) ;
}
```

With all this, the very complex operations required to play the tusk harp and materialize its results into sound are hidden from the main user. Inside the actual algorithm that generates a musical piece, the user has access to the Harp simply by calling its Play() method, without worrying about the gruesome details required to fulfill that request.

The next step is to formalize the fingering rules. Remember that the fingers are thought to move across the fretboard and the strings and you can play with all five fingers.

When moving fret-wise (horizontally, if we imagine the strings running parallel to the ground), we can either keep in the same fret, move to its neighbors or to no fret (open string). From an open string, we can return to any fret. String-wise (vertically), you can move according to the availability of fingers. The fingers are numbered from 1 to 5, in reverse order than the piano fingering tradition. You can move to a new string if there is a finger available in that direction, remembering that two adjacent fingers do not have to necessarily move string by string, that is, jumps are allowed.

Chords up to six notes are possible (or only five notes, if one of the string is declared to be "forbidden") and depend on the position of fingers at each moment. Since from a fret you can only reach its neighbors, only two adjacent fret regions (of different strings, obviously) can be stopped simultaneously. For a six note chord, at least one of the notes has to come from an open string.

Here are the methods that perform the melodic changes of position and the creation of chords:

```
//      a_string, a_fret, and a_finger refer to the current string, fret and finger
//      position.
//      n_string, n_fret and n_finger refer to the new calculated positions.
//      t.rnd_int(x,y) is a method from class Tools that returns a random integer value
//      between x and y.
//      a_string >= 1 and <= 6 ; a_fret >= 0 and <= 5 ; a_finger >= 1 and <= 5 ;
//      down_is_forbidden(), up_is_forbidden() and all_is_allowed() are boolean
//      methods that verify availability of fingers.
```

```
void move_to_new_position( int * a_string , int * a_fret , int * a_finger )
{
	int n_fret, n_finger, n_string,direction ;
	float xx_fl ;
	Tools t ;

if ( *a_fret == 0 )
{
	n_fret = t.rnd_int(1,5);
	n_string = *a_string ;
	n_finger = *a_finger ;
}

if ( *a_fret != 0 )
{
	if ( *a_fret ==  1 ) n_fret = t.rnd_int(0,2) ;
	if ( *a_fret ==  5 )
	{
		direction = t.rnd_int(1,3) ;
		if ( direction == 1 ) n_fret = 0 ;
		if ( direction == 2 ) n_fret = 5 ;
		if ( direction == 3 ) n_fret = 4 ;
	}
	if ( *a_fret > 1 && *a_fret < 5 )
	{
		direction = t.rnd_int(1,4) ;
		if ( direction == 1 ) n_fret = 0 ;
		if ( direction == 2 ) n_fret = *a_fret - 1 ;
		if ( direction == 3 ) n_fret = *a_fret + 1 ;
		if ( direction == 4 ) n_fret = *a_fret ;
	}

	if ( *a_fret == n_fret && n_fret != 0 )
	{
		if ( up_is_forbidden(*a_finger) )
		{
		if ( *a_string <= 1 ) n_string = 1 ;
		if ( *a_string > 1 ) n_string = t.rnd_int(1,*a_string ) ;
		if ( (*a_string - n_string) == 0 && *a_string <= 1 ) n_finger = 1 ;
		if ( (*a_string - n_string) == 0 && *a_string > 1 ) n_finger =
*a_finger ;
		if ( (*a_string - n_string) == 1 ) n_finger = *a_finger - 1 ;
		if ( (*a_string - n_string) == 2 ) n_finger = *a_finger - t.rnd_int(1,2) ;
		if ( (*a_string - n_string) == 3 ) n_finger = *a_finger - t.rnd_int(2,3) ;
		if ( (*a_string - n_string) == 4 ) n_finger = *a_finger - t.rnd_int(3,4) ;
		if ( (*a_string - n_string) == 5 ) n_finger = *a_finger - 4 ;

		}
		if ( down_is_forbidden(*a_finger) )
		{
		if ( *a_string >= 6 ) n_string = 6 ;
		if ( *a_string < 6 ) n_string = t.rnd_int(*a_string,6 ) ;
		if ( (n_string - *a_string) == 0 && *a_string >= 6 ) n_finger = 5 ;
```

```
                if ( (n_string - *a_string) == 0 && *a_string < 6 ) n_finger =
*a_finger ;
                if ( (n_string - *a_string) == 1 ) n_finger = *a_finger + 1 ;
                if ( (n_string - *a_string) == 2 ) n_finger = *a_finger + t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == 3 ) n_finger = *a_finger + t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == 4 ) n_finger = *a_finger + t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == 5 ) n_finger = *a_finger + 4 ;
                }
                if ( all_is_allowed(*a_finger) )
                {
                n_string = t.rnd_int(1,6) ;
                if ( (n_string - *a_string) == 0 ) n_finger = *a_finger ;
                if ( (n_string - *a_string) == 1 ) n_finger = *a_finger + 1 ;
                if ( (n_string - *a_string) == 2 ) n_finger = *a_finger + t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == 3 ) n_finger = *a_finger + t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == 4 ) n_finger = *a_finger + t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == 5 ) n_finger = *a_finger + 4 ;
                if ( (n_string - *a_string) == -1 ) n_finger = *a_finger - 1 ;
                if ( (n_string - *a_string) == -2 ) n_finger = *a_finger - t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == -3 ) n_finger = *a_finger - t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == -4 ) n_finger = *a_finger - t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == -5 ) n_finger = *a_finger - 4 ;

                        if ( n_finger > 5 ) n_finger= 5 ;
                        if ( n_finger < 1 ) n_finger= 1 ;
                }
        }

        if ( *a_fret != n_fret && n_fret != 0 )
        {
                if ( up_is_forbidden(*a_finger) )
                {
                if ( *a_string <= 1 ) n_string = 1 ;
                if ( *a_string > 1 ) n_string = t.rnd_int(1,(*a_string)-1 ) ;
                if ( (*a_string - n_string) == 0 ) n_finger = 1 ;
                if ( (*a_string - n_string) == 1 ) n_finger = *a_finger - 1 ;
                if ( (*a_string - n_string) == 2 ) n_finger = *a_finger - t.rnd_int(1,2) ;
                if ( (*a_string - n_string) == 3 ) n_finger = *a_finger - t.rnd_int(2,3) ;
                if ( (*a_string - n_string) == 4 ) n_finger = *a_finger - t.rnd_int(3,4) ;
                if ( (*a_string - n_string) == 5 ) n_finger = *a_finger - 4 ;

                }
                if ( down_is_forbidden(*a_finger) )
                {
                if ( *a_string >= 6 ) n_string = 6 ;
                if ( *a_string < 6 ) n_string = t.rnd_int( (*a_string)+1 ,6 ) ;
                if ( (n_string - *a_string) == 0 ) n_finger = 5 ;
                if ( (n_string - *a_string) == 1 ) n_finger = *a_finger + 1 ;
                if ( (n_string - *a_string) == 2 ) n_finger = *a_finger + t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == 3 ) n_finger = *a_finger + t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == 4 ) n_finger = *a_finger + t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == 5 ) n_finger = *a_finger + 4 ;
                }
```

```
                if ( all_is_allowed(*a_finger) )
                {
                        n_string = t.rnd_int(1,6) ;
                        while ( n_string == *a_string ) n_string = t.rnd_int(1,6) ;

                        if ( (n_string - *a_string) == 1 ) n_finger = *a_finger + 1 ;
                if ( (n_string - *a_string) == 2 ) n_finger = *a_finger + t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == 3 ) n_finger = *a_finger + t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == 4 ) n_finger = *a_finger + t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == 5 ) n_finger = *a_finger + 4 ;
                if ( (n_string - *a_string) == -1 ) n_finger = *a_finger - 1 ;
                if ( (n_string - *a_string) == -2 ) n_finger = *a_finger - t.rnd_int(1,2) ;
                if ( (n_string - *a_string) == -3 ) n_finger = *a_finger - t.rnd_int(2,3) ;
                if ( (n_string - *a_string) == -4 ) n_finger = *a_finger - t.rnd_int(3,4) ;
                if ( (n_string - *a_string) == -5 ) n_finger = *a_finger - 4 ;

                        if ( n_finger > 5 ) n_finger= 5 ;
                        if ( n_finger < 1 ) n_finger= 1 ;
                }
        }

        if ( n_fret == 0 )
        {

                n_string = *a_string ;
                n_finger = *a_finger ;
        }
}


*a_string = n_string ;
*a_fret = n_fret ;
*a_finger = n_finger ;


return ;
}

bool up_is_forbidden(int finger)
{
        if ( finger == 5 ) return TRUE ;
        else return FALSE ;
}

bool down_is_forbidden(int finger)
{
        if ( finger == 1 ) return TRUE ;
        else return FALSE ;
}

bool all_is_allowed(int finger)
{
        if ( up_is_forbidden(finger) || down_is_forbidden(finger) ) return FALSE ;
```

```
        else return TRUE ;
}

//      The struct chord will hold an array of string, fret and finger values for
//      each note of the chord.

typedef struct { int array[10][10] ; int length ;} chord ;
chord choose_a_chord( int * a_string , int * a_fret , int * a_finger, int n_notechord,int
forbidden_string )
{
        chord result ;
        int chord_array[10][10] ,co, co_a,redo_flag,sort_array[10],xx_int ;
        float xx_fl ;
        Tools t ;

//      Initializes the chord array

        for (co = 0 ; co < 10 ; co ++)
        {
        for (co_a = 0 ; co_a < 10 ; co_a ++) chord_array[co][co_a]=0 ;
        }

//      Chooses and sorts an array of fingers

        chord_array[0][2] = *a_finger ;
        for (co = 1 ; co < n_notechord ; co++)
        {
                redo_flag = 1 ;
                while ( redo_flag == 1 )
                {
                        redo_flag = 0 ;
                        chord_array[co][2] = t.rnd_int(0,5) ;
                        if ( chord_array[co][2]== 0 )  chord_array[co][2] =
t.rnd_int(0,5) ;
                        for (co_a = 0 ; co_a < co ; co_a++)
                        {
                        if (chord_array[co_a][2]==chord_array[co][2]) redo_flag = 1 ;
                        }
                }
        }

        for (co = 0 ; co < 10 ; co ++)sort_array[co]=0 ;
        for (co = 0 ; co < n_notechord ; co++) sort_array[ chord_array[co][2] ]++ ;
        co_a = 0 ;
        for (co = 0 ; co < 10 ; co ++)
        {
                if ( sort_array[co]!= 0 ) { chord_array[co_a][2] = co ; co_a++; }
        }

//      Chooses and sorts an array of harp strings

        chord_array[0][0] = *a_string ;
        for (co = 1 ; co < n_notechord ; co++)
```

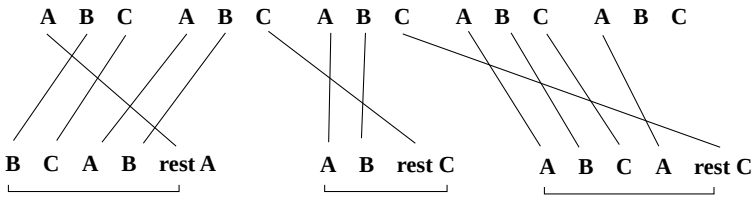
```
	{
		redo_flag = 1 ;
		while ( redo_flag == 1 )
		{
			redo_flag = 0 ;
			chord_array[co][0] = t.rnd_int(1,6) ;
			while(chord_array[co][0] == forbidden_string)
chord_array[co][0] = t.rnd_int(1,6) ;
			for (co_a = 0 ; co_a < co ; co_a++)
			{
			if (chord_array[co_a][0] == chord_array[co][0]) redo_flag = 1 ;
			}

		}
	}

	for (co = 0 ; co < 10 ; co ++)sort_array[co]=0 ;
	for (co = 0 ; co < n_notechord ; co++) sort_array[ chord_array[co][0] ]++ ;
	co_a = 0 ;
	for (co = 0 ; co < 10 ; co ++)
	{
		if ( sort_array[co]!= 0 ) { chord_array[co_a][0] = co ; co_a++; }
	}

//	Now deals with the frets.

if ( *a_fret == 0 )
{
	xx_int = t.rnd_int(1,4) ;
	for (co = 0 ; co < n_notechord ; co++)
	{
		chord_array[co][1] = t.rnd_int(xx_int,xx_int+1) ;
	}

	for (co = 0 ; co < n_notechord ; co++)
	{
		if (  chord_array[co][2] == 0 ) chord_array[co][1] = 0 ;
	}
}


if ( *a_fret != 0 )
{
	xx_int = t.rnd_int(1,2) ;

	for (co = 0 ; co < n_notechord ; co++)
	{
		if ( *a_fret == 5 ) chord_array[co][1] = t.rnd_int(4,5) ;
		if ( *a_fret == 1 ) chord_array[co][1] = t.rnd_int(1,2) ;
		if ( *a_fret > 1 && *a_fret < 5 )
		{
			if (xx_int == 1) chord_array[co][1] =
t.rnd_int(*a_fret,*a_fret+1) ;
```

```
                        if (xx_int == 2) chord_array[co][1] = t.rnd_int(*a_fret-
1,*a_fret) ;
                }
        }
        for (co = 0 ; co < n_notechord ; co++)
        {
                if (  chord_array[co][2] == 0 ) chord_array[co][1] = 0 ;
        }

}

//      The code now transmits one of the finger positions of the chord as the current
//      finger for the next harp operation

xx_int = t.rnd_int(0,(n_notechord-1) );
while ( chord_array[xx_int][2] == 0 ) xx_int = t.rnd_int(0,(n_notechord-1) );


*a_string = chord_array[xx_int][0] ;
*a_fret = chord_array[xx_int][1] ;
*a_finger = chord_array[xx_int][2] ;

//      code transmits the calculations to the chord struct

result.array = chord_array ;
result.length = n_notechord ;


return result ;
}
```

Finally, to make the tusk harp play some musical fragment, we still have to add rhythmical procedures. The one I used here is based on a fixed row of an user defined number of durations. These durations are chosen at the beginning of the algorithm, between 0.3 and 1.0 second, scaled by a "speed" proportion also defined by the user. The way to deploy this set of durations is a little bit intricate, but it generates very interesting "syncopations" that were later reused for the dance of the Huris in scene 3 of KA.

First, a certain number of successive notes to play is defined, chosen between 2 and 7. The durations are always used in the same order they were originally chosen, but the first action performed for a successive group of notes is to hold the duration on the top of the pile as a rest to be performed at the END of the group of notes. As an example, suppose we have a row of three durations, a, b and c, and we have to play three groups of notes with lengths of 4, 2, and 4 notes, respectively:

Fig. 19. Rhythmical procedure for the Tusk Harp



The main program will be controlled by the user. At the command line of the program, he has to define the name for the output soundfile, the total duration of the musical fragment, the speed (the multiplication factor for the row of durations), the forbidden string (because the instrument will sometimes have only five strings), the number of elements of the duration row, the sound output mode (real time or disk space), and a random seed. The output result of the program is identical every time you run it with the same seed.

```
main(int argc, char ** argv)
{
	FILE* write_file ;

	chord chordHere ;
	int co ,co_a,co_b,co_c,dummy_flag, current_finger, fret, string ,direction,dice ;
	int val[5][4] , x, xx, xxx,pitchHere,redo_flag,forbidden_string,co_rh_pt,n_rh_pt;
	int n_notechord;
	float time,amp,dur_to_rest,total_dur,speed ;
	float * rh_pt ;
	char output_soundfile[100],command[100];

	Tusk_Harp * harp ;
	Tools t ;

	if(argc!=8){ fprintf (stderr,"usage:[outputsoundfile] [total duration] [speed]
[forbidden string][n rh pt][ dummy run->0][random seed]\n"); exit(-1); }

	strcpy(output_soundfile,argv[1]);
	total_dur  = atof(argv[2])  ;
	speed  = atof(argv[3])  ;
	forbidden_string =  atoi(argv[4])  ;
	n_rh_pt =  atoi(argv[5])  ;
	dummy_flag  = atoi(argv[6])  ;
	srandom( atoi(argv[7]) ) ;

	write_file=fopen("bbbbogus_write","w");

	if (n_rh_pt < 1 || n_rh_pt > 300 ) { fprintf(stderr,"I'd prefer n_rh_pt to be
between 1 and 300\n"); exit(-1);}

	rh_pt = new float [n_rh_pt] ;
	for ( co=0 ; co < n_rh_pt ; co++) rh_pt[co] = t.rnd_float(.3,1) ;

	if ( dummy_flag == 0 ) harp = new Tusk_Harp("STRUM",write_file);
	if ( dummy_flag != 0 ) harp = new Tusk_Harp("strum",write_file);

	harp->prepare();
	if ( dummy_flag != 0 ) fprintf(write_file,"output(\"%s\")\n",output_soundfile);

time = 0.0 ;

fret = t.rnd_int(0,5);
string = t.rnd_int(1,6);
while ( string == forbidden_string ) string = t.rnd_int(1,6);
if ( string <= 3 ) current_finger = t.rnd_int(1,3);
if ( string >= 4 ) current_finger = t.rnd_int(3,5);
co_rh_pt = 0 ;

while ( time < total_dur )
{
	dur_to_rest = rh_pt[co_rh_pt] * speed ;
	co_rh_pt++ ;
```

```
if ( co_rh_pt >= n_rh_pt ) co_rh_pt = 0 ;

dice = t.rnd_int(1,3);
if ( dice != 1 )
{
        co_a = t.rnd_int(2,7);
        for ( co = 0 ; co < co_a ; co++)
        {
                if ( time > total_dur ) break ;
                harp->play(string,fret,time,t.rnd_float(.5,1)) ;
                time = time + (rh_pt[co_rh_pt] * speed ) ;
                co_rh_pt++ ;
                if ( co_rh_pt >= n_rh_pt ) co_rh_pt = 0 ;

                redo_flag = 1;
                while (redo_flag == 1)
                {
                        redo_flag = 0 ;
                        pitchHere = harp->get_pitch(string,fret) ;
                        for ( co_b = 0 ; co_b < 2 ; co_b++)
                        {
val[co_b][0] = string ; val[co_b][1] = fret ; val[co_b][2] = current_finger ;
move_to_new_position( &val[co_b][0] , &val[co_b][1] , &val[co_b][2] ) ;
                                if ( val[co_b][1]== 0 )
                                {
val[co_b][0] = string ; val[co_b][1] = fret ; val[co_b][2] = current_finger ;
move_to_new_position( &val[co_b][0] , &val[co_b][1] , &val[co_b][2] ) ;
                                }
                                if ( val[co_b][1]== 0 )
                                {
val[co_b][0] = string ; val[co_b][1] = fret ; val[co_b][2] = current_finger ;
move_to_new_position( &val[co_b][0] , &val[co_b][1] , &val[co_b][2] ) ;
                                }
val[co_b][3] = pitchHere - harp->get_pitch(val[co_b][0],val[co_b][1]) ;
if ( val[co_b][3] < 0 ) val[co_b][3] = val[co_b][3]*(-1);

                        }

                        x = val[0][3] ;
                        xx = 0 ;
                        for ( co_b = 1 ;co_b < 2 ;co_b++)
                        {
                        if ( val[co_b][3] < x ) {  x = val[co_b][3] ;  xx = co_b ;}
                        }

                        if ( val[xx][0] == forbidden_string ) redo_flag = 1 ;
                }

                string = val[xx][0] ;
                fret = val[xx][1] ;
                current_finger = val[xx][2] ;
        }
}
```

```
	if ( dice == 1 )
	{
		co_a = t.rnd_int(1,4);
		for ( co_c = 0 ; co_c < co_a ; co_c++)
		{
			if ( time > total_dur ) break ;
			n_notechord =  t.rnd_int(2,5);

			chordHere = choose_a_chord( &string , &fret ,
&current_finger, n_notechord , forbidden_string) ;
			for ( co = 0 ; co < n_notechord ; co++)
			{
				harp->play(chordHere.array[co][0],
chordHere.array[co][1], time+t.rnd_float(-0.02,0.02),t.rnd_float(.5,1)) ;
			}

			time = time + (rh_pt[co_rh_pt] * speed ) ;
			co_rh_pt++ ;
			if ( co_rh_pt >= n_rh_pt ) co_rh_pt = 0 ;
		}
	}

	time = time + dur_to_rest ;

}

harp->terminate();


fclose(write_file);
delete [] rh_pt ;

strcpy(command,"\0");
sprintf(command,"rm -f  %s\0",output_soundfile);
system(command);

if ( dummy_flag == 0 ) system("STRUM < bbbbogus_write");
if ( dummy_flag != 0 ) t.crank_cmix_score ("strum", "bbbbogus_write",
output_soundfile, 2);
system("rm -f bbbbogus_write");

}
```

4.4. The Function of Algorithmical Composition

Although the decisions of what to play in the Tusk Harp example are made randomly, these decisions revolve around a system of probabilities based on strict sets of constraints. As you would expect from a Musical System, these algorithms "taint" the sounds that come from it in a very recognizable way. For example, the horizontal profile of the harp melodies and the structure of its chords is totally dependent on the fingering rules. An important point to notice is that these algorithms were created NOT to generate a musical passage, but only to generate kindred musical materials. Here we have a finite set of possible sounds, carefully chosen so that they all seem to emanate from the same source (they bear the same "origin mark", the same timbre), and we also have a playing style, generated from the coupling of the rhythmical system and the fingering rules. In other words, the C++ code materializes a pseudo musical instrument.

The algorithms themselves have no musical value in a piece created with their participation. Once musical objects are created by the algorithms, the objects themselves become what the piece is about and the algorithms are discarded, they are only a tool to achieve an effect, the "means" and never a final goal. This is important to remark because it precisely shows the nature of my conception of "algorithmical composition". To generate such closely related musical materials would be an extremely difficult, almost impossible task if done "by hand". With the help of a computer, I become able to materialize ideas that otherwise would be prohibitive. By

controlling the command line parameters and trying different random seeds, I can generate millions of different musical fragments that are all variations, variants, recombinations of the same basic ideas. The way I personally proceed after I create one of these algorithms is to run the program thousands of times, each with different settings and Listen to the results. The best metaphor I can provide is that I "go fishing" for the unexpected, the unique, for something I would have never thought of. Whenever I find a musical fragment that attracts my Ear, I carefully keep all the parameters and settings used to manufacture it (that information can then be further exploited). The Montage of all the "fished" objects will be based solely on my Listening, on my understanding of how all the Representations can generate a final Image.

You can hear my Tusk Harp in action in the "Laili's song" sequence of the scene seven of KA (it actually monopolizes the whole section). Also, the sequence of Laili's kiss in scene five was constructed based on information extracted from a specific fragment played by the Tusk Harp in scene seven. There, the musical information was re-interpreted and re-orchestrated by another set of unique algorithms.

5. Closing Statement

And so I have tried to show you how I am seeing, at this moment of my life, my task as a composer of Music and as an artist, how I am facing my materials

(sound itself), my techniques, my *modus operandi*.

I expect to be in constant philosophical and technical evolution, despite the pressures of this World of ours. It is difficult, but one HAS to go against these pernicious tides of mechanistic, behavioral beliefs that infest our modern times. "Or else mankind is finished !", no kidding this time.[51]

At the end, despite all my failures and defects, I want to leave registered here that all I desired was to produce flowers, like Drummond de Andrade's Flower, cutting through the "asphalt, the boredom, the nausea and the hatred".

I have been composing music for fifteen years now and it is only at this time that I feel I have caught a glimpse of what is really my Task. I am not saying that I know for sure and precisely what things are supposed to be done and how. What I feel is that I am now more in control of my faculties, I believe I can, indeed and after all, think about piloting the ship with a real trajectory in mind.

But as Guimarães Rosa wrote once, "querer é uma coisa, realizar é que são elas"[52].

---

[51] These quotes come from the opening lines of Scene One of my radio-opera KA.

[52] "Wanting is one thing, now, accomplishing ... well, that is another story".
I'm quoting this totally by memory. It is inside a letter of Rosa to a friend that comes as a preface to the edition of "Sagarana" I read.
By the way, Guimarães Rosa is a Brazilian writer considered one of the greatest writers of the 20th century, at least in Brazil, that is.

BIBLIOGRAPHY

- Cazals, Patrick. *Serguei Paradjanov*. Éditions de l'Étoile/Cahiers du Cinéma, Paris, 1993.
- Chion, Michel. *Pierre Henry*. Fayard/Sacem, Paris, 1980.
- Costère, Edmond. *Lois et Styles des Harmonies Musicales*. Presses Universitaires de France, Paris, 1954.
- Dovzhenko, Alexander. *The Poet as Filmmaker*. The MIT Press, Cambridge, Massachusetts, 1973.
- Eco, Umberto. *Six Walks in the Fictional Woods*. Harvard University Press, Cambridge, Mass., 1994.
- Eco, Umberto. *A Theory of Semiotics*. Indiana University Press, Bloomington, 1976.
- Eisenstein, Sergei. *The Film Form*. Meridian Books, New York, 1957.
- Eisenstein, Sergei. *The Film Sense*. Meridian Books, New York, 1957.
- Khlebnikov, Vielimir. *Collected works of Velimir Khlebnikov*. Harvard University Press, Cambridge, Mass., 1987.
- Khlebnikov, Velimir. *Selections. The King of Time* . Harvard University Press, Cambridge, Mass., 1985.
- Maiakovski, Vladimir. *How Verses are to be Made*; in *Selected Works* in three volumes. Raduga, Moscow, c1985-1987. Volume 3, pages 179 to 211.
- Nattiez, Jean Jacques. *Music and Discourse: Toward a Semiology of Music.* Princeton University Press, Princeton, N.J., c1990.
- Schaeffer, Pierre. *Traité des Objets Musicaux*. Éditions du Seuil, Paris, 1966.
- Schaeffer, Pierre. *Vers une Musique Expérimentale*. La Revue Musical, Paris, 1957.

- Tarasti, Eero (editor). *Musical Semiotics in Growth.* Bloomington: Indiana University Press ; Imatra: International Semiotics Institute, 1996.

- Tarkovsky, Andrei. *Sculpting Time*. Bodley Head, London, 1986.

- Xenakis, Iannis. *Formalized Musi*c. Indiana University Press, Bloomington, 1971.