

Relationship Analysis Model of Musical Syntax Categories

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Abstract: *The music is born and evolves into a formal space between sensible and intelligible, between intuition and reason. The work of art is the unity of the sensible and understanding. This unit is crystallized, as a global dynamic category in which are growing forces of attraction and rejection as well as in any natural process. We present a theoretical analysis model of the monophony having the objective to uncover the relationships that operate within each syntactic category of music. The result is a starting point in the objective study of the musical phenomenon.*

Keywords: *phenomenology, identification, syntax, correlation, pre-reflexive and ante-predicative substrate.*

1. Phenomenological reality of music

A rational approach to what the music world hide behind its manifestations always brings a special interest. Such an approach requires the use of a mathematical instrument that is adapted to the subject. The music is born of a basic necessity of expression, a need that finds its source in the pre-reflective layers of human spirituality. It is in these layers, passive data, ante-predicative, that determine without any formal logic entities perceptive and imaginative inherently necessary for all manifestations of the phenomenon of musical creation [5].

The music, which was primarily intended to structure a temporality both human and cosmic, starts a phenomenological ontology that probe in detail, the inner primary of human. In this sense we can think of musical sounds like a prime way to express emotions, feelings and ideas. Indeed, there is a kind of independence of the music that has made itself into a communication system, man to man and vice versa between man and cosmos, a system based on the mechanism that aim the elements components of the internal perception at the level of primitive substrates, fundamental, consciousness of self.

The music work appears as the result of the hermetic interpenetration of two essential elements: the initial idea and the act of thought [8] [10]. These two elements, in a first instance, belong to the world of intuition, the world of deep interiority of the soul. The understanding of this inner and the intrinsic power to capture the rhythmicity of "space-time" context, perceived by humans, lead to the pre-reflective genesis of the musical idea. The music of Stravinsky is entirely built on his aesthetic "creed" according to "the phenomenon of music that is given to us solely for the purpose of establishing an order between man and time" [9]. For there, is indeed a deep rhythm, founder of the universal reality. Human consciousness perceives the universal rhythms as a manifestation of order and cosmic harmony. Messiaen, a man that know very good the metric Greek and Indian thought that the substance of the world is the polyrhythmic framed in a metric versatile and rigorous. He claimed that "... the substance of the world is polyrhythmic".

These rhythms govern also the inherent relationship "initial act musical idea of thought". Mastering this immanent relation enriches and develops through stages, the process of creation.

For the musical expression, the man passes from the world of essences to the existential world [4]. He discovers the mystery of reality "space-time" in which he lives, the mystery of existence, and ultimately the mystery of "the one". In this sense we can speak about reality as a potential anticipation of a singularity that is waiting to be served in the sensible world.

It is a sort of induction of the primordial universal experience in the human spirit, whose aim is the realization of this singular reality in a determined musical expression. In other words, it is a "primordial experience homologated at the birth of the world", in order to use the words of Mircea Eliade.

The experience of life gives to the musical its reason for existence, namely, to live in the sensible world the extraordinary beauty of the relationship between the world of nature and the world of the spirit [3]. A constant movement of self into and exit from itself defines this relationship.

This movement generates the musical expression and is in fact the aesthetic existence of man. The art of counterpoint, with its multiple ordinations structures that characterize so much complexity and spirituality of the unthinkable is an exemplary model. If in the spatiotemporal game of classical counterpoint, the movements are linear, in the same spatiotemporal game webernian in the twentieth-century, they resemble of Brownian motions that characterize and determine the organization of matter.

The music work accompanies faithfully the smaller oscillations of the hidden order in the world and thus the phenomenological vision of music greatly expands the ontological dimension of the human spirit. By then, the man understands better its rationale and, ultimately, the nature of man.

2. The systemic vision of musical expression

Baumgarten, the father of aesthetics, defined art as a way of "thinking in beauty". For most artists, the core mission of artistic endeavor is to divulge the nature of things, to highlight the intrinsic reality, the real immutable and timeless, and the absolute. Platon's beauty is a timeless essence, an idea, but for Aristotle's, at contrary, the beauty lies in the objective, that is to say in the internal order that governs the creation of something or someone alive. The correctness of proportion equally aimed at the sensible and at the reason.

For its complexity, for its continuous and deep transformations, for its dialectical features, the musical work can be seen as a living structure telling truth, as a powerful and scalable system in the mind of a clearly defined end [1].

That purpose is a internal necessity within the spirit, a necessity which has the force of the innate. In speaking of his creation principles, George Enescu said that for him "the music is not a state (static) but an action (dynamic), that is to say, a set of sentences that express ideas and movements that lead these ideas in one direction or another" [11].

We can watch the entire musical composition as a global dynamic category in which are growing forces of attraction and rejection, as well as in the natural dynamic processes.

The musical discourse is indeed a scalable system with a strong feedback mechanism that allows it to correct errors of expression and analysis on the route of the proposed final expression.

In this sense it is a departure that represents the initial moment, the moment of decision, moment that is determined by a combination of intuition and reason and determined

by the composer's work. Thus sets up the musical discourse in a first step. We therefore share the elements $X(x', x'', x''' \dots)$ to get to the elements $Y(y', y'', y''' \dots)$. The trip is strongly influenced by disturbances $P(p', p'', p''' \dots)$ that represents the global result of outside influences on the spirit of the creator.

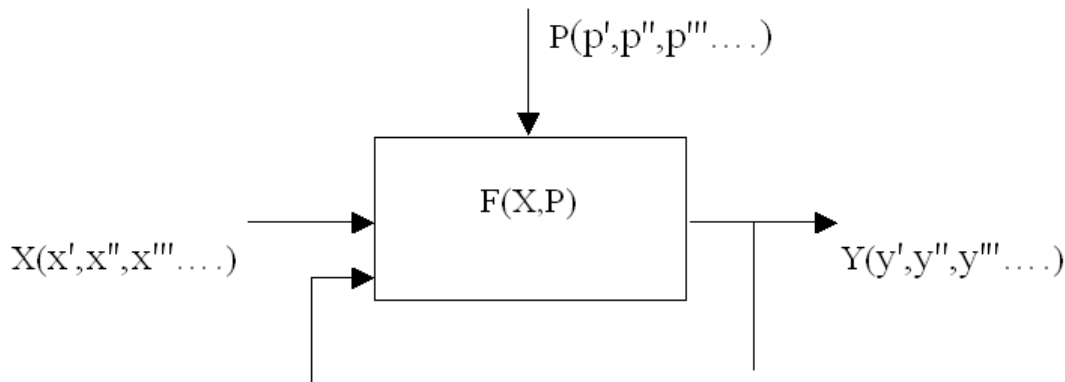


Fig. 1. Mechanism of feedback

The next step brings the elements of Y at the entry system to begin the decision-making process in the new conditions, which is to say in the new state of mind of the composer or the performer or even the listener. And all of this is thanks to the natural, biological and retroactive mechanism. The mechanism of feedback is the result of the symbiosis between the spiral of intuition and that of reason, harmony that is always present in the mind of the musician.

The final form of musical discourse is the result of a sequential process that creates each movement of the movement that precedes it. The process is also a decision making process, an intermediate step being fully vested after the intervention of feedback mechanism that directs the outcome of the previous step to the starting point of the incipient stage. The iteration ends when the musical work meets the required qualities.

Here we find the Aristotle's conception on time, which states that "the previous and post are in motion, and it is they who make the time, as they are innumerable".

The dynamics of the musical work as a system introduced the time in the sensitive reality, because it directs the creative pulse of the mind in a manner entirely consistent with the time of nature.

The structural unit of this system ensures the convergence of intermediate steps towards a stable form, permanent and unique, a unit of perception. This unit gives to the work its final meaning by combining organically which means with what is served.

In this sense the separation between form and substance remains arbitrary. The unity of the musical work does not come from the outside; it is seen and worked in a thorough process conducted within the expression and which is highlighted by the global interrelationships.

Indeed, the fundamental problem is to establish the identity of the process [2]. In terms of analysis, to identify the system must write the function $F(f, f', f'' \dots)$:

$$Y = F(X, P)$$

A correct and complete structure for the vectors $X(x', x'', x''' \dots)$, $Y(y', y'', y''' \dots)$, $P(p', p'', p''' \dots)$ offers a further chance for the function $F(f, f', f'' \dots)$ really represents the identity of the process, that is to say the knowledge of it.

The definition of the vectors X, Y, and P is currently being set up by the enlargement of the discipline objectives of the experimental aesthetics, a discipline that tends to penetrate, as thinly as possible, in the details of artistic creation process. All of these problems come from a new concept of the artwork, a concept initially determined by the artistic practice and then enriched by new mathematics, philosophy, and media conquests. Besides that Stravinsky believes that "more the art is controlled, limited, worked, more it is free" [9].

3. The structural categories of musical syntax

In the musical syntax there are four structural categories that are distinct and irreducible: the monophony, homophony, polyphony and heterophony [6]. The aesthetic structure of each of these syntactic categories is still a controversial subject, but from the structural viewpoint they can be broadly defined as follows. The monophony is a horizontal concatenation of sound objects.

The polyphony is constituted as a vertical distribution of distinct monophony that evolves simultaneously in relative independence. The homophony is a special case of polyphony in which the syllables of each constituent monophony are changing simultaneously.

Finally heterophony is structured as a distribution of similar monophony changing between two limit states; a state of total dependence (the sound objects are identical) and a state of real independence (the overlapping objects are completely separate).

This last case represents the heterophony itself. In accordance with the above definitions, the heterophony appears as a musical category intermediate between homophony and polyphony, remaining at the same time a separate category. For all the time, the musical creation is structured around these syntactic categories, knowing that in any musical discourse scheduling of sound objects in a specific syntactic relationship determines the authenticity and the musical work ability to impose its viability.

The scheduling process should follow the natural order which, of course, is dependent on the socio-cultural context of the moment, but there is a component thereof that is transcendental and immutable. The authenticity of the musical discourse is determined by the ability to observe this component.

Taking into account these observations, it appears obvious that the study of musical phenomenology must go through a deep analysis of relations that operate within each category of musical syntax.

For what follows, one can observe that all four basic categories of musical syntax can be formally defined as compared to only one, namely the monophony. It follows that a study of dynamic relationships within the monophony can be effectively extrapolated to the analysis of other syntactic categories, with the condition that the chosen method has the ability to take into account the elements that make the mentioned syntactic categories of separate structures.

4. A mathematical approach to the dynamics of monophony

A monophony, by its complexity, by its continuous and deep changes, by its dialectic functionalities can be seen as a living structure telling the truth, as a powerful and scalable system in the spirit of a clearly defined end [7].

Each sound object belonging to the monophony has a position that is strictly determined by the aesthetic logic of the end.

Our analysis is based on the following observations:

- starting from the definition adopted above, in any monophony each sound object - "os_i" - is on a position unique determined - "x_i" -. Each sound object is also characterized by a set of parameters - "p_{ji}" - (frequency, duration, timbre, attack mode, etc.);
- the emergence of a sound object on a specific position "xi" is determined by a complex of factors whose evolution can be regarded as having a quasi-random character. We remember here the opinion of I. Xenakis, who regarded the poetry of mathematics close to poetry of music. He said: "the laws of probability enter in composition through musical necessity. But other ways also lead to the same stochastic crossroads. First, naturalistic events, such as impacts of hail or rain on hard surfaces, or the song of cicadas in a field in summer... So if you want a big pile of such contemporaneous notes such as pizzicato strings, you must know these mathematical laws, which are also neither more nor less than an dense and tight expression of a chain of logical reasoning" [12];
- each sound object plays its role in the evolution of the monophony; this role is determined in a way by a relational manner through each item (or group of elements) constituting the monophony and in another way by the entire monophony, knowing that the process of creation is a phenomenon of global synthesis;
- the monophony in all its complexity can be seen as a micro-system that has its own life, and that is included in a larger system by the specific laws of complex systems (musical works). From this observation we have already entered in the field of musical phenomenology, whose exhaustive study requires the application of laws of general systems theory.

4.1. The dynamic analysis of a monophony structure

The dynamic analysis that is proposed here attempts to determine in a quantitative way some clues that highlight the complexity of existing functional relationships within the monophony and which are maintained by each constituent sound object. This analysis represents a first step on the study path of monophony viewed as a functional system.

The important volume of calculation, consequence of the rigorous need, requires the use of numerical methods of calculation. In this sense we came to the sampling operation.

Sampling, in accordance with the definition of monophony considered above, it combines an array of numeric values as follows:

$$\begin{array}{cccccccc}
 x_1 & x_2 & \dots & x_i & \dots & x_n & & \\
 p_{11} & p_{12} & \dots & p_{1i} & \dots & p_{1n} & & \\
 \dots & \dots & \dots & \dots & \dots & \dots & & \\
 p_{j1} & p_{j2} & \dots & p_{ji} & \dots & p_{jn} & & \\
 \dots & \dots & \dots & \dots & \dots & \dots & & \\
 p_{m1} & p_{m2} & \dots & p_{mi} & \dots & p_{mn} & &
 \end{array} \quad (4.1.1)$$

It was noted by:

x_i – the position of the sound object "i";

p_{ji} – the parameter "j" of the sound object located on the position "i" (the parameters $p_1, p_2, \dots, p_j, \dots, p_m$ can be: the frequency, duration, timbre, mode of attack, etc.).

The variables « p_{ji} » take values in the discrete set of values commonly used in musical practice.

Table (4.1.1) rewrites the monophony as a favorable form to the use of numerical calculation methods for the sole purpose of contributing to the discovery of the essential element - the complex of mutual bonds which determine the evolution of monophony.

In this sense we define correlation indicators that can express in a quantitative way the functional dependency between two or more sound objects considered separately or simultaneously.

To better meet the specific dependence within the monophony seen as a global micro-system we can identify several types of correlation indicators. These indicators can be calculated using standard formulas of mathematical statistics.

4.1.1. Indicator of simple correlation

The simple correlation indicator shows the degree of association between each sound object of parameter "p_j" and a reference sound object based on the position "i" of the same parameter "p_j".

$$R_{p_{j1} \cdot p_{ji}}, R_{p_{j2} \cdot p_{ji}}, \dots, R_{p_{jk} \cdot p_{ji}}, \dots, R_{p_{jn} \cdot p_{ji}} \quad (4.1.1.1)$$

By writing the simple correlation indicators for all sound objects (i = 1, 2, 3,..., n) we get a general table that overall defines the simple dependence just inside the monophony (for a single parameter p_j).

i = 1	R _{p_{j1} · p_{j1}}	R _{p_{j2} · p_{j1}}	.....	R _{p_{jk} · p_{j1}}	.....	R _{p_{jn} · p_{j1}}	
i = 2	R _{p_{j1} · p_{j2}}	R _{p_{j2} · p_{j2}}	.....	R _{p_{jk} · p_{j2}}	.....	R _{p_{jn} · p_{j2}}	
.....							
i = i	R _{p_{j1} · p_{ji}}	R _{p_{j2} · p_{ji}}	.....	R _{p_{jk} · p_{ji}}	.....	R _{p_{jn} · p_{ji}}	(4.1.1.2)
.....							
i = n	R _{p_{j1} · p_{jn}}	R _{p_{j2} · p_{jn}}	.....	R _{p_{jk} · p_{jn}}	.....	R _{p_{jn} · p_{jn}}	

Each row of the table (4.1.1.2) is a step, where we take as a reference element a single sound object seen at that time as the main factor in the evolution of the monophony.

The values of indicators R_{p_{jk} · p_{ji}} are between a maximum and a minimum value (if they are normalized between 0 and 1). A value close to the maximum value shows a strong interdependence between the objects considered and a value close to the minimum value indicates an almost complete independence between them.

In a real analysis, the values of indicators R_{p_{jk} · p_{ji}} can express at a moment a close liaison between a sound object located on a position "i" and another sound object distant from the point of view of the position it occupies in the monophony, but with which the functional reciprocity is very important.

At the same time all the values (4.1.1.2) give us the measure of the influence exerted by a sound object taken at a given time as a reference element throughout the monophony viewed as a global functional system.

Thus, we clearly see how these indicators can establish a first image on the existing mutual connections within the monophony.

4.1.2. Indicator of multiple correlations

The multiple correlations indicator shows the degree of correlation between each sound object and other sound objects of the monophony considered simultaneously.

For a parameter p_j and for all the monophony sound objects ($i = 1, 2, 3, \dots, n-1$) we obtain the following table:

$$\begin{array}{l}
 R_{p_{j1}}(p_{j2}, p_{j3}, p_{j4}, \dots, p_{jn}) \\
 R_{p_{j2}}(p_{j1}, p_{j3}, p_{j4}, \dots, p_{jn}) \\
 \dots\dots\dots \\
 R_{p_{ji}}(p_{j1}, p_{j2}, p_{j3}, \dots, p_{j(i-1)}, p_{j(i+1)}, \dots, p_{jn}) \quad (4.1.2.1) \\
 \dots\dots\dots \\
 R_{p_{jn}}(p_{j1}, p_{j2}, p_{j3}, \dots, p_{j(n-1)})
 \end{array}$$

The value $R_{p_{ji}}()$ is the indicator of multiple correlations between the sound object located in position "i" with parameter p_j and the other sound objects of the monophony (of course - with the same parameter p_j). This value varies, if it is normalized, between 0 and 1.

A value closer to 0 indicates a weak integration of the object, against a value close to 1 indicates a strong integration of the sound object in the entire monophony.

Thus, the indicators of multiple correlations provides the image of the integration degree of each sound object in the global structure represented by the entire monophony. They also creates a measure of stability within the monophony - system.

4.1.3. Indicator of partial correlation

The partial correlation indicator expresses in a quantitative manner the functional link between a sound object with parameter " p_j " ($j = 1, 2, 3, \dots, m$) located in position "i" ($i = 1, 2, 3, \dots, n$) and infra-structures containing 2, 3, 4, ..., n-2 sound objects of the same parameter " p_j ". In this way we obtain the following table:

$$\begin{array}{l}
 R_{p_{j1}}(p_{j2}, p_{j3}), R_{p_{j1}}(p_{j2}, p_{j3}, p_{j4}), \dots, R_{p_{j1}}(p_{j2}, p_{j3}, p_{j4}, \dots, p_{j(n-1)}) \\
 R_{p_{j2}}(p_{j1}, p_{j3}), R_{p_{j2}}(p_{j1}, p_{j3}, p_{j4}), \dots, R_{p_{j2}}(p_{j1}, p_{j3}, p_{j4}, \dots, p_{j(n-1)}) \\
 \dots\dots\dots (4.1.3.1) \\
 R_{p_{ji}}(p_{j1}, p_{j2}), R_{p_{ji}}(p_{j1}, p_{j2}, p_{j3}), \dots, R_{p_{ji}}(p_{j1}, p_{j2}, p_{j3}, p_{j4}, \dots, p_{j(n-1)}) \\
 \dots\dots\dots \\
 R_{p_{jn}}(p_{j1}, p_{j2}), R_{p_{jn}}(p_{j1}, p_{j2}, p_{j3}), \dots, R_{p_{jn}}(p_{j1}, p_{j2}, p_{j3}, \dots, p_{j(n-2)})
 \end{array}$$

The $R_{p_{j1}}(p_{j2}, p_{j3})$ indicator highlights the degree of correlation between the sound object located at position 1 and the sound objects located on positions 2 and 3, $R_{p_{j1}}(p_{j2}, p_{j3}, p_{j4})$ expresses the same dependency between the object located at position 1 and the sound objects located on positions 2, 3 and 4, and so on until the last indicator where one takes into account the infrastructure 2, 3, 4, ..., n-2.

The order in which the sound objects are arranged in the reference infrastructure is not necessarily an increasing or decreasing series, in terms of their position within the monophony. This order can be determined by various criteria, one of them may appeal to the scale of indicator values of simple correlation.

The partial correlation indicator is a measure of the intensity of existing relationships between each sound object and the various infrastructures of monophony. The set of values gives us a picture of the interdependence of monophony infrastructures, image that highlights the global character of its evolution, and the last time the overall vision of the creation act.

The analysis described above attempts to demonstrate in a quantitative way the relationships that develop within the monophony and which effectively determine the life of it in the broader context of the musical work seen as a natural whole. This analysis can also

guide the aesthetic considerations of the musical work towards a more objective world and therefore closer to reality.

This mathematical model of analysis can be applied to any type of music syntactic category if we take into account its specificity.

5. Conclusions

The initial real, that is to say the truth, enter between the presence of subjective life through the transcendental experience of intuition. In the philosophy of Pythagoras, the number represents the root of all things and principles that govern the universe.

Kant [3] at his turn affirmed that "all our knowledge begins with the senses, goes from there to the understanding and ends with reason". In this sense, the modern world has created an environment "real - symbol" that evolves simultaneously with the context "space - time" of natural phenomenology. The two contexts intersect at the onset of every intellectual movement.

The goal of any analysis is to separate the components of the system under research and determine the criteria and ways in which our knowledge of it progresses.

In this sense we have proposed a sampling method of monophony, separating at the same time the characteristic parameters of sound objects within it. We can analyze each parameter separately, drawing the specific conclusions to each of them.

We have also proposed a method based on the definition of correlation indicators that highlight the different mutual relations existing within the monophony. The calculation of these indicators, in a practical analysis is done using the appropriate statistical-mathematical methods and of course the algorithms necessary for their implementation on digital computers.

The advantage of the analysis described above is derived from its broad scope, as it can be used for any monophony: from Gregorian chant to the contemporary monophony.

Obviously, the synthesis of all the conclusions of the proposed analysis represents a problem of independent study which will highlight the systemic character of the monophony and following any type of musical syntax.

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