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Immediate constituent analysis as a future model of electroacoustic music theory

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Introduction

Since the birth of electroacoustic music, the development of methods to understand this new genre is well underway and today, numerous examples of analysis methods can be seen that help us to understand its architecture. While classical concepts of music theory like Schenkerian analysis or musical set theory approach instrumental material in different ways in order to highlight structural aspects, electroacoustic music implies exceptional challenges for examination because of the nature of its novel texture. This paper wants to investigate in a first step three conventional models of music theory by outlining their fundamental characteristics. Then, a new method of analysis will be presented, which is focusing on larger coherence deriving from the field of linguistics.

Three classical models of music theory

Three standard concepts of music theory, which are in practice today, are *Schenkerian analysis, functional theory* by Hugo Riemann and *musical set theory* mostly represented by US-musicologists Allen Forte and Howard Hanson.

German scholar Hugo Riemann developed a model, which is referring to the fundamental structures of tonal music based on a traceability of roots in sound-constructions, which has already been declared in 1722 with the *basse fondamentale* by Jean-Philippe Remeau‘s publication *Traité de l‘harmonie.* [1] Riemann advanced the hierarchical structures by emphasizing a duality between major and minor, assuming both versions to be a natural product.[2] Furthermore, he abandoned the simple degrees of a scale and gave functional names for chords according to their tonal gravity such as the dominant, which postulated that chords could have an individual quality of sound. His functional indications of different degrees were also the beginning of a psychological description of sound relations, which was about to be continued years later by scholars such as Ernst Kurth.[3]

In contrast to that, Heinrich Schenker focused on broader structures such as melody and voice leading and tried to detect an ancestry of a fundamental line in a large context, which he called *Ursatz*.[4] At the same time, Schenker‘s concept of harmony relied heavily on scale degrees instead of psychological functions and postulated a greater independence of the degrees, which

[1]See also: Jean-Philippe Rameau, *Traité de l‘Harmonie,* Paris, zurfluh editeur, 2009
[2]Reinhard Amon, *Lexikon der Harmonielehre*, Vienna/Munich, Doblinger-Metzler, 2005, p. 268-270
[3]See also: Helga de la Motte-Haber, *Psychologie und Musiktheorie*, Frankfurt am Main, Diesterweg, 1976
[4]See also: Heinrich Schenker, *Neue musikalische Theorien und Phantasien, Band 1: Harmonielehre, Band 2: Kontrapunkt*, Berlin/Vienna, J.G. Cotta / Universal Edition, 1906-1922

are related to the tonic by a cycle of fifths.[5] Unfortunately, his academic input did not survive in the German-speaking landscape, because of the political climate since 1933 and it has not been reestablished until today.

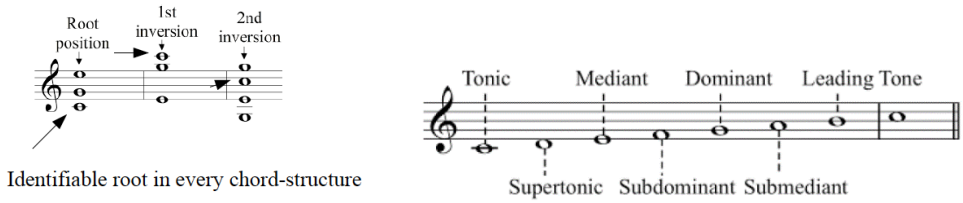

Figure 1: Functional theory with the hypothesis of chord roots and functional degrees in a C major scale.

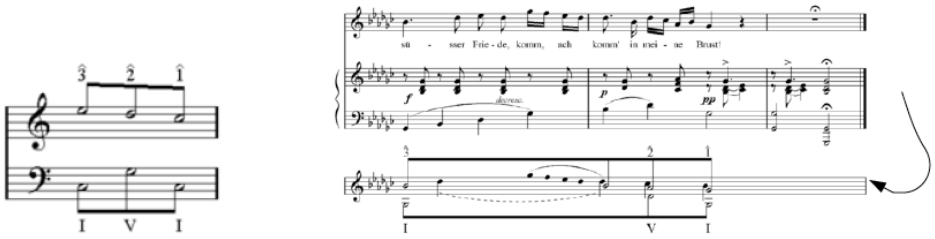

Figure 2: Schenkerian analysis with the fundamental reduction of musical composition, the *Ursatz.*

One of the most recent theories in the field of music analysis, is *musical set theory.* A completely different model originating from mathematical logic, which studies especially atonal music through classification of collective entities, called *sets.*[6] A version of this is the collection of different pitch classes, which is performed in the so called *pitch-class set theory.* One set contains a collection of several pitch classes belonging to simultaneous or successive intervals. The relation is according to the distance in semitones to a center tone, which is however not a root, but a pitch center. For instance, an excerpt with the center around B-flat and the tone F has, as a natural fifth, the distance of 7 semitones. According to the equation of a pitch interval *pi (a,b) = b – a*, this fifth would be classified as a *dyad pi (0,7) = 7 – 0.* The belonging pitch class *pc* can be calculated in modular arithmetic according to octave equivalence: *pc (0,7) = pi (0,7) mod 12 = (7-0) mod 12 = 7 mod 12 = 7.*[7] These pitch classes indicate pitches, which are related to each other by an octave. If this fifth as pitch class 7 is taken together with a minor third E-flat as pitch class 3, the relation of these two intervals to each other can again be described in an interval class: *ic (3,7) = pc (3,7) mod 12 = (7-3) mod 12 = 4 mod 12 = 4.* This interval class indicates the shortest distance between two pitch classes in pitch-class space, which is not taking octave-separation into consideration. Because of the shortest distance in the interval class, the equation must be considered as: *unordered pitch class interval i (a,b) = the smaller of i <a,b> and i <b,a>.*[8] Overall, 6 possible interval classes can be identified:

[5]Ibid.
[6]Musical set theory also focused on tonal music in the beginning. See also: John Rahn, *Basic Atonal Theory.* New York, Schirmer Books, 1980 and Allen Forte, *The Structure of Atonal Music.* New Haven / London, Yale University Press, 1973
[7]Ibid.
[8] Ibid.

Interval class	Included pitch intervals
0	0
1	1 and 11
2	2 and 10
3	3 and 9
4	4 and 8
5	5 and 7
6	6

A fundamental characteristic of *musical set theory* is its assumption of equivalency regarding octave, enharmonic spelling and inversion. This leads to a certain degree of abstraction, since several intervals are now summarized, which tonal theory differentiated.

This principle of analysis through inductive reasoning can also be seen in the comparison of larger sections of intervals, which are then as entities studied regarding their formations. For this demonstration, additional to the model of quantification from mathematical logic, concepts from geometry such as translation and reflection are used to express variations of musical sets such as transposition and inversion.

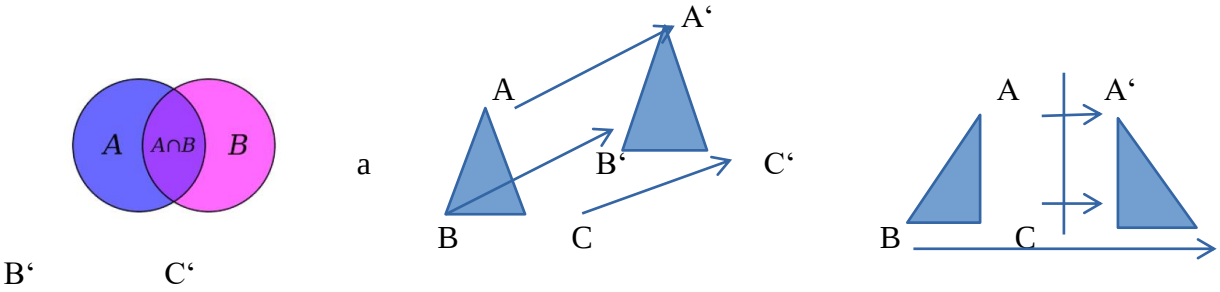

Figure 4: Examination of collective entities in mathematical logic through intersection, translation and reflection.

All the three demonstrated systems of analysis have the ability to describe and even define certain structures in music. While Hugo Riemann‘s theory is defining harmony very precise according to relating chords in a pattern of psychological hierarchy, Heinrich Schenker tried to discover an origin in every piece of music, that is often buried beneath several layers of context. In contrast to that, musical set theory is a more statistic method of analysis, since the procedure itself has its roots in mathematical logic with the new intention of interval investigation in music, classified according to acoustic qualities. This perspective of summarizing elements is a feature, which sets itself apart from the other two models of analysis, because of the quantification. However, it can also be seen as an enriching novelty. Against that, Schenkerian analysis and functional theory focus on the individual relation of elements in music without quantifying them. While Schenkerian reduction analysis tries to uncover deeper structures through inductive reasoning, functional theory focuses on the identification of harmonic phenomenons as a psychological relation of the elements themselves, which are present in the composition.

Concerning the point of structural context in music without classification or derivation, functional theory is closest to the desired result of analytical insight. But even Riemann‘s system is only capable of describing and evaluating chord qualities in a dualistic major/minor

opposition, which was the main point of criticism during the 21st century by many architects of new sound.

A shift of analysis perspective from chords to larger units could produce a new and better insight in the material. For this dimension, a detour to another structural field will be necessary outside of music: language.

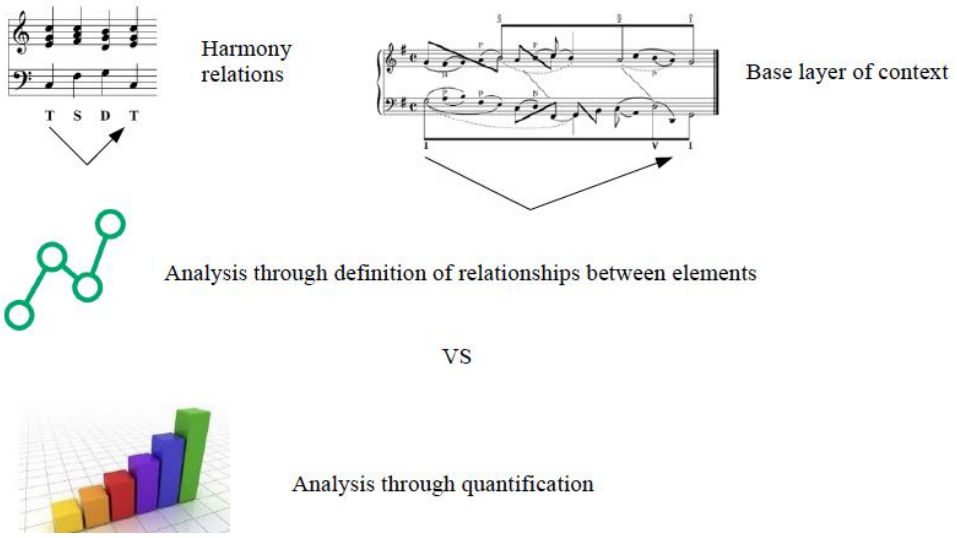

Figure 5: Different aspects of analytical models in music theory.

Syntax theory

The discipline of linguistics, which was founded originally by Swiss linguistic Ferdinand De Saussure with his *Cours de linguistique générale* published in 1916, took a new turn into the school of language research, after a group of German scholars tried to persuade a method of diachronic investigation of language through historic development.[9] Saussure‘s new principle of synchronic investigation led to insights in different areas of comparative language examination – one of these new special fields was the aspect of syntax.[10]

Even today, the term *syntax* is not easy to define and there are only a few scholars that have ever given an answer to this difficult question. One of those is British professor Peter H. Matthews from the University of Cambridge, whose publication *Syntax* is still one of the most recommended among linguists around the world. According to his definition, syntax is as expressed by the Greek term *syntaxis* simply as a set out arrangement.[11] In grammar, this can be seen in a sentence with inflected words showing a relation of meaning to each other like a verb which relates to a noun and is often dictated by the position order of words in a sentence like in this example ‘‘The boy bit the dog‘‘ (Figure 6).

A fundamental characteristic of syntax is a constructional attribute, which means that a certain number of elements are connected with each other, for instance in the case of language through

[9]Ferdinand de Saussure, Peter Wunderli, *Cours de linguistique générale*, Tübingen, Narr Verlag, 2014, p. 56-60
[10]Ferdinand de Saussure, *Wissenschaft der Sprache*, Frankfurt am Main, Suhrkamp, 2003, p. 153
[11]Peter H. Matthews, *Syntax*, Cambridge, Cambridge University Press, 1981, p. 1

certain inflected forms like "I am old". In a bigger sentence like "He said, I am old", the former "I am old" can stand on its own for a proper meaning and is called a *syntagm* (Figure 7).[12] This smaller unit is in the bigger phrase of the sentence related to a thought, emitted by *he*. Such a constructional relation can be identified in any larger sentence consisting of smaller syntagms.

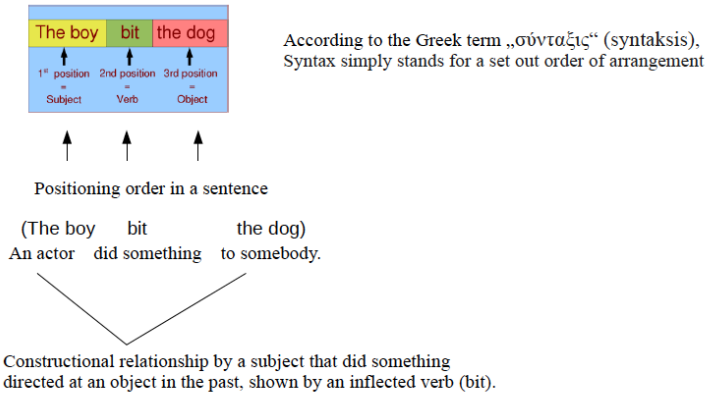

Figure 6: Definition of syntax through ordered positioning.

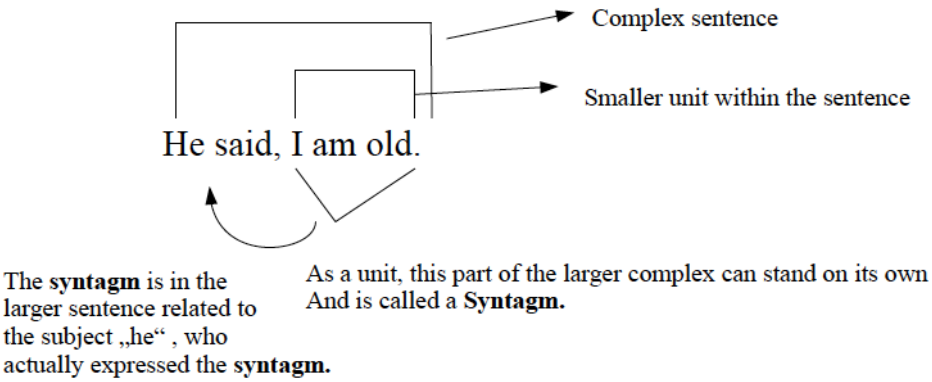

Figure 7: Syntagm as a unit in a constructional relation.

So far in language – but is it possible to define such structures in music? To begin with, one thing is clear: morphological inflections can not be found in music of course – but instead, something else.

Syntax in music

Looking at an excerpt from a periodic German folk-song, the following can be identified: 2 units, which can stand and be heard on their own and form a larger unit (Figure 8).[13]

Each unit is constructed out of two elements, known as motives and which form the so called *antecedent phrase* and *consequent phrase* consisting of 4 bars and forming the famous 8-bar

[12]Ibid. p. 2
[13]Hermann Grabner, *Allgemeine Musiklehre,* Kassel, Bärenreiter, 2008, p. 163

phrase.[14] This classic analysis from musical morphology shows that structures can be identified in music to some extent like in a colloquial syntax. One big difference however is that if a tone in one of these units would be changed, their relation and meaning would not be completely destroyed as long as the ending notes would be the same – only the line of the melody and its progress would be changed and could sound somewhat strange to the listener.

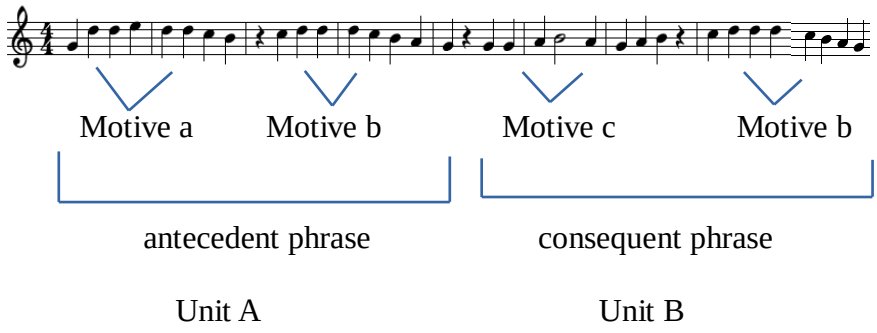

Figure 8: Identification of phrase structure in a folk-song.

Concerning the analyzed song, it is possible to say that the elements, motives A, B and C, stand in constructional relation to each other by forming two units, which in fact can stand on their own as an entity. Moreover, the *antecedent* and *consequent phrase* can be heard perfectly alone, although the periodic 8-bar adjusted ear would miss another 4-bar phrase. If the listener would hear just the elements from the units, this would not be a satisfying result, because the ending would feel strange since the listener expects to finish on a different tone – it would sound like an unexpected interruption in the middle of a sentence like "I am at ...", lacking of course the indication of a local position. The constructional relation of the motives in the two phrases is the same, since they form a unit by the same means in the same length of 2 bars constructing 4 bars (Figure 9).

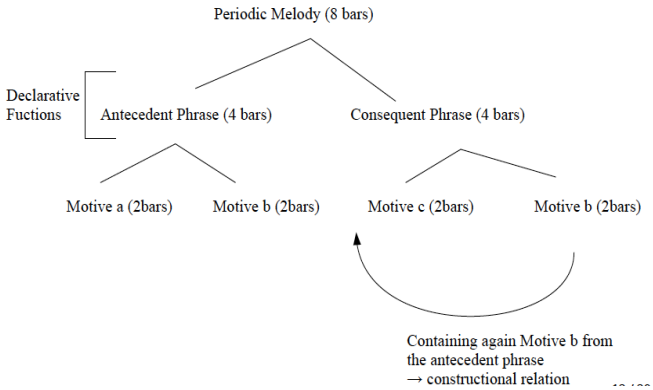

Figure 9: Constructional relations in an 8-bar phrase.

Since it is possible to distinguish constructional relations even deeper in linguistic grammar, the question is if this can be done in music, too. Taken for instance the sentence "He likes food

[14]Ibid.

which tastes Italian", the three words "which tastes Italian" are identified as a unit known to grammarians as a relative clause. Such a differentiation is quite difficult to make in a musical phrase as the example has shown earlier, since a relative clause is referring to an antecedent noun. But looking deeper into the structure, we can identify the motive c of the consequent phrase and later on motive b again, which was also used before. Thus, the second unit is in a way referring to the first one by using its element and although the two phrases can stand on their own, there is a constructional relation even between them and a differentiation of quality: If the first unit would be heard alone, it would be perfectly to take it as a statement, therefore this could be identified as a *declarative function* like in a main clause. Regarding the second unit, this would also make sense, but the listener would suspect that he might have missed something in the beginning and lets him suspect that there must be an antecedent somewhere. However, terms like relative clause and main clause are dangerous to use in such an example, since the difference in structure of morphology of language and music is so grave. But the constructional relations are obvious even in the aforementioned folk-song – therefore, it is possible to say, that the second unit is a modified version of the first one with a new element motive c, which is also connected to motive a and b. Because of that, the *consequent phrase* can be identified as a head-driven modifier of the head *antecedent phrase*, which is standing higher in the hierarchy of relation as a declarative function (Figure 10).[15]

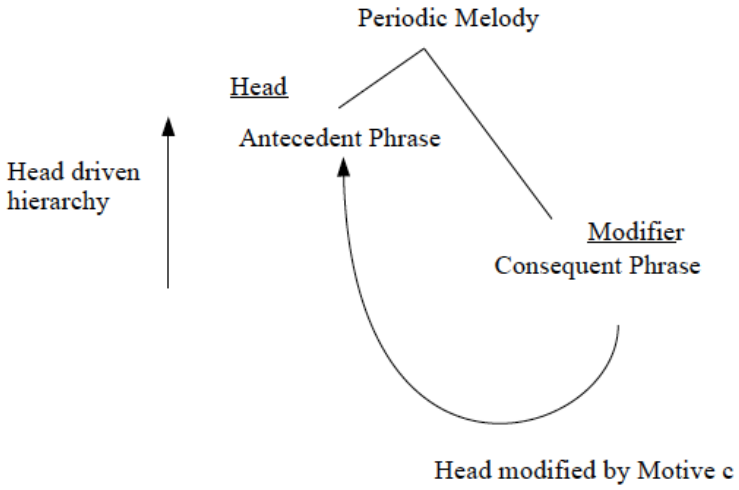

Figure 10: Head and modifier in musical structures.

These thoughts of constructional relation lead to very important considerations of syntax theory. The careful formulation of phrase structure in language and music culminates in a new model of grammar, known today as *constituent analysis.* As a fundamental term, *constituency* is defined by Peter Matthew as follows:

"In the crudest form of constituency model, a unit **a** is related to a neighbouring unit **b** solely by their placement within a larger unit **c.**"[16] This leads again to our first example and reminds

[15]This term is borrowed from the field of *Head-driven Phrase Structure Grammar.* See also: Robert D. Levine, W. Detmar Meurers, *Head-driven Phrase Structure Grammar: Linguistic Approach, Formal Foundations and Computational Realization.* In: https://www.asc.ohio-state.edu/dm/papers/ell2-hpsg.pdf

[16]See also: Peter H. Matthews, *Syntax*, Cambridge, Cambridge University Press, 1981, p. 73

us that the first phrase was structured out of motives **a** and **b** and the second of motives **c** and **b**. Both phrases were described as syntagms (Figure 11).[17]

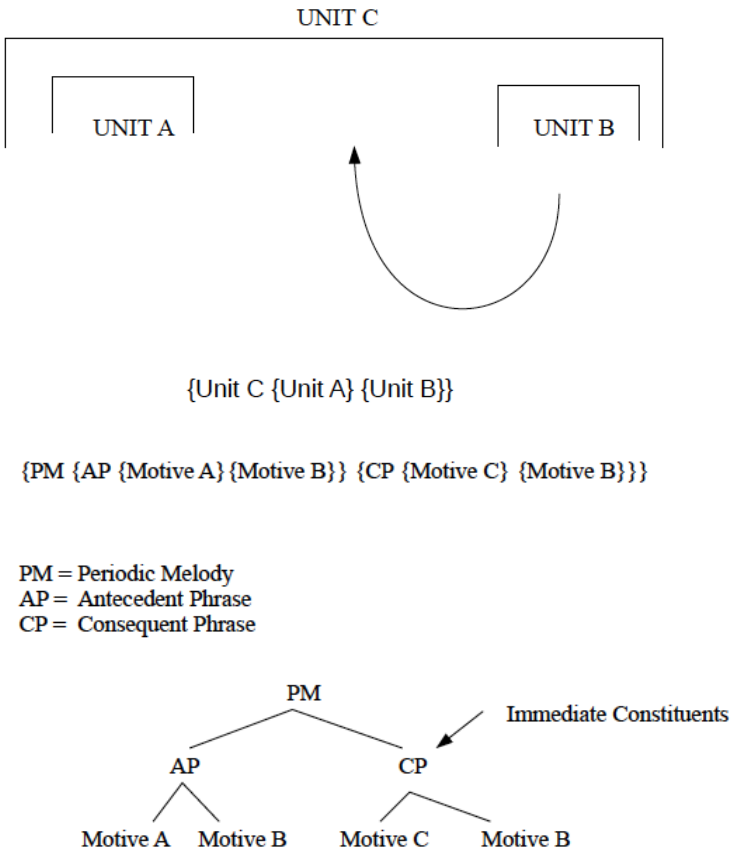

Figure 11: Definition of constituency through units and constituency analysis of a periodic melody.

In brackets the folk-song example can be defined as follows:

[PM [AP [Motive **a**} {Motive **b**]] [CP [Motive **c**} { Motive **b**]]] with the song form as the biggest unit with its two phrases and their motives as smaller units. Another way of expressing this is with nodes and roots to the units, which can be seen in the lower diagram of figure 11. The song form as the highest node joins all units together to the well-known 8-bar scheme. The elements enclosed in a syntagm are called *constituents,* in this case the motives. Those that directly form a syntagm are called *immediate constituents,* thus the two phrases AP and CP. The same can be said in language in the phrase "*The cat sat on the mat"* with specifications of the phrases such as verbal phrase VP, noun phrase NP etc. But what can this model possibly deliver to electroacoustic music?

Analysis of *Inventario I*

[17]Ibid. p. 1-2

To take the theory of constituency analysis into electroacoustic music practice, the composition *Inventario I* by composer Germán Toro Perez will be used as an example. Commissioned for the Institut International de Musique Electroacoustique Bourges, performed in 1999 and revised in 2003, the piece belongs "to a group of pieces dealing from changing perspectives with the structure of time experience and aspects of syntax like repetition, bound of small sound fragments to bigger structures (…) Those kinds of syntax are present in different time-levels of musical organization: texture of sound material, rhythm, sound sequences, order of parts. (…) An important formal idea for the whole cycle is the list, the succession of elements sharing a special format. They may be logical structured or formalized (…) For our perception possibly means this interruption, jump, cut but also variation and remembrance (…)."[18]

To start with, the first minute and ten seconds will be taken into consideration: In the first part, long extended similar sounds like soft ringings can be heard. In fact, their repetition can be classified in: 4 sounds in a row after a longer interruption, then 3 more and after a second interruption another 3 sound elements. Since this pattern of succession and interruption is a shaping factor in this first part of *Inventario I*, the successions can be seen as a unit of their own and can be compared to what was defined as a syntagm in the first analysis earlier. These 3 syntagms are all part of the first phrase of this first minute and all descend from the sound element of the first soft ring, which will be called *element I* or just *I*. The constructed syntagms all relate to each other by the fact, that they are constructed by this element in modifications, which are identified as *Ia Ib Ic* and displayed in figure 12 by a tree diagram in relation to element I with a node.

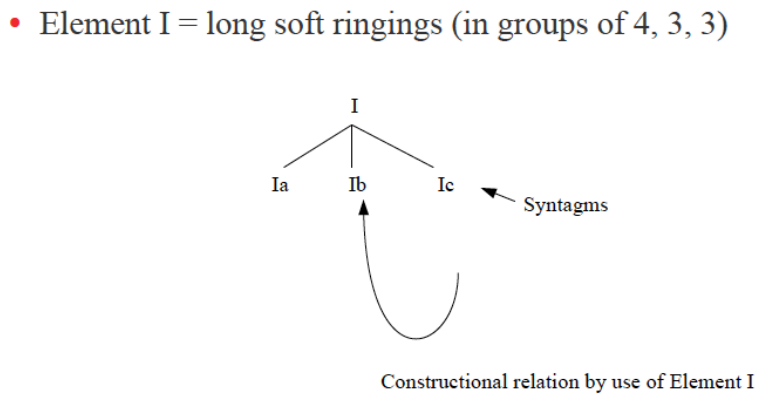

Figure 12: Tree diagram of the first minute of *Inventario I.*

After the first minute, an excerpt at 1:10 with a new sound element can be recognized: chirping sounds in different pitches, called *element II* and being combined with *element I*. From minute 1:20 on, only *element II* can be heard with a modification of it through higher pitch and different rhythm, which is labeled as *element IIv*. From Minute 1:30, all three sound elements, *I, II* and *IIv* are present and in minute 1:50 a new element enters again as a bell sound, called *element III*. As the composer has stated in his explanation to this composition, one factor of the highest importance in order to constitute a syntax is repetition. Therefore, the whole second part of the excerpt 2 after minute 1:10 with elements *II*, *IIv* and *III* can be divided into 4 syntagms (Figure 13).

[18]http://www.toro-perez.com/works/electroacoustic-works#slider-4

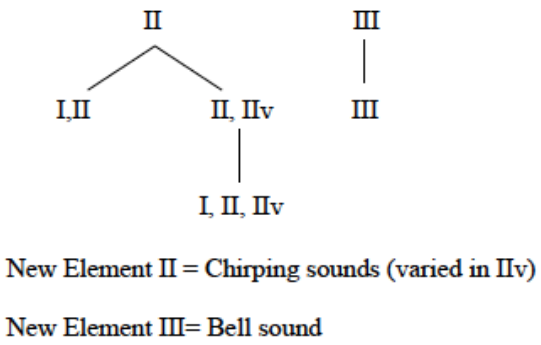

Figure 13: Constituency analysis of the second part of *Inventario I* after minute 1:10.

While this division is clear and not difficult to make, it is important to consider that in two cases of the second part, the *element I* is heard as well. This means, that while subdividing this second half of the composition excerpt, we have to keep in mind that this part is relying on something that has happened before. In the first minute of *Inventario I*, *element I* has been elaborated and because it is now being incorporated again in the second half, the new structures are relying on something that has appeared already before and seen from the chronological order, are depending on the first half. From the point of structure, what has been done until now is investigating the constructional relations by constituency. Taking the reappearance of *element I* in the second half into consideration, we are not talking anymore about *constituency*, but now of *dependency*. Because of the fact that *element I* has been introduced and exploited in detail in the beginning, we can say that the second phrase is in two cases even governed by this. In the diagram this is made visible by placing not only arrows to the first phrase, but also by placing the syntagms of the second part with *element I* on a lower level to point out the hierarchy (Figure 14).

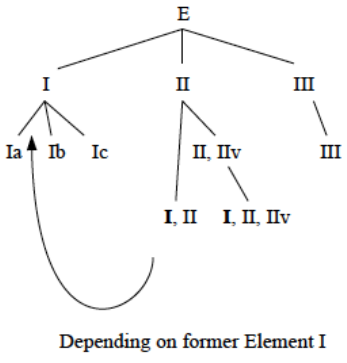

Figure 14: Complete constituency analysis of the first part of *Inventario I*.

However, this analysis must also be treated carefully since it tries to postulate a relationship in the sense of a lower factor, which couldn‘t exist without the higher one. Such arguments lead to controversy today even in language and it is not clear in all cases, if anything can be traceable to one point in such a model. Moreover, dependency and constituency analysis are usually kept

separate in linguistic research, while in this example of *Inventario I* there is a way of showing both relationships in one graph with their connections (Figure 14).

But can this be of any help? First of all, it is obvious that other tools like functional theory with the dominant and the tonic or Schenkerian analysis with the excavation of melodic context in a composition will be not of great help for electroacoustic compositions, since functional chords or classical melodic structures can not be found in *Inventario I* as well as in most electroacoustic pieces. This is also the reason, why pitch-class set theory would not be very helpful as well, because precise seconds or fifths can not be classified and regrouped in a certain order. Structural analysis however, which is in this case represented by constituency and dependency analysis, is able to give a picture of structural relationships within the elements of a piece, no matter what they look like. Be it language, sounds, pitches, harmony – this model is able to identify relationships of any kind and can deliver a clear insight in the construction by the composer.

In the case of *Inventario I,* it is beneficial having a composer, who is giving already a hint about such a construction in his own description of the work. But despite that, in any electroacoustic composition structural analysis could reveal relationships of the elements. Of course, there is the danger to define exactly what elements can be or to what extent a syntagm could be acting like it does in language. Not all electroacoustic composers have given a clear and very academic definition about their own technique like for instance Peirre Schaeffer did in his *Traité des objets musicaux,* where he even identifies sound objects as elements of his grammar. But it is clear, that through the model of constituency analysis the artistry of electroacoustic music in constructing new sound elements and their relation to each other can be seen very clearly, which is why it can help to understand this sometimes complex genre of music through transparency.

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