

Constructivism in the Works of Iannis Xenakis as a New Link between Avant-garde Art and Music

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Abstract: The aim of this presentation is to show a new aspect of avant-garde in the works of Iannis Xenakis in relation to the Russian constructivism. Both the above-mentioned 20th-century art movement and the composer present an undeniably innovative character. It manifests itself not only in a radical rejection of traditional systems and the application of various scientific theories in the creative process in order to develop a formal language of art, but also in the synthesis of non-representational art, science and technical knowledge as well as fascination with modern technologies and machines. During the presentation, a short description of Russian constructivism will be given, with a special emphasis put on its aforementioned avant-garde character, which may also be considered at the level of ideology. Afterwards, parallel assumptions will be made on the level of music as an attempt to create more accurate definition of constructivism in music. Subsequently, the main theses of constructivists will be found in particular works of Xenakis, as follows: *Achorripsis* with its sound pattern based on the theory of probability, *Nuits*, portraying non-representational, pure art, *Nomos Alpha* constructed with use of utterly innovative music material, *Metastaseis* with clusters of glissandi reflecting the structure of Philips Pavilion – a sample of Xenakis's architectural output, examples of space, tape and electro-acoustic music and finally *Polytopes*, spectacles of light and sound, remaining his most astonishing interdisciplinary work. This comparative approach will reveal connection between avant-garde in art and music.

The term *constructivism* is relatively rare in musicology and its generalized meaning is usually limited to the rational, purposeful and functional construction, e.g. in description of Renaissance motets, symphonies of A. Panufnik or H. Górecki's *Sonata for Two Violins* op. 10 (Siemdaj 2003, 313). However, narrowing the term to a rule of shaping a musical form in accordance with some structural logic ignores its broad, artistic aspect and this can only be found in relation to ideas and definitions offered by Russian constructivism. Short description of this movement given below seems to be vital to expound the meaning of constructivism in music.

Russian constructivism

Thorough studies reveal that constructivism was a highly innovative, avant-garde art movement which developed in Russia at the beginning of 20th-century, in times of mutiny against bourgeoisie and quest for new order, solid ideological foundations and better values. Moreover, constructivism not only was strongly ideologically connected with Bolshevik Revolution of 1917 and emerging industrial society, but was also part of the European avant-garde mainstream settled in the intelligentsia. The term itself was taken from Latin *construo* [to bond], and has not been used until 1920, when The First Working Group of Constructivists was settled. However, as a symbolic beginning of the movement we usually consider an exhibition called Donkey's Tail, organised in 1912 by Mikhail Larionov and Natalia Goncharova.

Similarly to the futurists, the founders of constructivism were fascinated with modern technologies and machines, as well as possibilities of human intellect which created them. As a result of turbulent arguments about the essence and aims of art, synthesis of art, science and technical knowledge became one of the main guiding principles of the movement. Constructivists strove for a new movement which would include many kinds of art and proposed rationalized work of a highly educated artist which would not only be entirely formalized and based on scientific background, but also prepared with mechanized means of production. However, instead of uncritically using, or even imitating the machine, they would rather find their own equivalent in its simple algorithms and logic.

In the initial phase of the movement the construction of non-utilitarian, abstract works of art was highly advisable, as long as it was based on the objective and universal truth discovered by means of analysis and experiment. As a consequence, the issue of traditionally comprehended aesthetic gave way to the rigorous logic of an undecorated form and clearly defined structure. Thus composition, which takes many possibilities into account, was replaced with construction which meant real action. More specifically, according to Alexander Rodchenko, construction meant system allowing to create things by purposeful exploitation of material (Turowski 1998, 258).

Constructivists emphasized the role of material, which until then had been considered of little importance in the creation of an artwork and now started to represent one of the main discriminants of the work. Most significant voice in this discussion belonged to one of the precursors of constructivism, Vladimir Tatlin who developed the notion of *the culture of material* and strongly insisted on *the truth of material* (Turowski 1998, 32). What is more, they invented their own materials and adapted others which had never been applied to art before. This, combined with the scientific and architectural aspect, stresses an interdisciplinary character of constructivism.

Finally, searching for a new form of aesthetic expression constructivists decided to take the artwork out of the frames of reality and deprive it of any reference – art became entirely non-representational. Simultaneously, they tried to extend the traditional plane which – at least until then – restricted all paintings. Abandoning traditional two-dimensional paintings for the sake of space resulted in a growing interest in architecture, which was a crucial component of constructivist art. Easel painting became history and the division between the audience and the work of art was abandoned.



Figure 1. Vladimir Tatlin, *Relief* (1914-17) – abstract, three-dimensional artwork made with innovative materials.

Definition of constructivism in music

Reassuming, by the analogy with Russian constructivism, the same notion in music could be defined as an avant-garde creative process, based on the common features of music and other artistic and scientific disciplines.

The main problem of constructivism in music would be the architecture of an artwork, as composition is here identified with construction. However, instead of creating *style as an invariable pattern* (Turowski 2000, 90) constructivists strive for new metamorphoses and improvements. As a result, material aspect is strongly emphasized and innovative results in that matter, often inspired with science or natural phenomena, are highly advisable. Furthermore, material is not the only component of construction. The rule on which this construction is based is far more important, since it is derived from science, especially mathematics and then applied with the use of modern technologies.

Constructivist artwork exceeds the limits of traditionally comprehended art because of its interdisciplinary character and links with architecture. Moreover, just like constructivist painting is no longer restricted to frames, music becomes spatial and its sound surrounds the audience. Finally, no composition presents reality in a direct manner, as it should focus the attention of a listener on pure art.

Short description of Xenakis' oeuvre in the light of the premises of constructivism

All these assumptions can be found in the work by Iannis Xenakis. First of all, his philosophy had similar sources. Political (socialistic) aspects were present in his life through the writings of Marx, as well as in times of participation in a communist resistance during World War II. More direct connection with Russian constructivism would be the influence of Le Corbusier, an architect-constructivist, or adaptation of constructivist poetry, as in *Trois poèmes* based on the text of Vladimir Mayakovsky.

Xenakis was an artist who transcended the centers of musical avant-garde of his time. Not only did he break with the traditional tonality, but he also rejected serial music which was flourishing at that time, claiming that it would be irrational to replace one determined system with another, even more rigorous one. As an alternative, he proposed original, sophisticated and scientifically-based idea originated from the probability calculus, called stochastic music. He expanded his assumptions in his early compositions, such as *Pithoprakta* (1956) and *Achorripsis* (1957). With time, his theory became more and more complex, including even Markov chains, which made final results independent of the initial state. Obviously, he applied various scientific theories in his creative process and made an attempt to develop formal language of art, as if continuing the constructivist thought.

Another constructivist feature would be the non-representational character of art. This feature becomes quite obvious given his early works with loss of the traditional melodic line for the sake of dense clusters, as well as some of his vocal works, such as *Nuits* (1968), in which an intelligible text was replaced with concrete sounds and ancient phonemes. At the same time Xenakis abandoned the traditional form of division between the audience and the work of art by composing space music for orchestra scattered among the listeners (*Terretektorh*, 1966) and thus gaining new dimension of art.

Iannis Xenakis was versatile. He did not confine to use stochastic within the macrostructure of his oeuvres but created brand new music materials, such as renowned sound galaxies and applied old ones in an original way (for example by transforming common glissando in a rightful form-building factor in *Metastaseis* and *Nuits*).

Furthermore, as an engineer, Xenakis was able to use specific methods to design his music. His architectural and musical projects often permeated themselves which can be seen in such work as *Metastaseis* (1954) and Philips Pavilion for the 1958 World Exposition in Brussels. Sometimes he even connected both his passions, which would result in *Polytopes* (1967 and later), his famous spectacles of light and sound (Capanna 2001, 19) connected with the architecture of the place. As a result, his works of art were often both *architectural* and interdisciplinary – hence constructivist in their character. In addition, he was a co-worker of the famous constructivist architect, Le Corbusier.

From the beginning of his career he was enthralled by the power and possibilities of machines. He created over fifteen works on tape, beginning with *Diamorphoses* (1958). In the 1970s, with the coming of information technology, he began to work on the algorithm of dynamic stochastic synthesis (GENDYN) and, irrespective of that, created UPIC, a system which transformed graphic samples to sound.

In the light of the above, characterizing Xenakis's oeuvre as constructivist seems to be justified. For a better understanding more detailed information will be given in next paragraphs.

Constructivist assumptions in selected works of Iannis Xenakis

Scientific-based avant-garde

Avant-garde *discovers new worlds, instead of holding tightly to the old ones* (Baranowicz 1975, 5). It seeks continuously, destroys patterns, rejects tradition and make rules out of breaking them. Iannis Xenakis also expanded existing frames, proclaiming even the crisis of innovative and revolutionary trends, including serial music.

He replaced determination with indeterminism. However, it was based on the probability theory far from the random aleatorism of John Cage. From defining particular sounds with sets of measurable variables, such as pitch, duration or density and applying stochastic laws which *entered composition through musical necessity* (Xenakis 1992, 8) originated free stochastic music. This issue occurs already in *Metastaseis* (1953-54) and *Pithoprakta* (1955-56) and seems to be most frequent in his works. One of the most distinct examples would be *Achorripsis* (1957), called *a sonification of probability distributions* (Childs 2002). The composer defined the macro-structure of the piece with a matrix filled with sound densities obtained by Poisson's formula.

$$P_k = \frac{\lambda^k}{K!} e^{-\lambda}$$

Figure 2. Poisson's formula used by Xenakis in order to obtain the distribution of sound densities in *Achorripsis*

Seven rows of the matrix represent 7 groups of instruments representing different timbres, whereas 28 columns designate time intervals (Xenakis 2002, 31). Interestingly, probability of an event of zero frequency (identical with the rest) is more than 0.5 and the one with four events occurs only once.

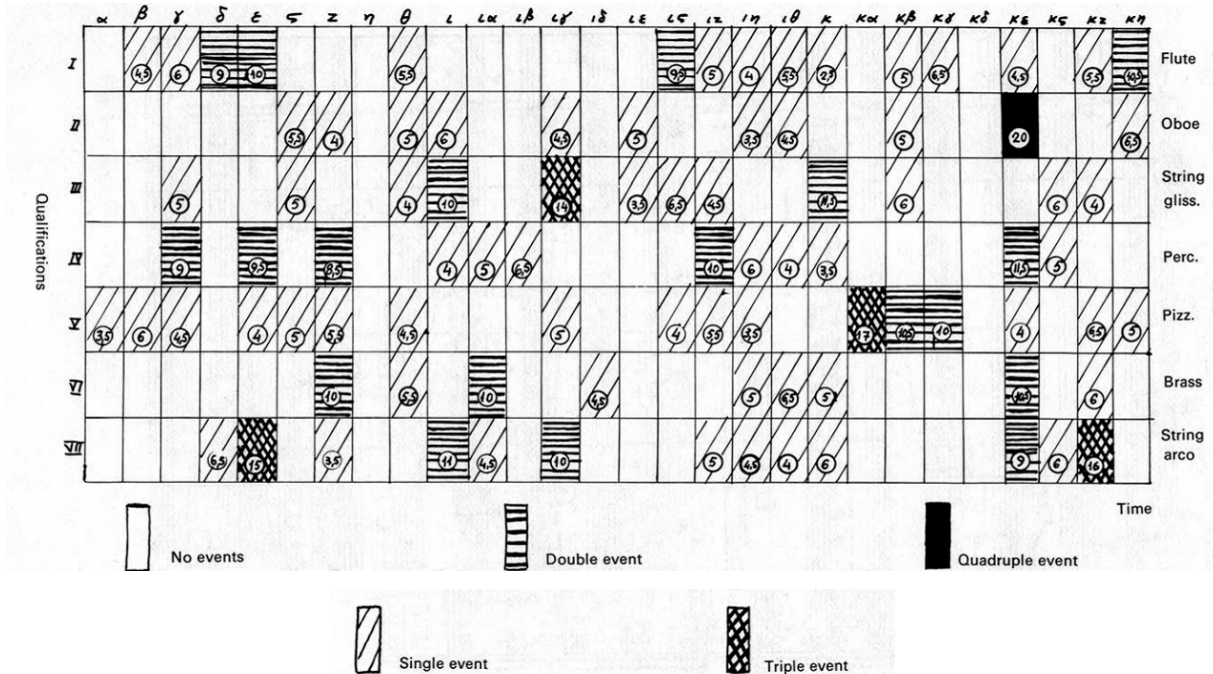


Figure 3. The matrix of sound densities in *Achorripsis* (Xenakis 1992, 28)

At the level of microstructure Xenakis used even three distribution types: exponential to define time structure, uniform to fix the initial interval and normal to specify glissando parts.

Having considered that the composer was familiar with the game theory as well, it seems obvious that the described solution does not determine one and invariable construction. As he stated, *this matrix is like a game of chess for a single player who must follow certain rules (...). This game matrix has no unique strategy* (Xenakis 1992, 32). This goes hand in hand with the thought of constructivists, who identified creation of an avant-garde artwork as forcing chaos to an order with the help of mathematics (Turowski 2000, 58).

Elements of non-representational art

Who needs this? Why reflect the life since we have it at one's disposal? – negated constructivists an old order of art (Fussioner *l'art et la vie*). According to them, the aim of art was not the interpretation of reality, but its attainable construction. Echo of this appeal to abandon *the themes and things* (Turowski 1998, 168) is still audible in Xenakis' output. It can be found both in his early works, with scarcely relevant melodic factor and in later vocal works with words replaced with phonemes.

At first, pitches were of minor importance in relation to the complicated structure, which destroyed any resemblance to the melody. Expression was built with numerous glissandi and impressive clusters. All that remains also in *Nuits* (1967) where complex glissandi replace *traditional* melody and text consists of Sumerian, Assyrian and Achaean phonemes, as well as of concrete sounds. Audience, devoid of references to the reality, pays more attention to the pure, independent sound, admiring the art itself and searching for its own meaning and message.

What is more, Xenakis used not only ancient phonemes, but also modern ones, derived from Shakespeare (cf. *Sea Nymphs*, 1994) and his own poetry (cf. *Knephas*, 1990). All this brings to memory transrational zaum language of Aleksei Kruchonykh, applied in the first constructivist opera, *Victory over the Sun* from 1913.

New proposals of construction material

Constructivists usually exploited materials in an unprecedented way, e.g. by applying glass or metal in their paintings. That issue comes to life in the works of Iannis Xenakis, who, as an architect, appreciated the role of material in the construction. He created new materials by dividing particular sounds into many sinusoid waves with use of his computer system. Moreover, he also discovered and adapted new methods of material organisation. Among his achievements in that field one can find sets, sieves, sound galaxies, glissandi, arborescences and random successions.

In the late 1950s Xenakis developed the idea of symbolic music (cf. Xenakis 1992, 155-177), based on algebra and calculus. The starting point of his theory became his first solo piano work, *Herma* (1960-61), in which all components were defined as consecutive variables, thus enabling the composer to use them in algebraic formulas. First of all, Xenakis isolated three inseparable subsets of 30 sounds each. Afterwards, he carried out simple operations of set theory, such as union and difference, in order to obtain new range of sound material.

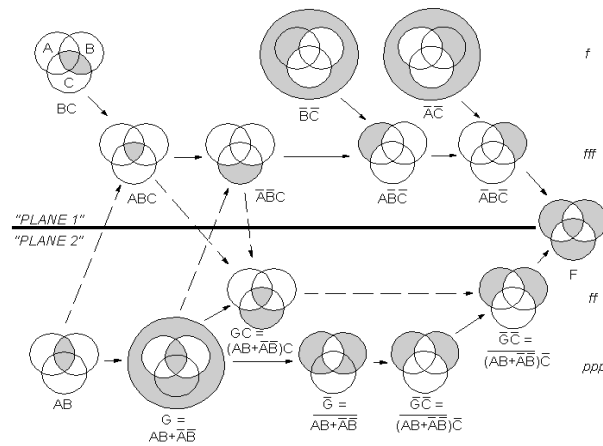


Figure 4. Scheme of sets and simple operations on them, creating the structure of *Herma*.

Leaving temporal structures to the group theory, in the course of time Xenakis developed outside-time structures called sieves, based on ancient Greek music theory and mathematically organized order of pitches, as opposed to the diatonic scale with its order suggesting sequences of sounds (Xenakis 1992, 268-276; Turner 2005; Exarchos 2008).

However, sieves are not the only methods of material organisation in Xenakis' music. Besides them he also included sound galaxies, that is stochastically estimated sound complexes, whose shape can be specified with a graph (with pitches on one axis and time on the other). Particular clouds (alternative name for galaxies) are arranged with permutation.

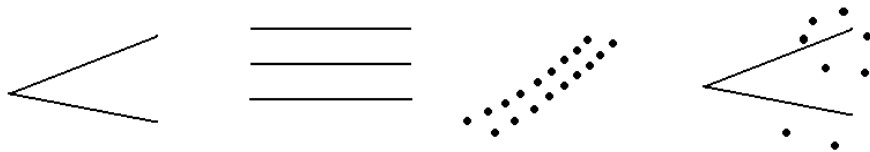


Figure 5. Examples of basic sound galaxies in *Nomos Alpha*

Apart from the above, the composer is famous for the innovative use of glissandi, as an alternative of single sounds and the basis of sound material. The composer claimed that the analogy between music and architecture is possible through the universality of line (Beaudot 1973, 17). That follows constructivist assumption of creating constructions by means of straight lines. It may also be considered as an analogy with constructivists' conclusion that *embellishment and processing of the material create possibility of gaining specific forms – noises* (Turowski 1998, 88).

While expanding his theories in orchestral works, Xenakis also devised new methods in the field of piano music. In the 1970s he included in his works numerous arborescences, i.e. constructions in which initial melody branches out and its scheme is transformed with permutation or 45-, 90- (inversion) and 180-degree rotation. In the early 1980s he started to use randomized successions – in a great simplification processes based on exposure to the random position changes – derived from physics.

Metastaseis as an example of interrelationship between architecture and music

Xenakis tends to be called *architect of sound* (Capanna 2001, 19). Given both his career as an engineer and his approach to composition, hardly ever more accurate comparison could be made. The most outstanding example would be here *Metastaseis* (1953-54). It is build on the

basis of Le Corbusier's constructivism rule of contrasts. Even the title, translated by Xenakis as *transformations* is based on the contrast between Greek *meta* reflecting to inconstancy and *stasis* as a stillness. Moreover, its project, permeated with many architectural solutions, became an inspiration for the Philips Pavilion built for the Brussels World's Fair (1958).

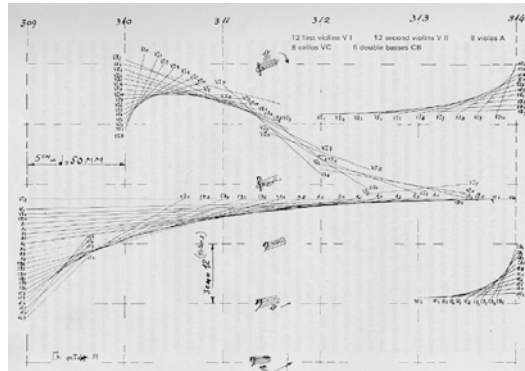


Figure 6. Scheme of glissandi in *Metastaseis*. This sketch (Xenakis 1992, 3) served as an inspiration when the Philips Pavilion was created.

Draft of glissandi, prepared as usual on the plotting paper and applied later in *Metastaseis* served Xenakis as an inspiration for the construction of hyperboloid curvature of the pavilion. In the score itself, glissandi, as *construction materials, like bricks, stones and wood* (cf. Hoffmann 2001, 607), enabled the composer to turn single sounds emerging at the beginning into a great, 46-sounds cluster. Finally, similarly to constructivists, as a basis of construction, Xenakis used a combination of straight lines and dynamic curves.



Figure 7. Architectural fulfillment of the musical project: Philips Pavilion (1958).

Abandonment of two-dimensionality

Abandonment of two-dimensionality, which results in *a new sense of space that surrounds everything with its infinity and leads to more collective creativity* (Turowski 1998, 140), emerged already in the first constructivist works. In the case of Xenakis, this requirement can

be considered twofold, both in relation with architecture, characteristic of his oeuvre and within space music. Unique example of an impact of this two is *Concrete PH* (1958) – this tape composition requires resignation from traditional sitting posture in favor of following the source of sound and is so inseparably connected with the Philips Pavilion (where it was played) that it seems impossible to experience the piece outside this building.

In 1965-66 Xenakis created *Terretektorh* for 88 musicians scattered through the audience. Reshuffling proceeded here in accordance with the rules of probability theory which implied new, kinematic idea of music that was impossible to obtain with any of electro-acoustic means of the time. Sound transformations in each layer influenced on the others, thus creating a specific kind of counterpoint (Hoffmann 2005).

Polytopes – Interdisciplinary spectacles of light and sound

As it was already stated, constructivists postulated a fusion of art, science and architecture. This interdisciplinary perspective can be found in Xenakis *Polytopes*, unique spectacles of light and sound, shaped with calculus and being an integral part of designated space. Thus their interdisciplinarity is based on mathematics, music, architecture and physics.

After Varèse's *Poème électronique* Xenakis paid attention to certain faults in mixed-media art if created by many artists simultaneously. According to him, that kind of experiment could succeed only in case of consolidation of all elements into one artistic vision. In 1966 he was given a possibility to fulfill his idea during EXPO'67 in Montreal. The accomplishment of the project went far beyond organizers' expectations and brought the composer great esteem along with further propositions. In 1971 he prepared *Polytopes de Persepolis*, performed in a grand style in the ruins of Persepolis. Hundreds of torches came along with tape music played with over 100 loudspeakers. Another projects of this type included light sculptures (*Polytope de Cluny*, 1972) and a special tent equipped with 400 mirrors (*Diatope*, 1978).

Production process given away to the machines

Constructivist fascination with apparently unlimited possibilities of modern sciences, application of advanced technology and only in part metaphorical calling artists to come to the factories found its equivalent both in tape and computer music of Xenakis. Even his first trials reveal signs of his interest in musique concrète and elektronische Musik.

Tape music creates new possibilities as far as material aspect is concerned. Unlike instrumental music, where the range of sounds is quite limited, here even one particular sound can be divided into many sinusoid waves. On the other hand, while working on *Metastaseis* the composer struggled with enormous data quantity. Therefore it seemed obvious to use a computer while solving complex stochastic equations. Along with developing IT technologies Xenakis continued his researches, creating a basis for almost all kinds of employing computers in music: algorithmic compositions, sound synthesis, interfaces and computerized performances.

In 1963, making use of his probabilistic theory on sound galaxies, Xenakis created computer language (ST), meant for stimulation of composition. It calculated pitches, duration, dynamics and instrumentation. In the meantime, the composer worked on a new project which would convert graphics into acoustic signals (UPIC). But these kind of works led to the machine code instead of sounds and only a living performer could have chosen the final outcome. Generating sounds *out of nothing* became possible only after Xenakis implemented an algorithm of dynamic synthesis (GENDYN).

In accordance with Xenakis' words, *music, by its very abstract nature, is the first of the arts to have attempted the conciliation of artistic creation with scientific thought. Its industrialization is inevitable and irreversible* (Xenakis 1992, 133). But this is not the only constructivist feature in case of electro-acoustic music. One can find here also an aspiration for the perfect construction of the artwork, expressed owing to the great precision of computers.

Conclusion

Xenakis' researches, leading toward abstraction and formalization of compositional process, gave rise to innovative techniques, such as symbolic music, sieves, sound galaxies and stochastic music, thereby throwing a new light on previous attainments of musical tradition such as space or electro-acoustic music. Since Xenakis aimed at a replacement of feeling with understanding logical implications of sounds, included unprecedented sound material in rationally planned, mathematic-based structures and abandoned two-dimensionality, not only did he realize ideas of constructivists but also fulfilled their dream of a New Art by applying modern technologies and merging together art and architecture.

Despite the fact that the history of Russian constructivism, especially in its social aspect, ended in late 1930s with the coming of socialist realism, its wide repercussions, often unconscious, can be found in contemporary music, in such Polish composers as A. Panufnik or W. Lutosławski whose technique in some aspects resembles the one of Xenakis. Nevertheless, the presented theory requires further detailed studies, therefore leaving wide range of possibilities.

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