Bulletin of the *Transilvania* University of Braşov • Vol. 2 (51) - 2009
Series VIII: Art • Sport

MATHEMATICAL CONCEPTS IN AUREL STROE'S MUSIC

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Abstract: *Professor Dinu Ciocan is the first person who found similarities between works of art and fuzzy sets, which are subject to gradual change. In compositional art, Aurel Stroe translates these notions into his music. This perspective is adequate, since mathematical notions are very close to the aesthetics of works of art, which involve a poetic dimension, the ethics of intentional ambiguity and vagueness, features which promote musical interpretation.*

Key words: *fuzzy sets, contemporary music, (non-)Euclidean geometry.*

The music of Aurel Stroe is one of the best Romanian works of art of the XXth century. The aesthetic approach on fuzzy sets is a way to analyze the profound signification of his art. The explanations I will provide further refer to the way mathematical arguments simplify the understanding of a work of art, especially in the context of the XXth century, when philosophy and art introduced "the primacy over the real". Mathematics is useless within a world in which the possible does not take precedence: "if you take the real for granted or consider it unique, you miss the unit of deeper mathematics. But if you double, triple or polymerize the real, if you dive into the ocean of the possible, then mathematics becomes a means to know, to explore the possible" [1, p. 61]. The work of art is itself a reality meant to multiply reality in a deeply recreative way, which is neither photographic nor mimetic. The musical masterpieces composed by Aurel Stroe are the best examples to support the statement above, as they reflect a perspective of the possible, infinite world, as well as the marginal visions of reality. The composer's spiritual refinement is transposed to his musical work, which is the fruit of his approach on world and art, and which explains why these concepts can naturally and organically be identified in his compositions.

Professor Dinu Ciocan is the first person who found similarities between works of art and fuzzy sets, "which are subject to gradual change" [2]. This perspective is adequate, since mathematical notions are very close to the aesthetics of works of art, which involve a poetic dimension, "the ethics of intentional ambiguity and vagueness", features which promote musical interpretation" [3, p. 62].

There is an obvious compatibility between mathematical notions and phenomena, which are deeply related to each other, and the artistic background, as it is shown in the specialized literature. Goethe promoted the mathematic approach concerning art, by pointing out the spiritual dimension of mathematics, which contributes to the development of the creative artistic phenomenon: "mathematics is an element of the inner superior sense; practically, it is an art. Nevertheless, mathematics is not able to perform any moral act; a mathematician is accomplished only if he is accomplished as an individual" [4, p. 53]. The end of the quotation made by the Romantic German artist makes the distinction between the artistic valuation of the artistic piece of work

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and its creator's moral profile, which proves to be so important. As one fundamental law of aesthetics states, "every aesthetic end product may not always be moral"; it proclaims the superiority of the spiritual quality over the aesthetic aspect.

"The Euclidean geometry is the perfect introduction to philosophy" [5, p. 35]. The work of art has a lot in common with the philosophical conceptions of non-Euclidean geometry, especially as regards the meaning of Aurel Stroe's composition work which displays complex ideational understood implications. Euclid, the famous Greek geometrician, who lived around 300 B.C., was a professor in Egypt; among other works, it is worth mentioning his book, "Elements", a geometry manual, which contains individual theorems for plane and special geometry, algebra and the theory of numbers. He promoted the logical reasoning and deduction and influenced Newton in his work "Principia". Today it is known that the Euclidean geometry is not the only independent geometric system due to Einstein's General Theory of Relativity ("the Euclidean geometry is not respected in vicinity of the black holes and the neutron stars, where the gravitational fields are very intense)" [6].

Mathematics is usually defined as the science which is concerned with structure, change and space. A modern approach on mathematics states that it is concerned with the investigation of abstract structures, axiomatically defined by formal logics. The basics of the structures investigated by mathematics are sometimes found in natural sciences (especially in Physics). Mathematics defines and investigates its own structures and theories, to synthesize and unify multiple mathematic fields as a unique theory, a method which usually simplifies generic methods for calculation. Occasionally, mathematicians study fields of mathematics strictly for their abstract interest; therefore this approach is more related to art than to science. The specific domains of mathematics are used to mark generically the limits of the trends approached by mathematics to date, in the sense of delineating three specific directions: the study of structure, space and changes.

The study of structure generally focuses on the theory of numbers (elementary algebra); abstract algebra is the result of a deep investigation and abstracting of these theories (abstract algebra studies the structures which generalize the properties of numbers in the usual sense). The "vector" concept, generalized in the sense of vector space, and studied by linear algebra, is specific both to the study of structure and space. The study of space naturally starts from (Euclidean) geometry and three-dimensional familiar trigonometry which later becomes non-Euclidean geometry and plays an essential role in the theory of relativity. The study of change, as it reflects the dramatic background of the musical discourse, is necessary, especially in case of arts, where measurement and predictability of changing some variables are essential.

The current development process of human society requires ever more resources, both material and human. We can notice a constantly changing scale of values and lifestyles; we are on the threshold of supportability, at a critical point in human evolution. It is the energy and the space-time of the habitat in which we are dwelling that keeps us together. All these barriers are also related to the level of civilisation we are living in, to the way people create, achieve and consume artistic products, and to the present cultural paradigm. Therefore, we should consider music from a space-limit perspective (a philosophical limit of non-Euclidean geometry): the conquest of a new dimension, the perception and pragmatic use of the properties of a new dimension could be more than an intellectual challenge, a step towards self fulfilment and, implicitly, a proof that man can survive in a world which seems to be consumed.

The issue regarding the fourth dimension is not only a mathematical issue, but also an aesthetical one. Nevertheless, nobody, excepting for the mathematician Howard Hinton who had intensively trained his

imagination, has got a picture of the volume in a non-artistic act with significant expressive implications. All great mathematicians, except for a few of them (Henri Poincare was ahead of them), agree to the fact that there is incontestably a four-dimensional space. Nowadays, a great number of scholars and philosophers are concerned with the issue of the fourth dimension. This issue replaced the interest people used to have for the squaring of the circle or for the perpetuum mobile. To conceive the fourth dimension, we should leave the strictly scientific, concrete dimension of the human universe which can be directly analyzed, and study thoroughly the meanings of art.

It is known that Euclidean geometry has three dimensions: length, width, height or thickness. It is only since 1621, due to the research done by Sir Henri Saville, that a new type of (non-Euclidean) geometry was born because of certain obscure issues specific to geometry (especially as regards parallel lines); this discipline was the result of the contributions made by Saccheri, Lambert, Gauss, Lobatschevsky (his research was highly appreciated by the scientific world), Bolyai, Riemann, Helmholtz, Beltrami and many others. Simultaneously with Lobacevski, the Hungarian mathematician from Transylvania Janos Bolyai (1802-1860) created non-Euclidean geometry. During his studies, but especially after he graduated the Academy in Vienna, Janos Bolyai made important discoveries which contributed to his major work "Appendix" (1832); his work was published in Latin as a completion of the manual written by his father. The results achieved are a thorough dialectic study of the issues of mathematics. Bolyai's research set up the foundation of new trends in geometry which, however, were not understood and appreciated by his contemporaries.

The research of the reference works mentioned above proves the profound correlation between them and the musical phenomenon created by Aurel Stroe, which has a unique interior geometry, developed according to other macro and micro formal laws than the ones commonly used in modern composition art. The tragic feature of the paradox of the non-Euclidean knowledge" [7, p. 122] is very well adapted to the aesthetic background approved by contemporary art.

This new geometry shows that space is no longer the Euclidean space. It is also obvious that we are able to understand various types of spaces with different properties, where parallel lines meet, where the angles of a triangle scale down unlimitedly while its sides become longer, and other similar anomalies. The non-Euclidean geometry turns into a hyper geometry or a metageometry, a theoretical background to investigate hyperspace, the fourth dimension. But what is hyperspace? Once this question is asked, difficult issues are brought into discussion. Is it a space accessible to man, to his spirituality, or is it a hypothetical space similar to Einstein's space?

Here we are very close to the concept of the infinity of the (aesthetic, expressive) universe which raises the following question: what is a bound? It may be more than "the extremity of a certain surface". The issue related to infinity is abnormally complex and out of the intricate network of numbers, of abstract or concrete geometry; it suffices to remember the difference between "the undefined" and "the infinity". The infinity which pushes our imagination to limits is nothing else but the undefined. It is nothing else but a variable infinity which oversteps the imposed bounds. Our imagination cannot perceive but a finite area, to which is added another finite area, and this circuit is endless. It can neither reach big infinity nor small infinity, only what is left finite. Imagination cannot reach infinity, neither the bound of big infinity nor zero, the bound of small infinity. These two "extreme states" of infinity are ideas which only reason can understand. "The infinity made of more pieces is nothing but the mobile and fugitive shape, the parody of infinity".

Mathematical infinity removes imagination and first appeals to reason. To conceive and reach infinity, reason does not have to cover the domain of infinity and waste the series of undefined bounds.

It is enough for reason to find that a finite right line can be prolonged on both sides, to find also that any given number can be added to a unit, and to notice that this is always possible, independent of the number or the line. The mathematic infinity is a kind of "spontaneous infinity", similar to the artistic infinity; it is an infinity which is made up outside imagination and reason, which gives birth to the force of things, the infinite numbers or the projections of superior geometry. According to Jouffret, "a geometrical being would be created with its own individuality, which is above the finite and the unlimited", while the unlimited is connected to our mind. Such a superior being could act in an interpersonal space which would overstep our imagination, either in big infinity or small infinity, without having anything in common with this imagination. It is a space which people can conceive beyond their reason, and this had been impossible but for the mysterious force of art, whose impact on the concepts of new mathematics has become obvious; it imposed the ideas of an extra human space, which at first sight seems more unreal than our hereditary space, where things happen similarly to the way they do in our familiar space.

It is not easy to know or to define a hyperspace (from a cultural, not from a geophysical point of view). It is difficult to define the three dimensional space: the Kantian formula, which states that space is subjective, a required supposition of all experiences, cannot be ignored. The comparison between aprioricists, who state that the idea of space is innate, and empiricists, who argue that this idea is the result of experience, does not ease the issue under discussion; neither do we find out whether to accept the idea that space is a structuration order in time and that time is a succession order, as Leibnitz stated. We do not go any deeper in understanding this issue if we state that time can be represented by space or that space is necessary for all representations.

All Kantian and Neokantian efforts made by idealist empiricists finish up by preserving the same obscure information on this issue; all philosophers who were preoccupied with space and time (Spencer, Helmholtz, Renouvrier, James Sully, Stumf, Wiliam James, Ward, Stuart Mill, Ribot, Foille, Iuyan, Bain, Lechalas, Balmes, Donnan, Bergson, and many others) were not able to solve the double enigma; their most controversial theories are still obscure. Among the scholars preoccupied with the exploration of the multiple dimensional geometry, it is worth mentioning Poincare and Goursat (France), Cayley, Hinton (United Kingdom and the United States of America). Certain theories promoted by Hinton or some remarks of Boucher's geometry state that the one who can use the fourth dimension will be able to see the whole interior of the material bodies, without being stopped by their surface and even without taking it into consideration; the tiniest interior and exterior particles of objects will appear as juxtaposed, not as superposed. Whatever we may think, what happens beyond our being is much more fertile than anything which happens anywhere else.

Schofield (Hinton's disciple) presented the three dimensional life in an ingenious way. He started from the non-dimensional being, who cannot see anything, not even herself/himself; everything is non-being and s/he is convinced that the non-being is her/his universe. On the next level, there is the linear being, who lives together with her/his fellows; s/he cannot see anything but the extremities of the line, a point. Then he analised the plane being, or the two dimensional being, who cannot see anything but two lines; in the end, the thinker described the volume being, who cannot see anything but surfaces and the hypervolume being (the artistic work), who can perceive volumes instantaneously and completely. All revelations and apparitions in the Old and New Testament come from beings who possess the fourth dimension: the spiritual dimension which makes the

perception and feeling of the artistic act possible.

Hinton proved to be the scholar who passionately dedicated himself to researching the fourth dimension. He was not only a mathematician, who used to make fun of the thrilling game of the most daring hypotheses, but also a balanced, gifted man with a vast, unique imagination, which allowed him to put forward viable theories for most of his abstractions. Besides the mathematical works, he also wrote scientific literary works, but only a few of them were successful. This is the case for the novel Stella, which narrates the life of a young girl, who was made invisible by her father (he took the principle of the refraction of light as a basis). In "The Fourth Dimension", the reader is led to the darkest of the greatest enigmas: the author pretends to have built some solid four-dimensional cells called tesseracts which are a close transposition of a four-dimensional space.

What Hinton wants us to develop by this experience is a special feeling (comparable with the fundamental power of the spirit). This means that we have to train our conscience to look at things from a different, non-conventional point of view: an artistic, aesthetic point of view. Hinton stated that "when we meet infinity at a certain moment of our thinking, this is a sign that this way of thinking is related to a reality which proves to be higher than the one we are used to". The space we usually conceive is limited, not in terms of surface, but in a way which cannot be grasped. But why does space have to be tridimensionally limited? The spiritual experience is the only capable of answering this question. We may experience the cultural existence of the fourth dimension; in a way or another, the human being is not simply a tridimensional (material) being. There have been put forward certain suppositions, which in an arbitrary and artificial way provided a draft of the relation of our body with the existence of the fourth dimension; it states that our spirit is able to identify it. Our spirit can develop a superior conception of the fourth dimensional space, adequate to our tridimensional space and it can use it likewise. The only difficulty is to decide or at least to sense that there is a fourth dimension (or even more dimensions) in the universe.

Therefore, the three dimensions are the measurements of matter in space. These measurements take into account only one feature or characteristic of matter: the extension in space. From this point of view it is impossible to find other dimensions, except for length, width and thickness. But it is likely that other senses (like the cultural sense) could reveal other unexpected coordination characteristics of space and time; thus, we might discover an extension of the fourth dimension. As Ouspensky stated, "by time we understand "the distance" which separates the events in their succession, connecting them to different entities. The distance can be found in a direction which does not exist in the three dimensional space: the fourth dimension. By the term "time" we express a reality, a certain space and a movement within the space and, consequently, the time extension is the extension in an unfamiliar space, which explains why time is the fourth dimension of space". Nevertheless, from a certain point of view, time and space are interchangeable. Mathematicians use time as it were the fourth dimension of space. The idea of explaining space by time and time by space is similar to the one by which we try to explain the night by the day and the day by the night. According to Ouspensky, "the sense of time is an imperfect sense of space, it is the limit of our space". Space is the visible present; time is a burning space which becomes past or future. Space is an intense time, a horizontal time; time-space is the lasting time, time is the ephemeral space. We cannot measure our limited space but as related to time. If we want to give time a reality, we can only represent it as an immaterial space. It provides a total lack of objects; in exchange, it is full of the

events it develops. For us, time begins when we cannot understand each other any longer; the picture of space is made up around us, when we follow the passing of time. Space and time share certain properties; for example, the centrifugal force (this mysterious energy which is the eternal enemy of gravitation), as the rotary motion of the Earth, has a mathematical representation by the formula in which time and space intervene. By virtue of this principle, time is limited only by time and space is limited only by space; space is almost always limited by time, and time is surrounded by space. They fight for supremacy and vanish in the dark. Space necessarily exists in time.

Eddington stated that "the fundamental measure is not between points in space, but between two points in space associated to some moments in time (the case of the work of art). We consider time a moving of space and space a break of time; in reality, time is as motionless as space. We picture it as a river which flows unceasingly. In reality, it has never moved, it is we who are flowing, not time. We are kept between space and time and end in a cosmic deadlock. When mathematicians get us out of space, when they get to a critical point in which space gives no feed back to their calculations, they make a fourth variable break into the background, time, which restores the balance of their calculations and allows them to go further.

The work of art is related to this temporal reality which contributes to the embodiment of the work of art and the cultural (even more, the spiritual) dimension, which is in fact the fourth dimension (left aside by mathematicians). In conclusion, Hilton assures us that we will never be able to see a four dimensional figure physically, but only with the mind's eye. The real, three dimensional and strictly material world is obsolete; it has to be replaced by non-Euclidean properties and by four dimensional space and time. The four dimensional world is not just a mere mathematical figure; it is the real world of physics, the way pursued by physicists to reach reality. Metageometry also looks outside our space for less conventional and subjective situations which have uncertain relations with the space we created (or which was created inside ourselves) to help us understand the phenomena of the universe.

"There is not only the sensuous music; there is also a spiritual music. There is not only the music which is being performed at present, but also the eternal music, which exists even when it is not performed. All lonely people have their silent music inside themselves and I am glad that there is such music. But where do people get the music from? They get it from us, the musicians, because it has to be first performed and listened to (…) so that any person can think about it and dream of it when s/he returns home" [8, p. 134-135].

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