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MAGIC NUMBERS IN THE MUSIC OF SOFIA GUBAIDULINA

Abstract: Sofia Gubaidulina's compositions are characterised by a special kind of symbolism and constructivism both based on numbers, i.e. mathematical proportions. In almost all her works so-called numerical plots can be detected. The proportions of the Fibonacci series provide a basis for many of her works composed since the beginning of the 1980s. In more recent times she used some rows derivating from the Fibonacci series, in particular the Lucas sequence.

Key-words: Sofia Gubaidulina, Fibonacci series, Lucas sequence.

The collection of Sofia Gubaidulina at the Paul Sacher Foundation in Basle includes some valuable sketches for her works from the 1990s. Most important for researchers are the working materials related to Gubaidulina's compositional techniques: formal plans, timbral schemes, and numbers. Many pages of the drafts are filled with formulas and calculations that refer to the temporal proportions of the form on different levels. Gubaidulina's interest in both the numerical aspect of composition and in numerical symbolism has been known for a long time, but only the drafts at the Basle archive give us concrete evidence of this fact.

Gubaidulina highly values two important elements in the compositional process: the constructive principle and symbolic meaning. She bases the constructive principle on numbers that become the core on which the whole composition is constructed.

Numerical structures in Gubaidulina's works are of different kind; For example, the number 7 («holy seven») has a sacral meaning for the composer. Examples are numerous:

a) 7 movements in the cycle (as found in the early cantata *Night in Memphis*, *Stufen* for orchestra, *Seven Words*, the choral *Alleluja*; in the *Perception* there are 13 movements, but in the seventh movement there appears a new text from David's Psalms); b) 7 performers (*In the beginning was the Rhythm*); c) 7 instruments (*In the beginning was the Rhythm* — 7 kettledrums and 7 other instruments — legno, campanelli, temple-blocks, 2 marimbas, 2 drums) ...*Heute frueh, kurz vor dem Aufwachen...* — 7 koto); d) 7 sections within the form (*Quasi Hoketus* — rondo in seven sections).

But this is only the external stratum of numerical aesthetics and as such it is not specific only to Gubaidulina's approach to composition but has the same sacral meaning for many composers. The most unique is the profound

stratum of the numerical aesthetics. Hidden from the eyes, it lies in the foundation of the musical composition and is organised through a complicated system of numerical ratios. It is practically impossible to «catch» the ratios with the ears, but only they create the temporal harmony of music.

Mysticism, ritualisation and submission to some external laws are very typical of Gubaidulina's creative method. It has been particularly noticeable in her work since the late 70s. The subject of *Gerade—Ungerade (Even and Odd)*, performed in the early 80s, can serve as an illuminating example. In that improvisation for voice, saxophones and percussion Gubaidulina used the famous Chinese «*Book of Changes*» (I-Ching) — the ancient practice of throwing coins to obtain chance numbers. She used to say that in that way «*fate itself was composing music*».

In Gubaidulina's music one can find symbols of different kinds:

- descriptive: for example, in her works for the bayan (accordeon). The bayan is a Russian folk instrument and is always connected with folk art. Gubaidulina was the first to use the bayan without these folk associations, simply as a small organ. She was attracted by one characteristic of the bayan: it «breathes». In the composition *Seven Words* this «breathing bayan» represents the heavy breathing of Christ on the Crucifixion.
- instrumental: for example, the crosses. In the piece *In croce* for organ and cello the registers of two instruments move crosswise: the organ – towards the low register, and the cello – towards the high; the point of their intersection forms a cross. In the cycle *Seven Words* the cross is expressed with the help of a glissando: the glissando intersects the cello string as if crucifying it (according to Gubaidulina, in that moment the cello feels pain almost physically).
- register: for example, all the choral *Lauda* are constructed on a gradual ascending register.

Numbers belong to the same set of symbols. Of course, numbers and numerical composition in general are not characteristic only of Gubaidulina's work. One should not take a one-sided approach to this matter. The artistic thinking of Gubaidulina as a composer is very complicated and versatile - as is the case of most outstanding creators. A lot of remarkable examples can be found in her work, for instance, in the sphere of sound. Sonoric images in her music are always very expressive.

But Gubaidulina made some innovations in the field of symbolism in music. They are very important for her own creative method and at the same time serve as significant and interesting examples of contemporary compositional techniques. That is why emphasis is placed on this phenomenon.

Gubaidulina's works stem from two sources: symbolism (including the numerical) and constructivism. From the beginning of the 1980s up to now, all Gubaidulina's works possess more or less developed numerical ideas.

She consciously uses numerical structures with sacral-mystical meanings. Ontologically, the numerical aesthetics of her music is based on the interlacing of Eastern mysticism with Orthodox symbolism.

In various interviews Gubaidulina has made comments on basic compositional techniques in contemporary music. She is convinced that *rhythm* is the most important foundation. However, Gubaidulina understands rhythm not only in the general sense as a series of durations. From 1984 on, she began working with the *rhythm of the form*, which refers to the special temporal structure of the work produced by the proportionality between sections of its form. Surely, this problem is not new and has always been of special interest for any creator of music. But in the twentieth century the *rhythm of the form* became an important aspect of contemporary compositional technique that is brilliantly demonstrated by Gubaidulina who creates individual *numerical plots* in almost every work. The expression *numerical plot* was found in her sketches for the choral cycle *Now always Snow* and for our purposes can be used as a special term for the compositional technique, meaning the proportional calculation of the whole form.

The proportions of the *Fibonacci series* are the foundation for a majority of Gubaidulina's works from the middle of the 1980s (*Perception, In the beginning was the Rhythm*, symphony *Stimmen...Verstummen* and others). This is a sequence of numbers each of which, after the second number, is the sum of the two preceding numbers; for example – 1 2 3 5 8 13 and so on. The series was named after the thirteenth-century Italian mathematician Leonardo Fibonacci (Leonardo of Pisa):

Basic Fibonacci series: 1 2 3 5 8 13 21 34 55 89 144

For Gubaidulina, the Fibonacci series as an organic, natural phenomenon has an important semantic meaning. These numbers break away from a mechanical regularity, approaching the ideal golden section and give the form the ability to “breathe”. The Fibonacci numbers were frequently used in works by such composers as C. Debussy, B. Bartok, K. Stockhausen, L. Nono, but it is difficult to find such diverse treatment as in Gubaidulina's music.

At first Gubaidulina was attracted by the logical beauty of the Fibonacci numbers; they exerted a fascinating and in some sense mystical influence on her. It was only later that this numerical series became the constructive basis of her works. She found various ways of using it. For example, in the work *Now always Snow*, one can find a complicated rhythmical structure underlying the entire five-movement cycle, and in the *Fourth Quartet* the purely musical proportions are accompanied by light projections: the 7 colours have their own rhythms, and together they are included in the formation of the rhythm of the whole form.

Several stages can be outlined as to how Fibonacci numbers were gradually introduced in Gubaidulina's works.

She used these numbers for the first time in the work *Perception* (1983). In the eighth movement of the cycle under the title *Col legno I* there are 2 musical strata: seven string instruments on the stage play to their own pre-recorded accompaniment. The phrases of the tape recorded stratum are divided by the pauses. The length of these phrases gradually increases to the end of the movement in accordance with the Fibonacci series:

3 - 5 - 8 - 13 - 21 - 34 - 55 (bars).

Similar features can be found in the piece *In the beginning was the Rhythm* (1984). In these two works (*Perception* and *In the beginning was the Rhythm*) the Fibonacci series determines the durations of phrases, the number of notes in phrases and the length of phrases, counted in bars.

In the symphony *Stimmen...Verstummen...*(1986) Gubaidulina went further. On the one hand it was an attempt to use the Fibonacci series to shape the proportions of the whole form (for example, the duration of the first, third, fifth and seventh movements is decreased according to the proportions of the series). But on the other hand, in this work one can find an absolutely new constructive and expressive numerical idea. In the ninth movement of the Symphony the orchestra is silent; it is a conductor's solo, a culmination of silence. The conductor's gestures, which are determined by the composer, define the rhythm of space according to the proportions of the Fibonacci series. Gubaidulina defines this rhythm as the principal theme of the Symphony, the Symphony's inner meaning.

Several works written in 1993 became the next stage in Gubaidulina's numerical evolution. Of all her works these opuses have the most astonishing characteristics because of their numerical ideas. It is interesting that in these works one can find not only Fibonacci numbers but also some other derivative rows, in particular the Lucas sequence¹.

In a very interesting article by the American musicologist Jonathan Kramer entitled *The Fibonacci series in twentieth-century music* he stated: «I do not know of many applications of the Fibonacci series other than to duration and to pitch».² Further two Gubaidulina's works will be shown that can serve as examples of different applications of the numerical sequences in the construction of formal proportions.

The first piece to demonstrate this has a poetic title *...Heute frueh, kurz vor dem Aufwachen...* (1993). It is written for 7 kotos, Japanese traditional instruments. The whole piece is based upon two series: Fibonacci and Lucas numbers. A key role is played here by the Lucas sequence.

Lucas Numbers: 2 1 3 4 7 11 18 29 47 76 123 199...

¹ A sequence 1 3 4 7 11 18 29 <...> was named after the nineteenth-century French mathematician Edouard Lucas.

² *Journal of Music Theory*, 17 (1973) 1, p. 141.

It is interesting to follow Gubaidulina's compositional process by studying three sketches created within a short period. Three of the final ones, *final sketch*, *last variant*, and *final variant*, all vary in length. Why did Gubaidulina keep changing the number of bars? She wanted to achieve a precise construction in which all of the numerical proportions were related to the principal numerical sequence. At first she chose 209 bars, then 212 and finally 217.

What is the significance of the number 217? It can easily be divided into several components derived from the Lucas numbers:

$$217 \text{ bars} = 199 \text{ bars of music} + 18 \text{ bars of silences}$$

Such division is not connected with the internal formal proportions; it explains only the general duration of the piece. However, the Lucas numbers determine the length of each of the 11 formal sections (in bars). In the following scheme one can examine the *numerical plot* of the whole piece:

Sections:										
	1	2		5		8		9		10
3	4		6		7				11	

bars:												
47			47			47			Climax		47	
11	7	18	29	18		1	18	29	18		18	
					1		(11		29		18	
							+7)					
golden section:												
47 + 47			+ 11 + 29			18			+ 18		+ 47	
					= 134				= 83			
in all:												
217												

As we can see, the numbers 11 and 18 twice interrupt the sequence of the number 47 (see numbers in bold):

before the climax: $47 + 47 + 11 + 47$

after the climax: $18 + 47$

Thus, the number 217 is obtained through the formula incorporating several Lucas numbers:

$$([47 \times 3] + 11) + ([47 \times 1] + 18) = 217$$

This formula is based on beautiful numerical proportions, but the problem is that they are not easy to find in the score. Instead the numbers are buried in the musical texture. It is easy to count bars if the piece has bars. In

a work such as *Heute frueh* there are both measured and unmeasured sections. In this case, the process of calculating proportions becomes significantly more complicated. To solve this problem both sections may be reduced to a common denominator with the help of an *absolute temporal unit* (microbeat). In other words, one needs to find the number of beats in the unmeasured sections where only the duration is indicated. In order to calculate it, two mathematical operations must be performed:

1. Calculate the *absolute length of the microbeat* by dividing the number of seconds in a minute (60) by the number of beats per minute (here 69): $60:69=0.869$. This is the value of the microbeat in absolute time.

2. Calculate *how many such microbeats* (0.869) are contained within the unmeasured section - the duration of which is 8 seconds. We divide the time in seconds by value of the microbeat: $8:0.869=9.2$. Thus, in 8 seconds there are 9 microbeats and 3 bars in $3/4$ time.

These mathematical calculations allow us to determine a correlation between the time in seconds, the number of beats and the number of bars. But what is the purpose of these calculations? The point is that only through such calculations and with the help of *one absolute unit* are we able to quantify the work from beginning to end and to reveal those numbers and proportions upon which the general *numerical plot* is based.

Thus, the following parameters are determined by numbers in the piece *Heute frueh, kurz vor dem Aufwachen*:

- the general number of bars (199+18),
- the length of each section (7, 11, 18, 29, 47),
- the number of sections (11),
- the length of unmeasured sections,
- the rhythm in a common sense (for example, in the opening of the piece one can find the following rhythmic sequence: in crotchets 3 1 3 4 3 7, these are Lucas numbers).

The second work to be used as illustration is *Meditation on the Bach Chorale "Vor Deinen Thron tret ich hiermit"* for cembalo and string quintet.

In general Gubaidulina's musical thinking is not connected with poly-stylistics. She doesn't like quotations or collage. While condemning poly-stylistics as a general rule, Gubaidulina does make use of other composers' music. This piece was written for the Bremen's Bach-Gesellschaft and one can expect quotations from Bach's music. Gubaidulina chose one of the most mysterious chorales - such a work suited her own numerical ideas.

The composer analysed the chorale prelude, considering it from the point of view of her most specific interest: she calculated the number of quarter- and half- notes in the sections of the form. Gubaidulina searched for numerical order and she found it. The numbers formed a sort of symmetrical structure.

Additionally, Gubaidulina used one numerical method that was particularly well known during the time of Bach. Every letter of the alphabet has its ordinal number. We can take the letters of a name and add them together. Thus, we get the symbolic number of the name. According to this system, the symbolic meanings of the following numbers can be determined: 14 – Bach, 23 – J. Bach, 37 and 79 – J. Chr., Christus:

9	=	J[ohann]
14	=	Bach
23	=	J. Bach
32	=	S. Bach
37	=	J. Chr[istus]
41	=	J. S. Bach

Gubaidulina added to these known symbols her own name — Sofia (48). Sofia when translated from Greek means *wise*. Thus, wise Sofia united the whole composition with her own number: the tempo of the piece is 48 (crotchet is 48).

Gubaidulina said that seeing this beautiful number sequence made her absolutely happy. And her work became an answer to the formal idea of Bach's composition, her personal fantasy on its number series.

Though Gubaidulina formed her *Meditation* on numbers and proportions that she had not used before, she used principles already known from her other works: the whole piece is calculated in a single tempo (the crotchet is 48).

The form of the piece is similar to Bach's chorale prelude: interlude, one chorale phrase, interlude, chorale phrase. Gubaidulina used only the first phrase of the chorale. Onlyt in the final section of the work does the whole chorale sound.

The last section of the form lasts 23 beats. This is more than just a number symbolising Bach's name. In the very last bars, four simple tonal chords allow Gubaidulina to spell out (in the upper voice of the chords) the famous monogram *B-A-C-H*.

Magic numbers form the duration of the sections of the whole piece. Its fundamental formula is:

$$384 + 111 + 23 = 518$$

The deciphering of this formula opens the deepest sense stratum of the work, uniting its main symbolic numbers:

- The first number 384 is divisible into 48 — Sofia's number,
- 111 is divisible into number of Jesus Christ — 37,
- 23 is a number of J. Bach.

384	+	111	+	23	=	518
(48 x 8)		(37 x 3)		(23 x 1)		(37 x 14)
Sofia	+	J.Chr	+	J.Bach	=	J.Chr + Bach

And finally, 518 (the number of absolute beats in the whole piece) is also a symbol. When we add all its elements together (5, 1 and 8) we get 14 — the number of Bach to whom this work of Guibaidulina is dedicated:

$$518 = 5 + 1 + 8 = 14 = \text{BACH}$$

Thus, we can examine two examples of Gubaidulina's numerical compositions. Similar numerical principles are found in other composer's works from the 1990s (in the piece *Dancer on a Tightrope*, in the *Music for flute, strings and percussion*, in the String Quartet No. 4, in the Second Cello Concerto *Und: das Fest ist in vollem Gang*, in the Viola Concerto, in the symphony composition *Im Schatten, unter dem Baum*, in the *Johannes-Passion*).

The question can be raised: is it possible to hear this large-scale formal rhythm? Of course, most listeners would not be able to register it. What one can hear, however, is a beautiful form, harmoniously constructed, with numerical proportions as its basis. In this sense the rhythm of the form is perceived as the surface beauty of the musical construction.

It is important to emphasize that the numbers in question form the inner stratum of Gubaidulina's music. She herself doesn't want to focus on them even though Gubaidulina has always spoken about numbers, number series, about the beauty of numbers with great enthusiasm. The following words are a prime example:

I am inspired by this working method: «the dance of the numbers» and pure intuition. Music is developing in two opposite directions: according to the numerical plot and by intuition. And when these two approaches intersect the unanticipated outcome is beautiful.

The Ancient Greeks said: numbers are the foundation of everything. And it seems that the numerical stratum of Gubaidulina's works of the 1990s should be understood in the sense of this Pythagorean conception. Perhaps it is not without significance that the Greeks demonstrated their number theory with the help of music.

Валерија Ценова

МАГИЧНИ БРОЈЕВИ У МУЗИЦИ СОФИЈЕ ГУБАЈДУЛИНЕ

(Резиме)

Композиције С. Губајдулине се карактеришу нарочитим типовима симболизма и конструкције базираним на бројевима, тј. на математичким пропорцијама. За њу је, на пример, седам свети број, па њена дела често имају седам ставова или толико одсека, или су писана за седам извођача. То је, међутим, само спољњи, лако уочљиви слој њене “нумеричке естетике”, док се тек у дубљим слојевима могу запазити компликовани системи нумеричких односа. За њену музику из 1970-их година било је типично коришћење метода надахнутог кинеском *Књигом њромена (И-чинџом)*, а током следеће деценије претежно је радила са пропорцијама Фибоначијевог низа. За Губајдулину овај низ је привлачан пре свега због тога што његова правилност није механичког типа, а приближава се идеалу златног пресека, дајући форми могућност да “дише”. У следећој фази њене стваралачке еволуције у њеним делима се могу уочити и други, изведени низови, нарочито Ликаов. У раду је детаљније анализирана примена овог низа у делу *...Луџрос рано, уочи буђења...*(1993), тако да се може закључити да Ликаови бројеви одређују дужину (у тактовима) целог дела и сваког од једанаест одсека, затим и сâм број одсека, дужину неметризованих одсека, као и ритмички ток. У *Медитацијама о Баховом коралу “Пред Твојим њрестоном”* Губајдулина користи нумерички метод познат из Баховог времена, а заснован на вези између слова и бројева. Како сама каже, она ствара музику која се развија у два правца – нумеричком и интуитивном, а када се ова два тока пресеку, резултира музички лепо.

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