

THE MIRROR-SYMMETRY, THE FIBONACCI SERIES AND THE GOLDEN SECTION IN THE RENAISSANCE MASS COMPOSITION

Irina Guletsky

Address: Department of Musicology, Hebrew University, Jerusalem.

The perfect proportions counting, among others, the mirror-symmetry, the golden section and the Fibonacci series, that were newly discovered and held in especially great esteem at the Renaissance era, expressed themselves most vividly in architecture and visual arts. In the music of that period their reflection does not appear to be so obvious, which results from the specifics of the style and the expressive means of the epoch.

Let me remind you that in the strict style polyphony, the principle of a constant rejuvenation of the music texture and the latter's fluidity step forward and stipulate a more significant role of the process factor in the form-making. Any repetition – and it is a repetition that the appearance of symmetry is linked to – has a veiled character. It is especially true for the cult music and, specifically, the mass that is going to be the subject of this article.

At the same time, it is the presence of various forms of symmetry that provides for the architectonic form and permits to perceive a large cyclic work as a whole and clear composition.

It is necessary to note that, unlike their colleagues-architects, the music theoreticians of the Renaissance failed to leave any works or instructions concerning musical composition and its proportions. The theory of proportions that further develops the Pythagorean teaching on the link between the radiuses of the planet orbits and the structure of the musical scale referred, as it is known, to the field of the music pitch and the mensural rhythm. This theory penetrated architecture and literally reshaped architectural forms (Wittkower 1949, pp. 101-143). Whether it applied to the musical form and to what extent it was realized is open for speculation.

Only within the last four decades (since the late 50's) there appeared a number of research works on the subject. These are the works by M. van Crevel (1959, 1964), M. Henze (1968), N.W. Powell (1979) and others. True, they were all devoted to the analysis of structure and proportions of *cantus firmus* (c.f.) in the works of Franco-Flemish composers of the 15th century. Let's recall that the structure of c.f. – the main thematic voice in the choral texture and the pivot of the composition – even though connected with the overall compositional proportions, cannot be identified with them. Besides, one ought not to ignore the following circumstance: at the early stage of its development – in the 14th century – the mass was not yet a composition based on a single c.f., while on the pick of its development, in the 16th century, it was already not.

Up to date, there exists not a single work devoted to the analysis of the overall compositional proportions and to the various ways of the symmetry manifestation in the Renaissance mass. This is exactly why these questions have become the purpose of my research.

In the present work I would like to stress the manifestation of the mirror-symmetry, Fibonacci series and the golden section in the overall mass structure that are expressed in the ratio of scales of parts and the whole. The overall structure is the first most significant compositional structure, sort of mathematical matrix, the most general plan, which the rest of the compositional structures depend upon to a certain extent. It is the overall structure that contains the chief principles of the compositional pattern. All the other structures – texture, ensemble plan, mode-cadence, polyphonic, etc. – are a kind of detalization of that basic plan of a composition. The higher the number of compositional structures that coincide with the overall structure in their proportional parameters, the clearer, the more crystal-like the musical form.

Before embarking on the analysis of concrete works, let us cast a look at the level of the musical form that is called *protoform*, as it is the protoform that contains, in a latent state, all these proportional ideas which will find their complete realization in the process of the genre development. The protoform is the most ancient and the most steady form level that appeared primarily and that can be defined as a form-idea. This stratum of the mass composition, in fact, gradually developed along the entire history of Christianity, together with the formation of Christian liturgy and as an integral part of the latter. The first known choral Ordinary that was found in the choir books of the St-Jaque monastery dates from 1254.

The protoform consists of seven structures that we are going to examine at length (see diagram 1).

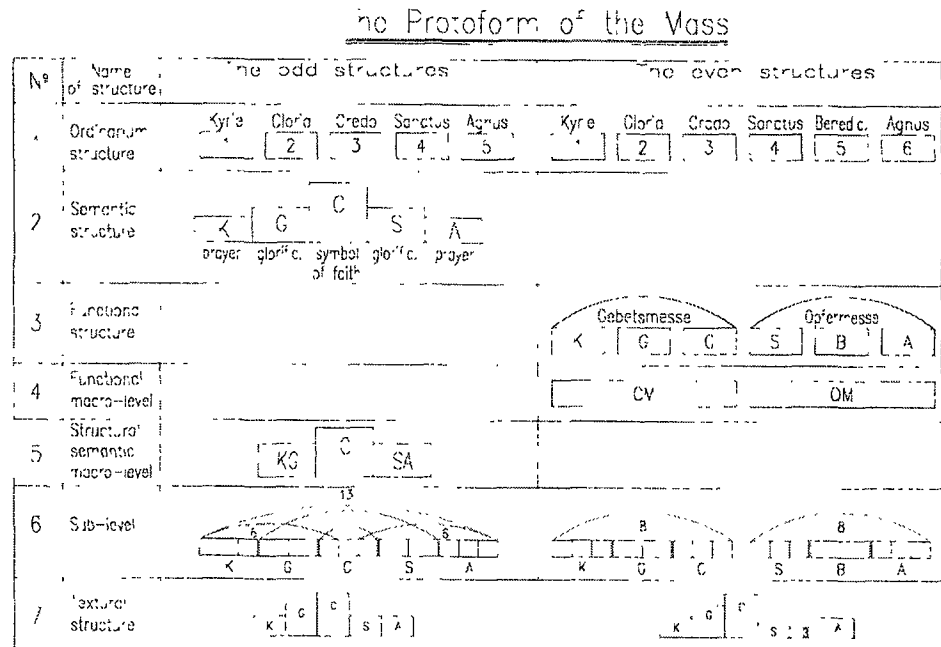


Diagram 1

The 1st structure: Ordinary (*Ordinarium missae*) is a musical cycle consisting of five parts (*Kyrie*, *Gloria*, *Credo*, *Sanctus*, *Agnus Dei*) and being a part of the Catholic office. In case *Benedictus* (a part of *Sanctus*) is treated as a separate part of the cycle, Ordinary will be a six-part composition. Besides Ordinary, the complete liturgy includes Proper (*Proprium Missae*), which consists of both musical and non-musical parts (e.g., readings, sermon, etc.). Unlike Ordinary, which is a permanent cycle, Proper varies dependent on concrete calendar days or event.

The 2nd structure - semantic - is defined by the contents of the verbal text, i.e., it reflects the meaningful functions of each part: *Kyrie* (K) and *Agnus* (A) - prayer, *Gloria* (G) and *Sanctus* (S) - glorification and gratification, *Credo* (C) - symbol of faith. It is important to note that this structure possesses a parameter of its own: it is hierarchic, for selfless glorification of the Lord (parts 2 and 4) stands higher as compared to the prayer (parts 1 and 5), while *Credo* is the climax, the central part of the entire liturgy.

The 3rd - functional - structure forms up as a result of the fact that the whole liturgy containing the five- or six-part Ordinary, falls into two functionally different parts: *Gebetsmesse* (GM) and *Opfermesse* (OM). *Gebetsmesse* is a prayer part of the liturgy, *Opfermesse* being an offering, or Eucharist. As a result, the first three parts of Ordinary

(*Kyrie*, *Gloria* and *Credo*) fall into *Gebetsmesse*, while *Sanctus* (*Benedictus*) and *Agnus Dei* - into the second part - *Opfermesse*. Thus occurs the unification of the parts of Ordinary into *two sub-cycles* with their respective titles and *the 4th structure* shapes up - *a two-part functional macro-level* of the form.

The formation of the *three-part macro-level* - *the 5th structure* - is also dictated by the distribution of the parts of Ordinary in the entire liturgy; however, it is not in the functional context already but rather in *the structural-semantic* one. What is meant is a specific order of placement of the parts of Proper and Ordinary. According to this order, *Kyrie* and *Gloria* sound directly one following the other; similarly follow each *Sanctus* and *Agnus Dei*. As far as the central part - *Credo* - is concerned, it is separated from the adjacent parts, *Gloria* and *Sanctus*, with a whole number of Proper parts.

Thus, *Kyrie* and *Gloria*, as well as *Sanctus* and *Agnus* join together forming macroparts. What appears as a result is a three-part macro-level, or a macro-structure, analogous to the semantic macro-structure (in the diagram they are united). The only difference is that the latter is hierarchic. *Credo* is singled out in it as the central, the main part of the liturgy.

The sub-level of the cycle is the 6th structure that results from the division of each part of Ordinary into sections. As we know, *Kyrie* and *Agnus Dei* were traditionally divided into three sections each; this tradition originated from the text of the Gregorian choral. *Sanctus* was traditionally divided into five sections, only two out of which being necessarily singled out: *Sanctus* and *Benedictus*. In *Gloria* and *Credo* a more liberal division was permitted, even though here too one can notice certain tendencies: in *Gloria* there were two strophes (*Et in terra* and *Qui tollis*) that were necessarily emphasized, while in *Credo* there were three (*Patrem*, *Crucifixus* and *Et in spiritum*) symbolizing the Holy Trinity. So, the protostructure of the sub-level contained 13 (and in cases of a more fractional division - 16) sections.

The last, *7th structure is textural*. It correlates with the number of syllables in each part and defines therefore the initially given proportions of the cycle.

As we can see, almost all the structures, with the exception of the textural one, are symmetric. Let us, for the sake of convenience only, call them odd and even. The odd structures are constructed hierarchically, the singled-out central part being the axis of the symmetry. In the even ones, the axis of the symmetry is imaginary and lies between *Credo* and *Sanctus*.

Such a division of the structures allows showing the sphere of influence of the two vectors of the musical form. Thus, in the odd structures, the vertical vector is emphasized which is responsible for the space-constructural aspect of the form, while in the even ones - the horizontal vector is emphasized, the one that reflects the time and process aspect of the composition. In this case it is possible to state the quantitative equality of the odd and even structures that testifies to a completely balanced protoform.

On the bases of the protoform one can distinguish five types of mirror-symmetry that will find their reflection in concrete compositions.

These are, first of all, the perfect types:

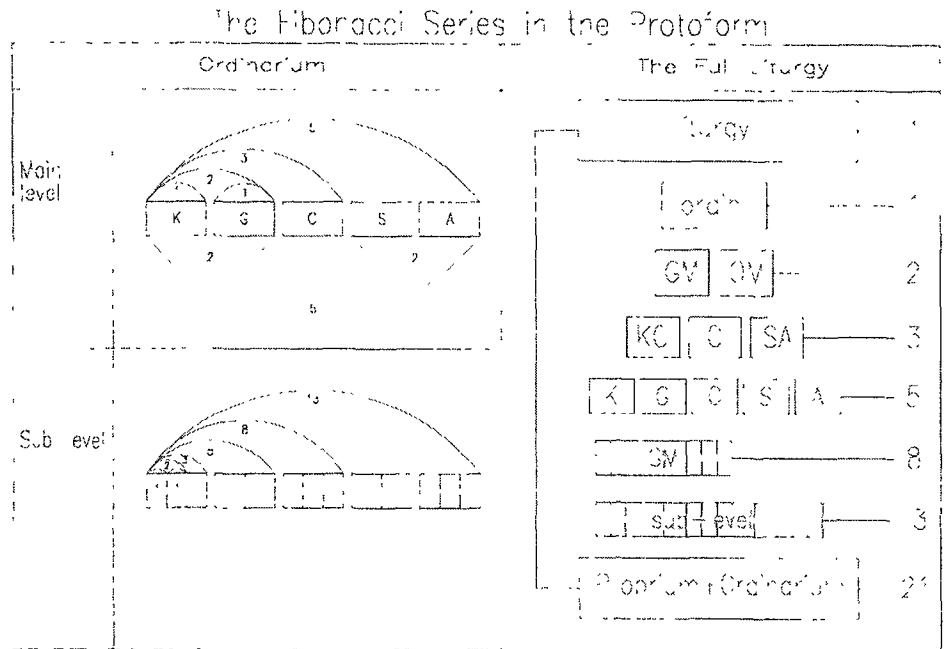
- 1) macro-symmetry – symmetry of a three-part macro-structure;
- 2) ordinary-symmetry – symmetry of the five-part Ordinary;
- 3) complete symmetry – symmetry of all three levels (the sub-level among them).

The imperfect types include:

- 4) partial symmetry – equality of only one pair (textural protostructure gives a sample of specifically this type of symmetry, as *Kyrie* = *Agnus Dei*, but *Gloria* does not equal *Sanctus*).
- 5) symmetry of ratios of parts – ratio of the scales of parts in form of proportions: $K/G = A/S$ etc. (in the protoform these ratios are equal, as are the corresponding pairs, but in compositions this type of symmetry will be expressed only as equal ratios, for *Kyrie* will not equal *Agnus*, while *Gloria* will not equal *Sanctus*).

As has already been mentioned before, some musicologists have written about the presence of additive series and golden section in the structure of c.f. in the masses of the Franco-Flemish composers. However, in the view of the imperfect methodology of calculating the mensural proportions and in view of the veiled form of these progressions, no consensus on the subject has been reached thus far. In this respect, criticism is also being levelled against musicologists and art experts, who are accused of being carried away by the beauty of these operations and the search for them (Busse-Berger 1990, p. 92).

However, if one examines this question from a different point of view, turning first of all to the analysis of the protoform, the protostructure of the five-part Ordinary presents, at a closer glance, the beginning of the Fibonacci series – the first five numbers (diagram 2):



as well as the first two numbers of the Evangelist series, the latter being placed in any direction and order:

2, 5, ... or 5, 2, ... (as in the Gospels)

This kind of structural division of the cycle can be explained in the following way: the first and second parts of the mass *Kyrie* and *Gloria* as separate isolated parts are the ones. Unification of these two parts, as well as *Sanctus* and *Agnus* into macro-parts gives number 2, which in both cases acts as a monolithic structural unit. Number 3 means the unification of the first three parts into the first sub-cycle - *Gebetsmesse*. Number 5 corresponds to all the five parts of the cycle. This yields the sequence:

1, 1, 2, 3, 5.

The sub-level yielding a more fractional division of a five-part structure also creates series and continues the realization of this progression. Thus, the following number - 8 - corresponds to the number of sections on *Gebetsmesse*, while 13 is the number of sections in the entire mass. This forms up a succession of seven numbers:

1, 1, 2, 3, 5, 8, 13.

Another interpretation of this succession originates from the position of Ordinary in the liturgy: if the liturgical performance as a whole is taken for one, then Ordinary inside the liturgy is the second one. Further, 2 sub-cycles inside the mass, 3 macro-parts, 5 parts of Ordinary, 8 sections of *Gebetsmesse* (sub-level), 13 sections of the mass (a complete sub-level) and, finally, 21 - the complete number of parts in the whole.

Thus, the protoform is based on the multi-level progress of the additive series from the largest form units to the smaller ones, and vice versa.

The golden section, or a quantity close to it, appears in the protoform as a consequence of ratios of the neighbouring members of the series and usually as a cardinal ratio of the two sub-cycles: OM/GM. Correspondingly, in the compositional proportions the golden section may express itself as a steady correlation among the parts and their totals, as well as the focus of the composition, i.e., its climax zone that will fall on the final part of *Credo*.

Let us now examine concrete examples the manifestation of the overall compositional mirror-symmetry, Fibonacci series and the golden section.

The earliest type of symmetry of the overall structure that I managed to find is the symmetry of the macro-level in the *Barcelona mass* (the middle of the 14th century). The number of imperfect semibrevises (that are a common measure unit for all the parts) is more or less equal in the both macro-parts and the *Credo*. Therefore, the correlation of the scales of the macro-parts approximates one. Symmetry in such a case becomes stronger as a result of the similar modus in the macro-parts and contrasting - in the *Credo*. Symmetry of the macro-level is obviously projected without being fully realized in "*Notre Dame*" by G. de Machaut - the first authorized mass, composed probably in 1364. It is the only one, among the three complete masses of the 14th century that reached us, that demonstrates a clear and symmetrical structure of the sub-level (diagram 4-C).

In spite of the fact that the earliest masses of the 14th century can already be characterized as possessing a high level of symmetry of the overall structure, the 15th century presents but not so many samples where these symmetric patterns are being developed. Thus, for example, out of the ten masses by J. Ockeghem only two possess the macro-symmetry or the ordinary-symmetry; out of 21 Josquin's masses - 3, while G. Dufay and J. Obrecht do not have them at all. Cycles containing the imperfect symmetry are much more frequent. The earliest among them are, obviously, masses by A. Busnois - "*L'homme armé*" - and by Ockeghem - "*Sine nomine*", dating from the middle of the 15th century.

The real flowering of the symmetrical composition falls already on the period of a high and late Renaissance. In the productions of N. Gombert, a composer of the first half of the 16th century, the basic pattern is the symmetric one. However, it is only possible to talk about a full realization of the potentials of the mirror-symmetry contained in the protoform in connection with the masses of G.P. da Palestrina, the greatest Italian master of the second half of the 16th century. Suffice it to say that out of 104 masses of the composer, about 80% possess one or another type of symmetry and over half of them - one of the types of perfect symmetry.

Palestrina "O admirabile commercium"

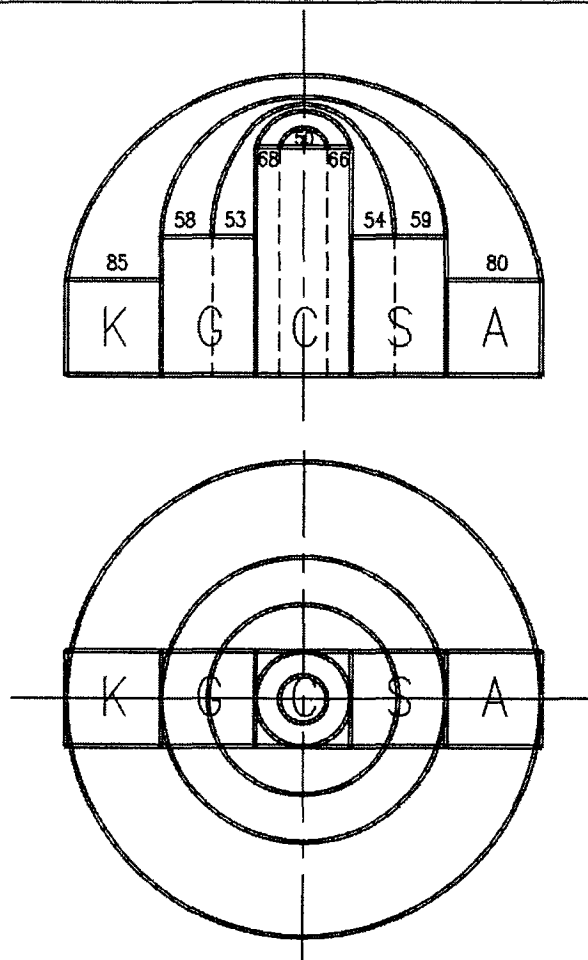


Diagram 3

One of the expressive examples of this type of construction can be found in the mass "*O admirabile commercium*" (diagram 3). As we can see, it is a perfectly symmetrical cycle wherein not only all the parts, but the sections too are corresponding. Equal number of sections is placed on each side of the central *Crucifixus*. In fact, it is only in Palestrina's mass that we find a fully symmetric construction that possesses a classic structure of the sub-level and, besides, is supported by a whole number of other compositional structures. Such a composition is, in the essence, a number of concentric circles. This is a qualitatively new stage in the development of the music form of the mass, its pick, and at the same time, its sunset.

The Fibonacci series find a realization in the cycles primarily in the structure of the sub-levels. The sub-level of any mass containing usually from 12 to 18 sections can be organized with the use of the Fibonacci progression, even though this is not always so. In diagram 4 we can see examples of the sub-levels of some masses consisting of 15, 16 and 18 sections. In them, the progressions are moving towards one another.

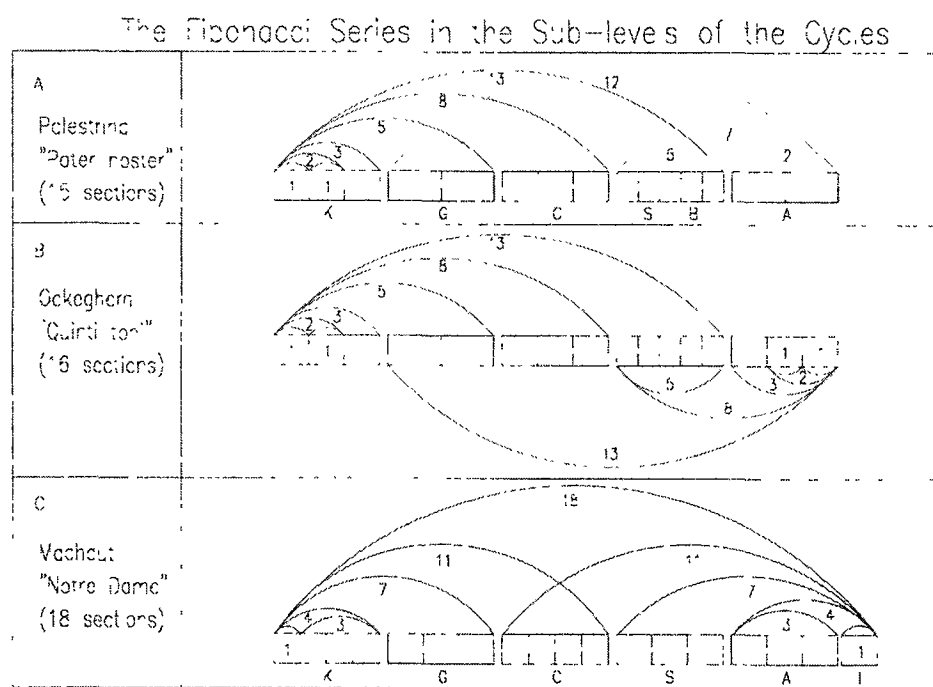


Diagram 4

Thus, if the Fibonacci progressions are programmed already in the protoform of the cycle and are *deliberately* introduced by the composer into the sub-level of the mass, it is hardly possible to suggest an "accidental" appearance of these series in the inner structure of the mass as well, in the c.f.; especially if one takes into account the fact that the hierarchy of precise calculations served as a sort of "ideal" basic plan of the would-be musical construction.

Along with the passing of the 15th century, the tradition of composing on the basis of c.f. disappears. The Palestrina's cycles, whose great majority has no c.f., possess a much more obvious form of progressions. Like the mirror-symmetry, they appear first of all in the sub-level structures and in the overall structure proportions. The sub-level structure of the Palestrina's mass possesses from 12 to 16 sections and is always constructed with the use of progressions.

Quantitative exponents of the scales of parts and their totals in the cycles of the Roman master frequently form additive series as well. Thus, for example, in the mass "*Nasce la gioia mia*" this series appears as follows:

K	G	C	G+C	G+C+S+A
(bars) 67	106	173	279	448

And in the mass "*O virgo simul et Mater*" the sequence is even more precise:

K	G	C	G+C	M (the entire Ordinary)
70	124	194	318	512

As for the mass "*Salve Regina*" a progression shows up both in the direct order and backwards:

		⇒		
K	G	C	C+S	G+C+S+A
80	138	220	362	581
		⇐		
K+G+C+S	G+C	C	S	A
580	358	220	142	81

A most interesting sample of a form construction with the use of recurrent series, particularly the Evangelist series, can be found in the mass "*Inviolata*" (diagram 5). The cycle consists of 14 sections (7:7), a form of segmentation which, as noted above, recreates the second Evangelist sequence. At the same time, in the division of the mass into sections one can discover the first series too (diagram 5-A).

The number of bars in the parts and their sums also form the first Evangelist progression (diagram 5-B).

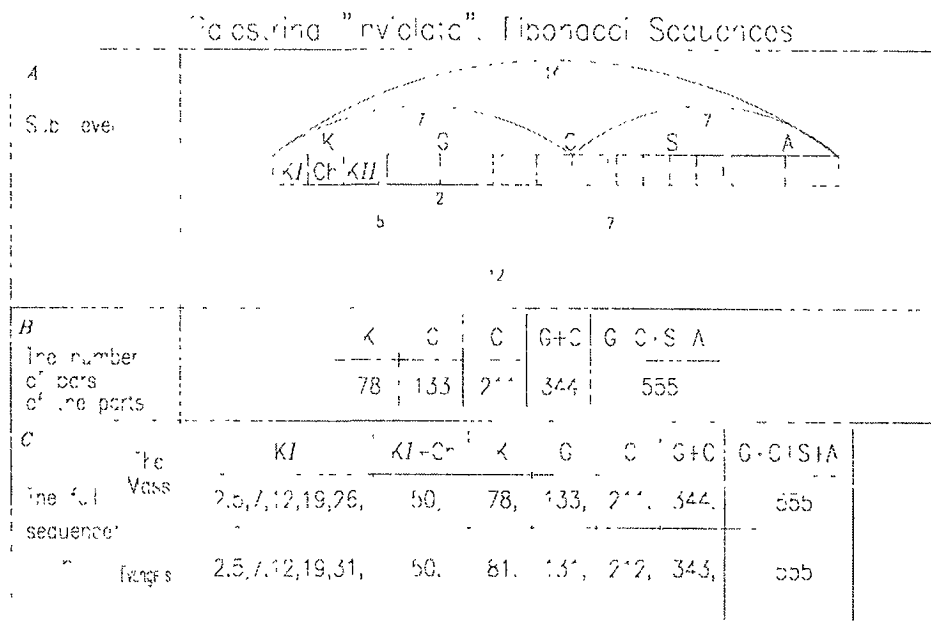


Diagram 5

As we can see, the sequence appears starting with the eighth member of the series, deviations being minimal. However, if we analyse the construction of the first part of *Kyrie - Kyrie I* we shall discover the first seven "missing" numbers of the sequence as well. Thus, the first section - *Kyrie I* (KI) is constructed in the following way: in the initial 2 measures the tenor leads the theme (one voice sounds); then cantus joins and up until the 5th bar included two voices sound; then the bass adds up and up until the 7th measure included - three voices sound; starting with the 12th bar starts a new theme (a full four voices); and finally, from the 19th bar until the very end of the section, which is the 26th bar, there follows a conclusion of the second theme.

Thus, in *Kyrie I* the following numbers fully corresponding to the Evangelist series are emphasized: 2, 5, 7, 12, 19.

Further on, the total of first two sections of *Kyrie - Kyrie I + Christe* = 50 measures (this is the seventh member of the progression). We get a series of 12 numbers (with slightest deviations in a few cases - diagram 5-C).

MISSA: INVOLATA

4 vocum.

Cantus.
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,

Altus.
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,

Tenor.
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,

Bassus.
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,
Ky - rie e - lei - son,

Chri - ste e - lei - son, Chri - ste e - lei - son, Chri - ste e - lei - son, Chri - ste e - lei - son,

As we can see, the entire mass is an unfolded progression embracing the whole of its cycle from the first until the very last measure. This resembles a mighty spring – a spiral half of whose coils (6 out of 12) appears already in the first section of *Kyrie*. In this case, by purely mathematical means is stressed the role of this initial section of the composition, its mighty energy potential as the one of a "mustard seed" out of which the "tree of life" grows.

One may note in the musical compositions of that period, a significant role of the golden sections which, being a consequence of the very same additive series, themselves form "golden sequences", as N. W. Powell (1979) puts it, in the c.f. structure.

Apparently, far from accidental is the fact that one of the earliest types of proportionality of the overall mass structure that I have found is connected with the golden section, which coordinates the duration of the cycle parts and their totals. These are the three masses "*L'homme armé*" by Busnois, Ockeghem and Dufay that appeared in the middle of the 15th century, between 1450 and 1460.

In the cycle of Busnois, the spiral of the golden section develops as follows:

<u>K</u>	<u>G</u>	<u>OM</u>	<u>GM</u>
A	K+G	GM	M
0.63	0.64	0.65	0.6

The same formula, with a slight deviation in numerical values, appears in Dufay's mass:

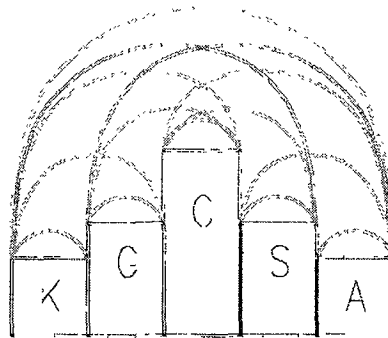
<u>K</u>	<u>G</u>	<u>OM</u>	<u>GM</u>
A	K+G	GM	M
0.618	0.66	0.67	0.6

A more extended version takes place in Ockeghem's mass:

<u>A</u>	<u>S</u>	<u>K+G</u>	<u>G</u>	<u>K+G</u>	<u>C</u>	<u>OM</u>	<u>GM</u>
S	C	OM	K+G	C	GM	GM	M
0.62	0.66	0.614	0.65	0.66	0.6	0.65	0.6

Proportions of the overall structure of Palestrina's masses are long series of golden sections, containing sometimes up to 18 members (diagram 6).

Palestrina
Mass "Pater noster"
(golder section)



$$\frac{K}{G} - \frac{G}{C} - \frac{S}{C} - \frac{A}{S}$$

$$\frac{G}{K+G} - \frac{C}{G+C} = \frac{C}{C-S} = \frac{S}{S+A}$$

$$\frac{K+G}{C+C} - \frac{K+G}{C+S} = \frac{S+A}{G+C} - \frac{S+A}{C+S}$$

$$\frac{G+C}{K+G+C-S} = \frac{G+C}{G+C+S+A} = \frac{C+S}{K+G+C+S} = \frac{C+S}{G+C-S+A}$$

$$\frac{K+G+C}{V} - \frac{C+S+A}{V}$$

$$= 0.618$$

Diagram 6

The most significant expression of the golden section proportion is in the climax zone of a composition, which is usually found in the closing section of *Credo*. In the mass by G. de Machaut, this is an unfolded solemn section *Amen* that is fulfilled in virtuous techniques of *goket*, as opposed to all the previous sections. In the mass "*Papae Marcelli*" by Palestrina, the closing section of *Credo*, starting with the 186th bar, there forms up a mighty culmination with a bell-like effect, which is due to the canonic sequences and imitations in all the voices.

Thus, the meaning of the perfect proportions inherent in the mass composition can be treated as follows.

Due to the mirror-symmetry the mass construction is analogous to the one of a cathedral as well as to the composition of an altar. Essentially, symmetry in the liturgical music formed up under a direct influence of the church architecture. Borrowing from architecture and further developing the laws of the mirror-symmetry, music assumes an obvious architectonic character, reflecting in its composition the main principles of a church building – its proportionality and multi-layer hierarchy with the centre in the dome.

So, the mirror-symmetry determines the space-constructural aspect of the form, which dominates in the five-part Ordinary.

The Fibonacci progressions reflect the unfolding of the form in time, i.e., a process. The semantics of these progressions in the masses is a hint at the evangelic episode of "the miracle with bread and fish" carrying a very important semantic message: the satiation with the spiritual food - the teaching of Christ. Besides, already in the text of the Gospels the expression of a miracle via progression symbolizes the Divine act of creation – the appearance of multitudes from One, a doctrine, which dates back to Plato's "*Timaeus*". Therefore, the Fibonacci series are interconnected with the six-part Ordinary expressing the time aspect of the form (let us recall the Six Days of Creation).

The Golden Section and the Compositional 'Spire'

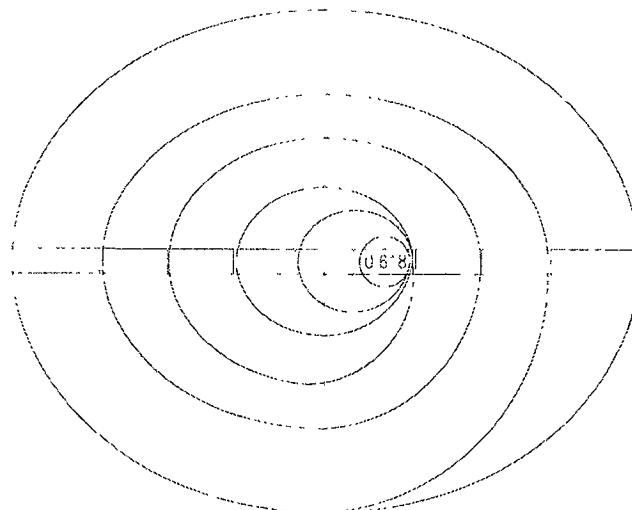


Figure 7

The five- or six-part Ordinary is one and the same form wherein the golden section unifies both vectors: vertical and horizontal, i.e., space and time. Being the centre of the broken symmetry and, consequently, of the highest tension, the golden section becomes the focus of the culmination zone, or the centre of the folding and unfolding of the compositional spiral (diagram 7). Analogous spirals appear in the famous *tondoes* by Botticelli and Raphael. This form is nothing else but a reflection of neo-platonics' most important statement that was formulated by N. Kuzanus as "*explicatio-complicatio*", i.e., the process of unfolding and folding of the world within the Almighty.

Therefore, one can draw a symbolic parallel: Creator and His creation - the world; a Composer and his creation - the mass (a model of this world). While the three perfect proportions that are present in the mass in a complete unity are a mathematical symbol of Divine perfection and the threefold of Divine substance.



Botticelli: *The Madonna of the Magnificat*, Uffizi, Florence

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