Livre Premier de Motets: The Time-Block Concept in OpenMusic

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The impossible but plausible is rather preferable to the possible but unpersuasive.

Aristotle, *Poetics* [2].

In the past few decades, the lack of interest for symbolic calculation tools in the major part of musical compositions led to a critical deadlock. The language has failed us, and the discourse is wearing off. Where can we find then the "true" discourse, if not in the *historical* approach to language itself and, in this case, to the musical form?

We all know that the main issue in music is *musical time*. Yet studies dedicated to the subject of musical time are filled with mere commentary; the articles that really get to the heart of the matter are rare.[1] The reflections worth of mention generally broach the issue from a purely practical side, displaying hesitations between phenomenological temporality and symbolic temporality, i.e., perception and notation, between *musica speculative* and *musica mensurabilis*, between experienced time and calculated time. We shall here focus on the latter, which seems appropriate in the present volume.

The practice of computer-aided composition (CAC) was essential in the creation of the *Livre Premier de Motets*. This work could not be understood without the CAC semantic context. By practice we do not mean only the use of the relevant tools, but also the questions that arose therefrom, questions that cast a shadowy doubt on the symbolic representation in music, and call for further theoretical inquiry. Furthermore, an important issue relates to the creation of the adequate tools, developed to meet the heavily demanding creative process. Thus the theoretical approach described hereinafter will be associated with a more pragmatic approach linked to the symbolic implementation of the work.

What therefore of the symbolic musical time? We find out here two fundamental principles: representation followed by what we shall call operability.

Representation

Musical time is, above all, a symbolic time that unfolds in the space of the score, in the form of synchronous and diachronic representations, as either discontinuous or continuous

[1] Stockhausen's "... *wie die Zeit vergeht...*" [9] is one of those outstanding works providing an advanced and thorough discussion about musical time.

indications, be they open or closed. All of these dichotomies are essentially indications of measure, hence the notion of measure as much broadly perceived.

In the same sense where the interval is a computable aspect of pitch, the measure determines the time, its beginning, its duration and its end. We shall not go into the various representations of time, introduced throughout the course of the history of musical notation, but rather put an emphasis on what we believe is a principal element in the relation between time and measure, a dual element that surfaced at a critical moment in the history of musical representation: the notion of *tempus* and *prolatio*.[2]

The notion of measure, which over the course of the seventeenth century gradually replaced the duo tempus-prolatio, was the subject of a great misunderstanding regarding its pressing need. Today the measure only fulfills its functional role. In the absence of tonal *cadenzas* or any other formal meaning, it is time to reestablish the true nature of the measure, i.e. its structural function. By reestablishing the notion of a measure which is independent of any tonal and, therefore, even syntax, by using the notion of an enlarged fractional prolation (notational signs indicating the duration or subdivision of a measure), the measure can embody three fundamental temporal entities: duration, sequence of durations and form.

Figure 1 shows the structure of *First Attempted Escape From Silence: Tunnels*[3] in an OpenMusic *maquette*. Each element (or structural voice) and each sub-element (or sub-section) is represented by a block (called *temporal object*).

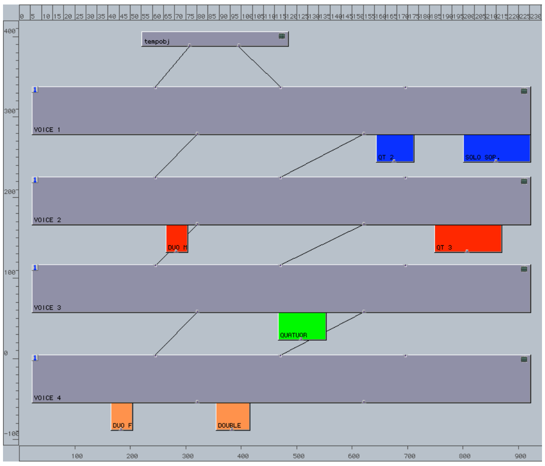

Figure 1. Maquette of *First Attempted Escape From Silence: Tunnels*.

The form here is derived from an initial measure with the proportion 150/1. The basic elements, namely the prolations[4] and the pitches, are contained in each of the main blocks, which in turn represent the different voices. Figure 2 shows a detail of the

[2]A system of time signatures and proportions, elaborated during the fifteenth and sixteenth centuries, that presupposed a division of measured time into perfect or imperfect time (three time, two time), and allowed for diverse and subtle prolations (binary, ternary).

[3]First act of the opera *Seven Attempted Escapes From Silence* (2005).

[4]That is, the notational signs indicating the duration or subdivision of a measure.

score for the third voice corresponding to this structure. A brief section (with a vocal quartet, also apparent in the *maquette* in Figure 1) is attached to this voice. This section reproduces the temporal structure of the initial block with a duration of reference that corresponds to the eleventh element (or subdivision) of the same structure.

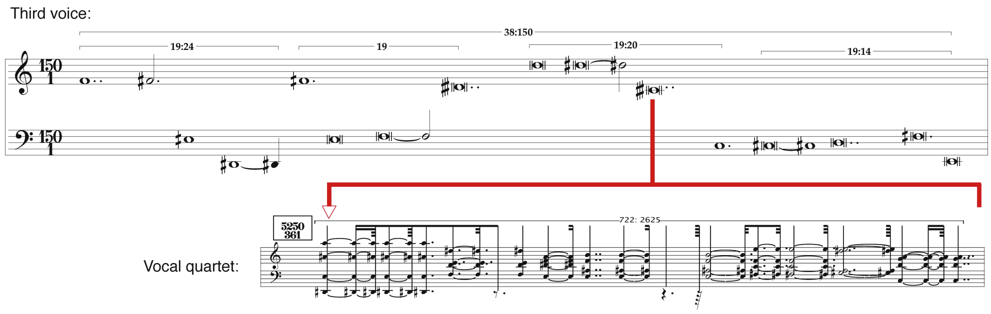

Figure 2. Total homothecy of the third voice reported to the eleventh duration of this voice.

Following this principle, one may easily imagine a space defining a musical form, comprising a single measure of a certain density, and in which each subdivision would in turn constitute a measure. This structural concept of 'nesting' preserves a temporal hierarchy amongst all the parts, both structural and local.[5] We shall associate this temporal spectrum with the concept of *time-blocks*. This framework will be the arena for different operations that will be described further on.

Consisting of a temporal space, the time-block represents an entity,[6] a combinable individuation that can contain proportions subjected to combinatorial or hierarchical relationships (should they be autoreferential or exoreferential[7]), susceptible to mutation i.e., permutations of the proportions, changes in magnitude by rhythmic calculation, auto-referential or exoreferential grafts, etc. It is a 'territory' (a ground) based on a duration. It is not a pre-established pulsated space with an arbitrary tonal time, since a pulsated whole is a subcategory of the time-block, or more precisely a time-block in 'molecular-becoming'.[8] Various derivations are therefore possible beginning with a totality (a work or an opus) and all the way down to a local phenomenon (sound event), be it or not a constitutive element.

Hence, the mapping and codification of time-blocks will play a decisive compositional role. There are several ways of indicating time-blocks, among which are the numerical-proportional notation and symbolic notation.

[5]This could be linked to a structural understanding of Stockhausen's *Momentform* concept: *"une forme momentanée qui résulte d'une volonté de composer des états et processus à l'intérieur desquels chaque moment constitue une entité personnelle, centrée sur elle-même et pouvant se maintenir par elle-même, mais qui se réfère, en tant que particularité, à son contexte et à la totalité de l'œuvre."* [10].

[6]One can also refer to a time-block or haeccity (*héccéité*) in the Deleuzian sense of the term: *"Une heccéité n'a ni début ni fin, ni origine ni destination ; elle est toujours au milieu. Elle n'est pas faite de points, mais seulement de lignes. Elle est rhizome."* [4].

[7]Meaning the reference to the material itself or to all other exogenous material. Below there is an example of an autoreferential generation.

[8]The becoming implies the topological notion of milieu: *"le devenir n'est ni un ni deux, ni rapport de deux mais entre-deux, frontière ou ligne de fuite."* [4].

Numerical-proportional notation is a more graphic and readable notation system (especially for the amateur), but it has also certain drawbacks, particularly as it may not be maneuvered from a compositional (combinatorial) stance, and cannot be integrated into a generative system. Figure 3 shows an example of a time-block subdivided into proportions that are proportionally and numerically represented.

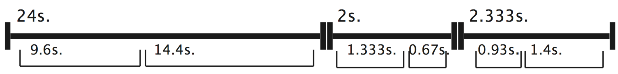

Figure 3. Proportional numerical representation of a time-block.

Another disadvantage of numerical-proportional representation is that it includes non-finite numerical expressions, such as floating points,[9] thereby adding an unnecessary degree of precision to the absolute expression of the time-block. The time-block becomes anchored, point-by-point, in a precise moment, making it dependent. Thus it loses the degree of abstraction needed to maintain its autonomy as a building block. It territorializes itself as a *major theme*.

Symbolic representation is, on the other hand, much better adapted to the diverse transformations that are possible in the combinatorial domain, and enables the integration of a variety of information defining its own entity. Given the abstract nature of the concept of time-blocks, morphogenic in nature and carrier of polymorphic information,[10] symbolic representation based on traditional musical notation, bolstered by the addition of new conventions (that are in fact not additions but improvements of the syntax itself[11]), seems to be the best means for the expression of musical time. Figure 4 shows the symbolic representation that corresponds to the numerical-proportional representation in Figure 3.

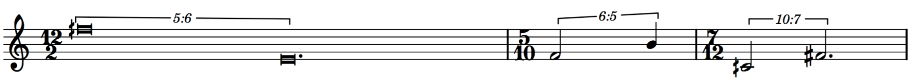

Figure 4. Time-block in Figure 3 represented in symbolic notation.

The time-blocks are designed for the compositional sphere. They can then be re-quantified for instrumentalists, using a more or less traditional notation. Figure 5 demonstrates the re-quantified version of the time-block in Figures 3 and 4.

However, as shown in Figure 5, meter can also play a functional role of a local and conjectural nature, anchoring the receding line of the time-block within a transversal context. In this example the added meter is emphasized by the dynamic envelope (crescendos and decrescendos). It would be possible of course to apply a meter derived from other time-blocks in conjunction with the quantification, which could stand for a polyphony, a dynamic counterpoint, etc.

[9] These cases take the form of irrational subdivisions of primary numbers, such as the subdivision into three (triplets, sextuplets, nonuplets etc.), seven, eleven, etc.

[10] Control, pitch, text, intensity, speed vectors, etc.

[11] For example the reference to a value of absolute duration, that is not relative to the trilogy duration/measure/tempo, but that assumes an absolute tactus.

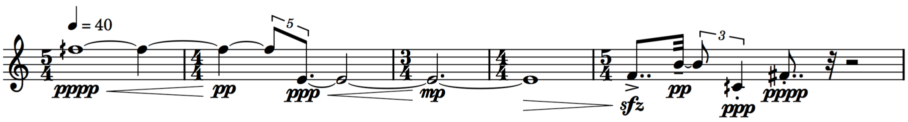

Figure 5. Quantified version of the time-blocks in Figures 3 and 4.

Operability: development and transformation

Time-blocks are implemented in OpenMusic as a class (*timebloc*), based on the *voice* object so that they benefit from the latter's internal structures and graphic editor. A time-block is defined by its meter expressed either as a fraction or as a list of two elements i.e., numerator – denominator, using the *make-timebloc* method. Figure 6 shows three possible instantiations of a time-block: in the form of an expressed duration, a silence or a sequence of pulsations.

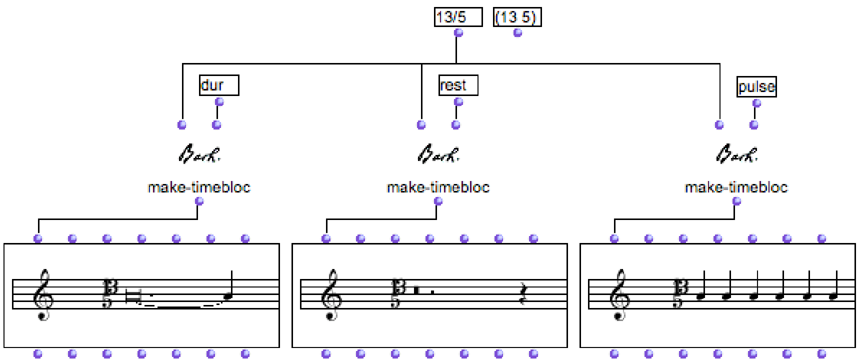

Figure 6. Instantiations of a time-block in the form of an expressed duration, a silence and a sequence of pulsations.

Elementary operations

The time-blocks in turns becoming duration spaces, rhythmic spaces, or other complex sound phenomena, can be diversely modified and transformed. They are manipulated using the rhythmic trees approach hitherto only implemented in the OpenMusic environment [1].[12]

Several kinds of operations can be performed on time-blocks. We shall examine in the first instance the elementary operations related to the transformation (mutation) of the time-block itself: addition (or concatenation), subtraction, multiplication (or change in magnitude), subdivision, reduction and omission.

[12]See the chapter *Some considerations on Brian Ferneyhough's musical language through his use of CAC Part I – Time and Rhythmic Structures*, by Mikhaïl Malt.

Addition and subtraction

The addition of two time-blocks is calculated based on their fractional expression.[13] For example, two different blocks of 12/5 and 5/12 produce the new block of 169/60. Figure 7 illustrates this first operation.

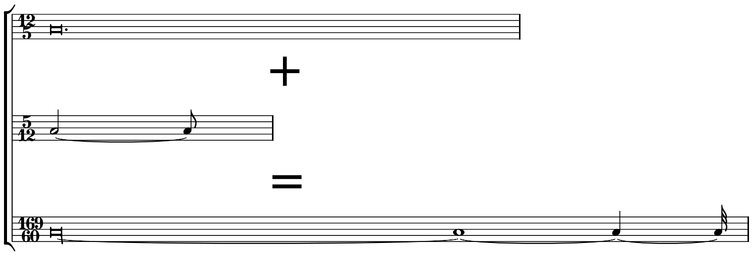

Figure 7. Addition of time-blocks.

This operation is carried out in OpenMusic with the function *timebloc+* (see Figure 8).

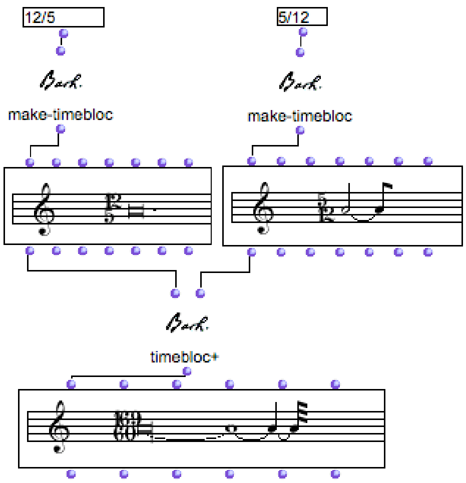

Figure 8. Addition of time-blocks in OpenMusic.

The operation of subtraction proceeds in the same way as that of addition. For example the two blocks of 23/10 and 11/12 yield a new block of 83/60 (see Figure 9). This operation is carried out in OpenMusic with the function *timebloc-* (see Figure 10).

[13] The fractions arbitrarily refer to divisions of the whole note, but could also refer to other values and magnitudes. This reference integrates the notion of celerity for each block, which makes the use of tempo obsolete.

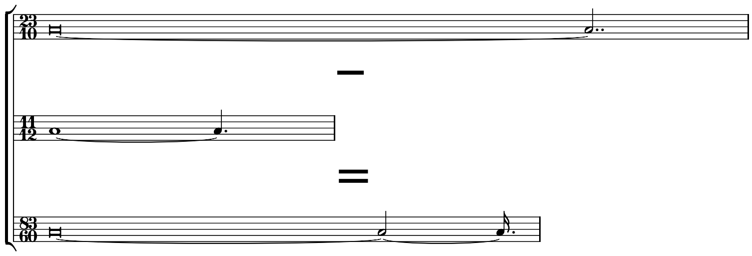

Figure 9. Subtraction of time-blocks.

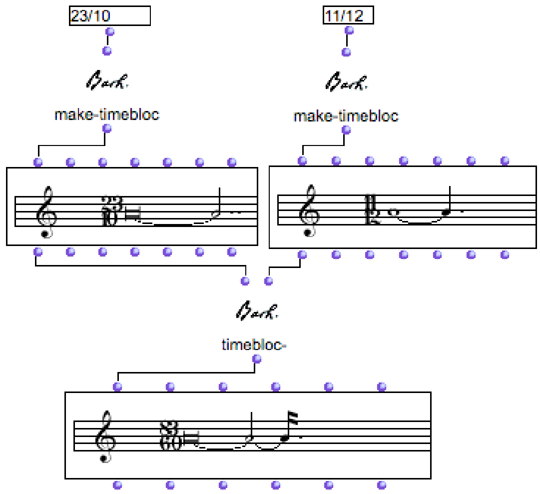

Figure 10. Subtraction of time-blocks in OpenMusic.

Multiplication

Multiplication leads to a change in magnitude,[14] the scaling of a block. Multiplication can be applied to any fraction. Figure 11 provides several examples based on a block with a magnitude of 12/5. Contrary to the preceding examples, this time the starting time-block contains autonomous subdivisions, and as a result the multiplication propagate to all the elements in the block.

The operation of multiplication of a time-block in OpenMusic is carried out using the *timebloc-scale* method with an input object *timebloc* or *voice* and a factor of multiplication (integer, floating or fractional). Figure 12 illustrates the application of the four operations from Figure 11 in OpenMusic.

[14]Magnitude means here the duration of a time-block calculated according to its meter.

Figure 11. Multiplications of a time-block.

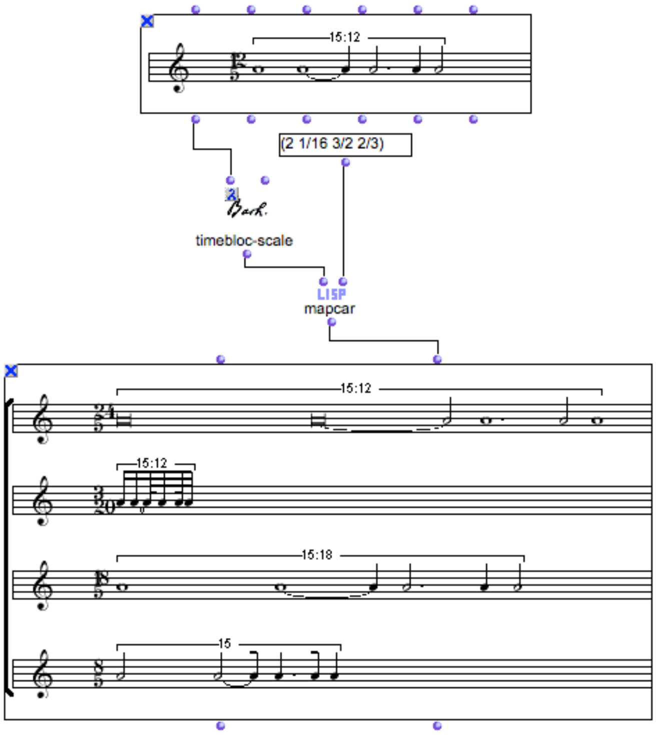

Figure 12. Multiplication of a time-block in OpenMusic.

Subdivision

The operation of subdivision consists of breaking down a time-block into a certain number of proportions. There are two categories of subdivision: simple subdivision and complex subdivision.

Simple subdivision consists in subdividing a time-block into n number of proportions so that the sum of the proportions is equal to a multiplication factor of the numerator of the block. For example, a time-block 21/12 can be subdivided by the proportions 11, 7 and 3 (11+7+3 = 21). Figure 13 illustrates this first mechanism of subdivision.

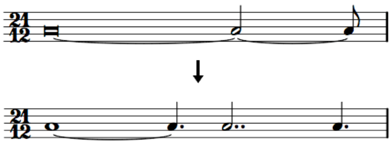

Figure 13. Example of a simple subdivision of a time-block of 21/12 (11, 7, 3).

Complex subdivision consists of subdividing a time-block into n number of proportions so that the sum of the proportions is not equal to any of the multiplication factors of the numerator of the block. For example the same time-block of 21/12 can be subdivided by the proportions 11, 7, 5 and 3 (11+7+ 5+3 = 26), as illustrated in Figure 14.

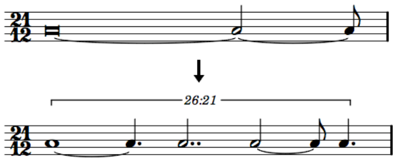

Figure 14. Example of a complex subdivision of a time-block of 21/12 (11, 7, 5, 3).

After an operation of subdivision the time-block is in what we call a state of *intermediary transformation*, in which each proportion can in turn become itself a time-block. Figure 15 shows the two previous subdivisions (Figures13 and 14) transformed into new time-blocks.

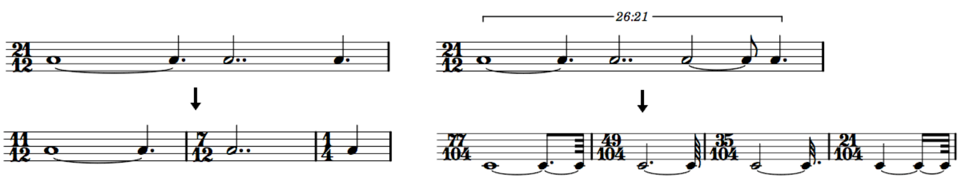

Figure 15. Transformation of subdivisions into time-blocks.

Thus the potential for mutation is apparent; once the time-blocks are transformed they yield new time-blocks. These new time-blocks are neither seriated nor reversible, in other words they do not form a hierarchy but have a tendency to proliferate.

Reduction and omission

As seen above, the time-block is made of two fundamental elements: the first corresponds to the old *tempus* (the duration of the time-block, or the fractional representation of what is commonly called 'time signature'), and the second to *prolationis*, that represents the subdivisions of the time-block (which become in turn themselves potential time-blocks). While the previous operations dealt with time-blocks as such, that is, they were mainly concerned with their *tempus*, the subdivision of the time-blocks leads us to examine the operations from the perspective of their prolational makeup.

Reduction consists of diminishing a time-block by eliminating one of the subdivisions (it is thus a subtraction at the prolational level). Either the first or the last value can be deleted from the time-block. Figure 16 illustrates the two cases.

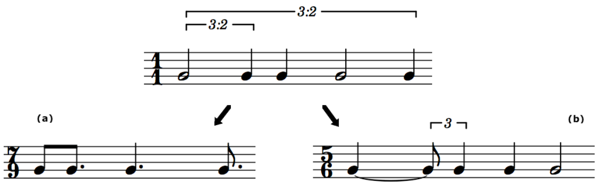

Figure 16. Reduction of a time-block: suppression (a) of the first or (b) of the last subdivision.

Omission is a variation of reduction. Contrary to reduction, this operation does not modify the magnitude (duration) of the time-block: only the different components are transformed. Hitherto, there are two variations for this computational procedure. First, what we shall call *absolute* omission, is the result of the strict calculation of the proportions of the symbolic note values; and the second, what we shall call *relative* omission, makes use of the syntactic proportions given by the representation of rhythmic trees. The two above variations, based on the block used in Figure 16, are illustrated in Figures 17 and 18 respectively.

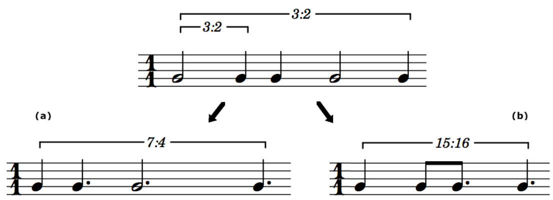

Figure 17. Absolute omission (a) by the first term and (b) by the last term.

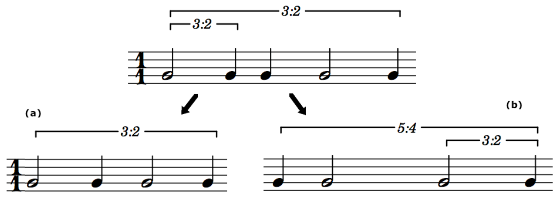

Figure 18. Relative omission (a) by the first term and (b) by the last term.

Recursive mechanisms and the generation of time-blocks

By combining the different elementary operations presented above, temporal structures could be created with the help of much more elaborate procedures. For example, reduction and omission operations could be used as recursive processes generating complex temporal structures. The recursive application of the operation of reduction based on the example in Figure 16 will generate the two sequences of time-blocks shown in Figure 19 (one is the result of the successive suppression of the first subdivision and the other the result of the suppression of the last one).

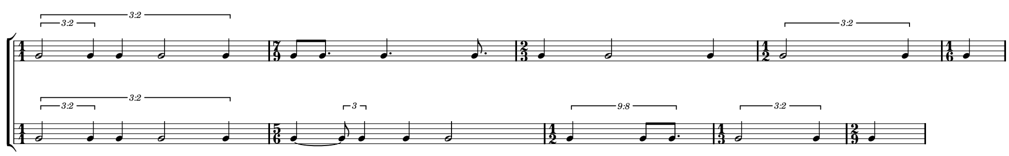

Figure 19. Generation by reduction.

This operation is interesting notably when it is combined with other processes such as interlocking. Figure 20 shows interlocking of the first sequence from Figure 19 with the retrograde of the second one. This generation using the retrograde with the reduction process creates an interesting false symmetry.

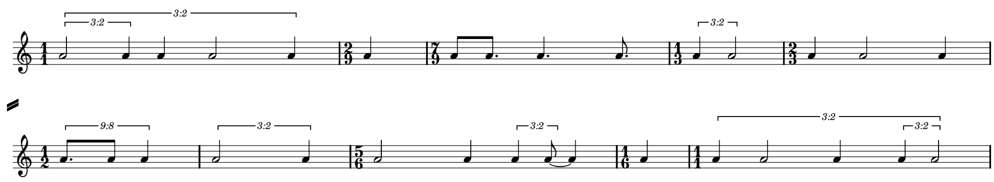

Figure 20. Interlocking of time-block reductions.

Figures 21 and 22 illustrate the preceding operations carried out in OpenMusic.

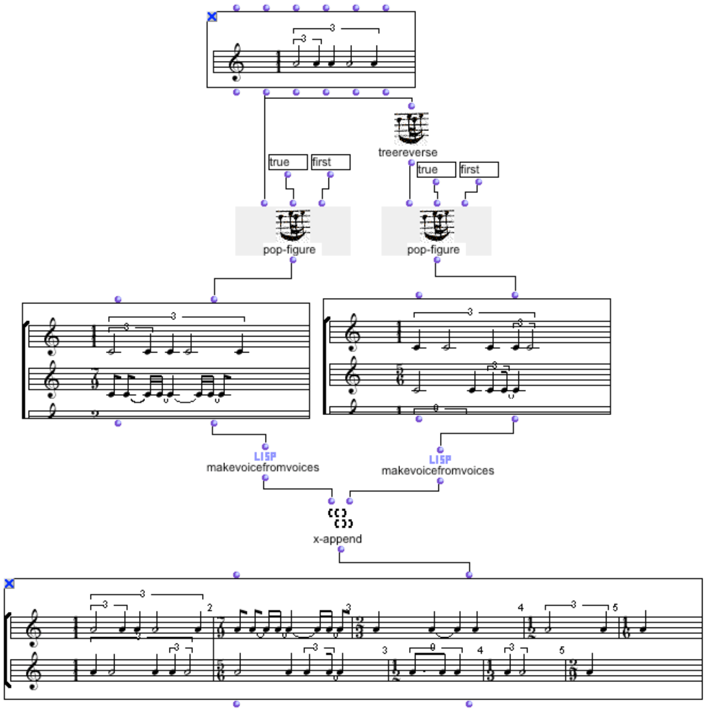

Figure 21. Recursive mechanisms for the reduction of time-blocks in OpenMusic.

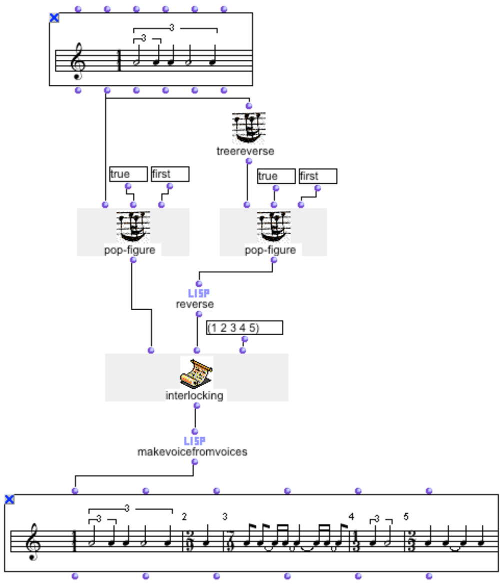

Figure 22. Interlocking based on the reductions of a time-block.

The same type of procedure can be performed with an omission operation. The four sequences illustrated in Figure 23 are obtained by reiteration carrying out the operations of absolute omission of the first term, absolute omission of the last term, relative omission of the first term, and relative omission of the last term, all on the same time-block. Figure 24 shows a patch performing this operation in OpenMusic.

Figure 23. Recursive application of the processes of omission to a time-block.

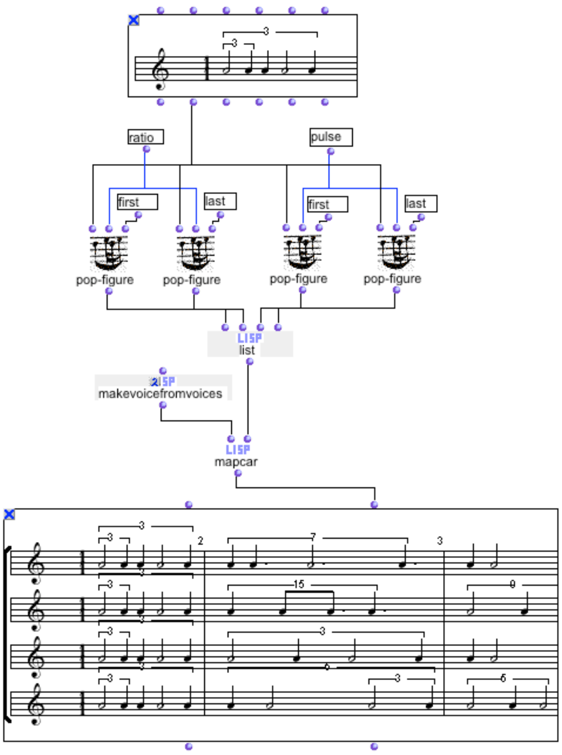

Figure 24. Recursive omission in OpenMusic.

As we emphasized earlier on, these new sequences can generate new time-blocks. Figure 25 shows a series of time-blocks based on the first voice from Figure 23.

Figure 25. New time-blocks derived from the subdivisions of the first voice in Figure 23.

Another possibility of deducing new time-blocks is by concatenation, in other words by adding the subdivisions of the time-blocs obtained from the succeeding reductions. Figure 26 shows the result of this operation applied to the time-blocks from Figure 19.

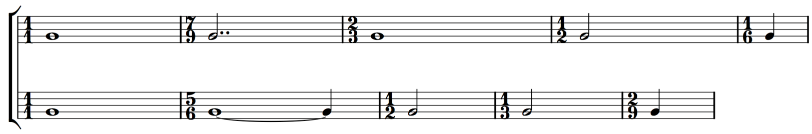

Figure 26. Deduction of time-blocks by the addition of the subdivisions in the sequences shown in Figure 19.

Once again, these bifurcations resulting from the generation processes are coherent on the compositional level and especially in the field of contrapuntal composition.

We can safely say now that part or all of every temporal entity (form, measure, subdivision) may be reduced to a time-block. As a consequence there is a great potential on the operational level, particularly in the combinatorial domain, as we shall demonstrate in the following section.

"*Ars combinatoria*"

We will provide here three examples of operations on time-blocks in the context of polyphony, proceeding from a specific case to a more general case. First, there is an intermediary transformation[15] of time-blocks subdivided by an auto-reference in circular rotation of the proportions (3 4 5 7).[16] The resulting structure is illustrated in Figure 27.

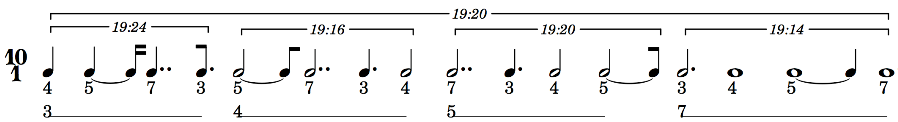

Figure 27. A block-time of 10/1 subdivided by auto-referencing.

[15]The intermediary transformation is a stage when the subdivisions are present in the time-block, but not yet transformed into new blocks.

[16]Auto-referencing is the process by which the parts of a whole are generated so that the form of the whole is always present within that of the parts and so, independently of the generation process itself.

In a first instance the new time-blocks are derived form the subdivisions of this intermediate transformation (see Figure 28).

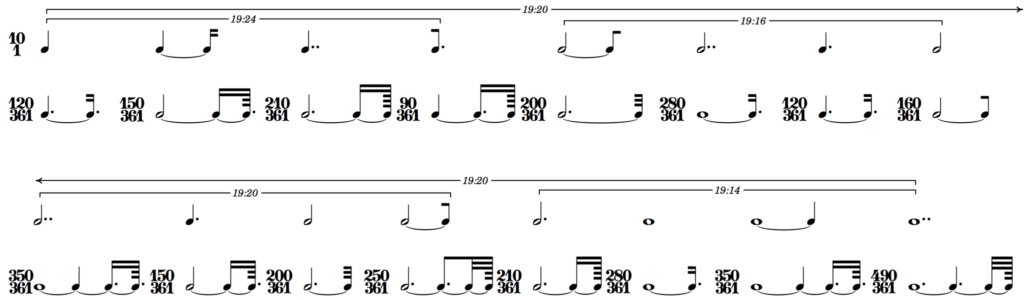

Figure 28. Construction of time-blocks based on the intermediary transformation shown in Figure 27.

Canon

To create a canon the onset dates of the different voices are calculated by successively concatenating all the time-blocks with the *addition* operation (see Figure 29).

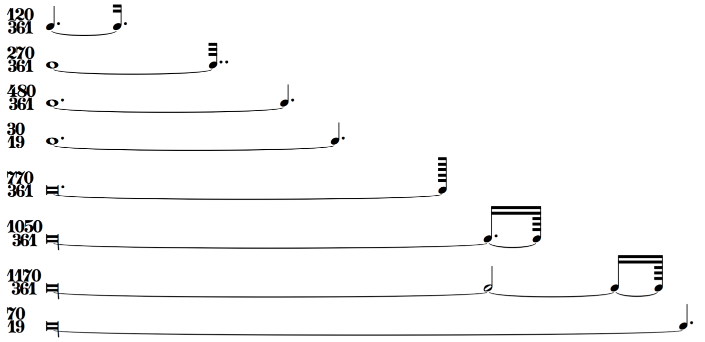

Figure 29. Concatenation of the time-blocks in Figure 28 used to determine the onsets of the voices in a canon (the first eight voices).

Each of the voices is then converted to rests, followed by the original time-block (the intermediary transformation from Figure 27). The resulting canon is shown in Figure 30.

Figures 31 and 32 show the first main steps in the implementation of the procedure in OpenMusic. In Figure 31, the initial time-block is built by auto-reference using the *autoref-tree* function, and each of its subdivisions is transformed into a new time-block with the help of the *voice2blocmeas* function. Figure 32 shows the general patch which creates the different voices in the canon.

Figure 30. Regular canon in a linear series (the first eight voices).

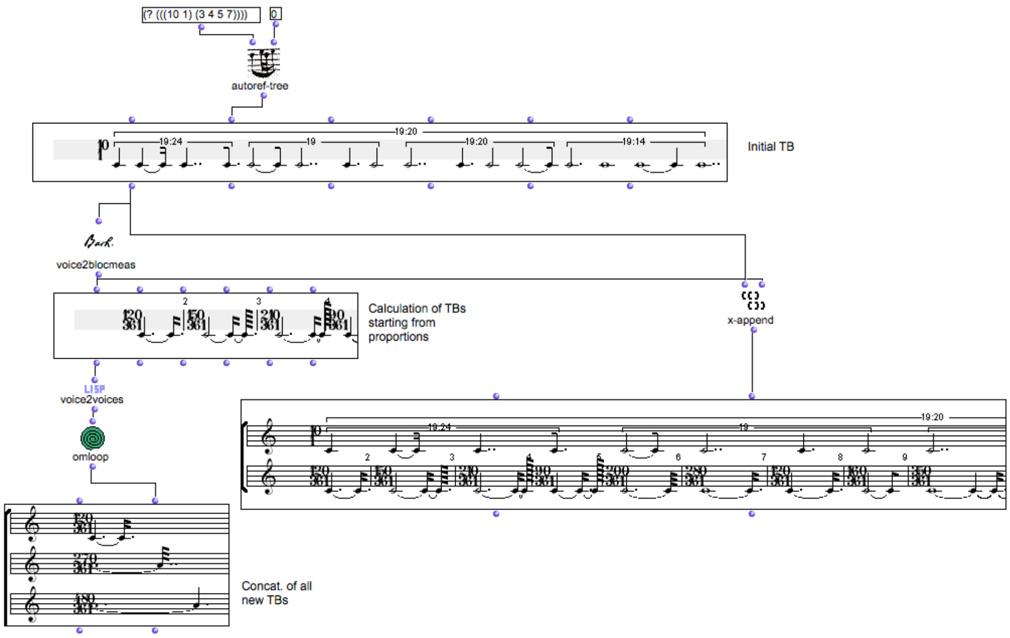

Figure 31. Creation of a time-block by auto-reference, and calculation of the onsets of the different voices in the canon based on this time-block.

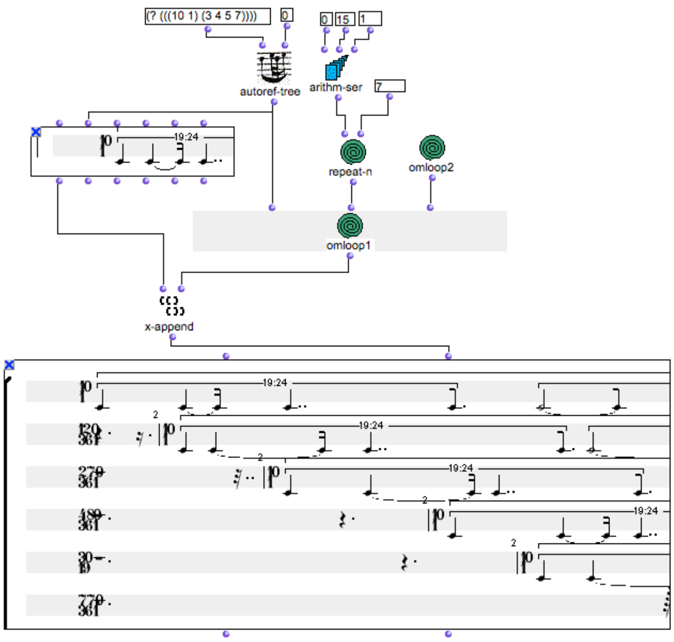

Figure 32. Calculation of a canon based on a time-block.

Homothetic transfers

The second example is based on the same principle as the first regarding the synchronization of the onsets of each voice. In this example however, we will use the principle of multiplication or scaling in order to scale down gradually the voices, thus establishing a homothetic relation between them. The "down scaling" of each of the voices is also relative to the proportions of the initial time-block.

A function called *homothetia* scales a given time-block in relation to other time-blocks. The arguments of this function are:

- an initial voice, represented by a rhythmic tree;
- a list of indices corresponding to subdivisions of the initial voice, which represent a region according to which the same voice will be scaled;
- an offset, also expressed using the voice subdivision indices, and computed by concatenation (addition) of the corresponding time-blocks.

A new voice, expressed in the form of a rhythmic tree, is then calculated by multiplication and shifted according to the time-blocks. (This function was also used to create the canon described above, using only the shifted offsets and a multiplication factor of 1.)

For instance, the initial intermediary transformation in Figure 27, which consists of 16 blocks, can be scaled down to fit the cumulative duration of the blocks from the second until the penultimate using as region the list (1 2 3 4 5 6 7 8 9 10 11 12 13 14) and with an offset of (0).[17] Figure 33 shows the outcome of this operation.

[17] Index zero represents the first value of the initial list.

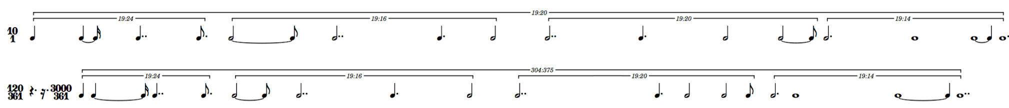

Figure 33. Homothecy of the time-block from Figure 27 on subdivisions 1 to 14.

A list of lists for the arguments of the *homethetia* function can be applied recursively to the newly-generated voices, producing an ensemble of voices. The region list of: ((1 2 3 4 5 6 7 8 9 10 11 12 13 14) (2 3 4 5 6 7 8 9 10 11 12 13) (3 4 5 6 7 8 9 10 11 12) (4 5 6 7 8 9 10 11) (5 6 7 8 9 10) (6 7 8 9) (7 8)), and the offset list of: ((0) (0 1) (0 1 2) (0 1 2 3) (0 1 2 3 4) (0 1 2 3 4 5) (0 1 2 3 4 5 6)), generate a polyphony in which the voices are compressed between the second and its penultimate proportion, between the third and the ante penultimate proportion, and so on. The result of this process is shown in Figure 34.

Figure 34. Recursive homothecy: the creation of a polyphony.

Monnayages (rhythmic substitutions)

Originally the technique of *monnayage* (rhythmic substitution), “already practiced by the Greeks and known as dissolution”, consisted in the subdivision of “longs and breves into shorter durations” [3]. But for us it is the process which consists in substituting one figure (or group of figures) by another group of figures. It can be thought of as the generalization of the process of homothecy described above. Yet this type of generative process is based on the proliferation of external combinations and is more complex than the previous ones.

For this example the same time-block from the previous examples is used, but with a different magnitude of 50/1 (see Figure 35).

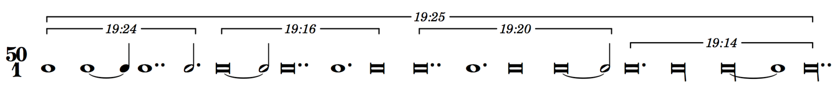

Figure 35. Initial time-block of 50/1.

In a first instance, we will use a list for grouping subdivisions of this time-block. Each grouping will produce a new time-block by addition. For example the list ((0) (1) (2) (3 4) (5 6 7) (8 9) (10) (11 12 13 14 15)) generates the eight time-blocks shown in Figure 36.

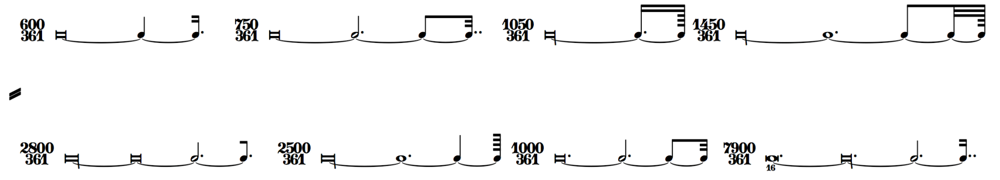

Figure 36. Eight grouped time-blocks.

Another list indicates the series of auto-referential generation representing the different substitutions based on an initial time-block (expressed in subdivisions indexes):

((0 1 2) (1 2 3) (2 3 4 5) (3 4 5 6 7) (4 5 6 7 8) (6 7 8 9 10)
(7 8 9 10 11 12) (0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15))

This new list will be mapped to the list of grouping of subdivisions in order to generate a new 'rhythmic substitutional' voice. Here, the first three elements overlap with the duration of the first original time-block, then the elements 1, 2, 3 overlap with the following duration, and so on. At the end the entire structure (blocks 0 to 15) overlaps with the additional durations of blocks 11 to 15. Figure 37 shows the superposition of the substituted voice with the initial time-block. Figure 38 shows this operation carried out in an OpenMusic patch.

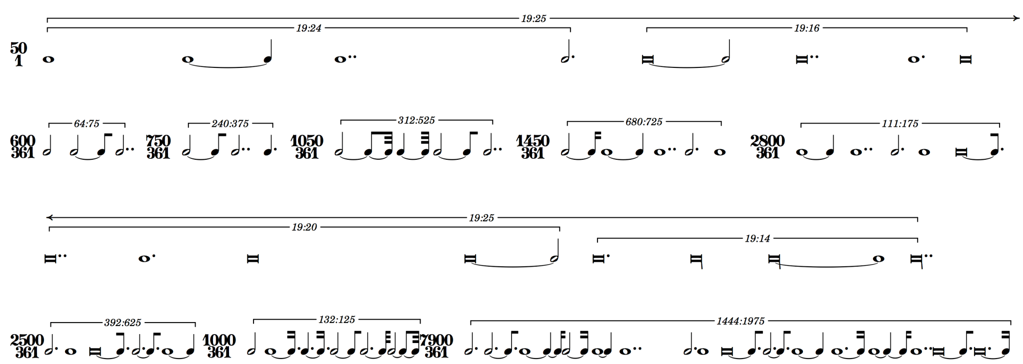

Figure 37. Substitutions of the time-block from Figure 35.

We have represented a non-exhaustive set of operations that may be performed on time-blocks. They can be thought of as a new potential for the production of material based on the time-block concept. Thus the time-block constitutes a key element for a new musical grammar that, we cannot stress enough, is made accessible through CAC.

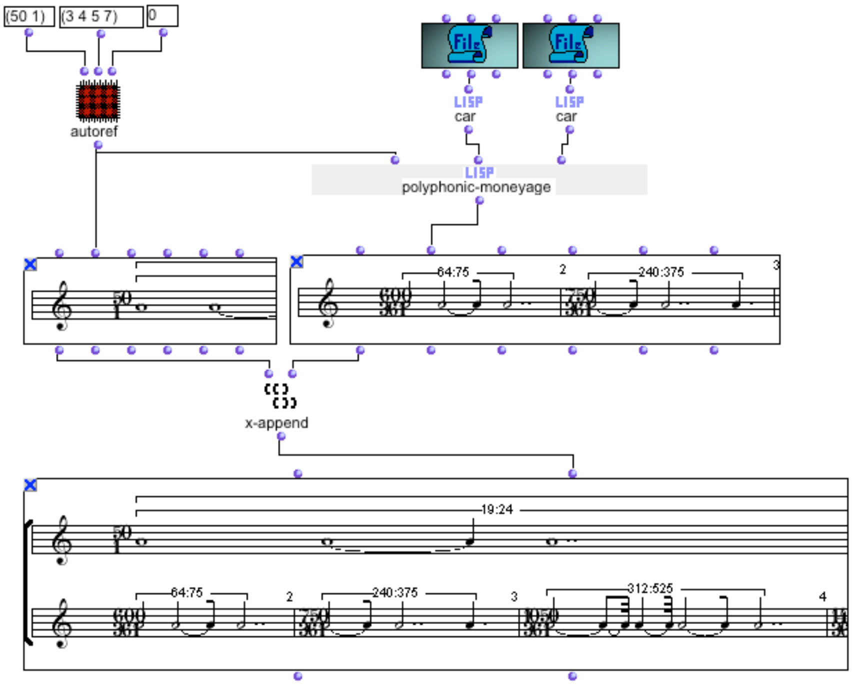

Figure 38. Substitutions of the time-block in OpenMusic.

Livre Premier de Motets

The compositions of the *Livre Premier de Motets*, written in the same spirit as Purcell's *Fantasies* and *In nominees* (as exercises in counterpoint), are primarily focused on the issue of the foundation of musical time (*la problématique de l'écriture du temps*). The distinctive resources of computer-aided composition were used, most notably the structures of rhythmic representation (rhythmic trees) [1], from which was drawn the concept of time-blocks.

There are several reasons why the motet was chosen as a field of investigation. First and foremost, the motet refers to the great fourteenth and fifteenth-century composers of polyphony. The motet is a fertile soil of references be it on the textual level (liturgical or profane, i.e. poetic, texts), or on the musical material level (the *cantus firmi* were often borrowed from the liturgy or from the profane repertoire). Secondly, the motet provides an apt framework for formal experimentation, since its only rule is the "imaginative virtuosity of a contrapuntal nature".[18] Finally, as O. Cullin defines it, "the motet is the logic of one or more texts that is equally worth the logic of a program and a system of representations" [3]. Thus, it is a system of representation with all of its formal and expressive possibilities that is explored.

[18] "Indeed the difficulty of understanding the motet lies in its multi-textuality. Less than a genre or a form, two notions that are often evoked to describe it, the motet's originality lies in the shaping process itself." [3].

This collection is composed of nine motets for two to five voices. They are based on extracts from poems by F. Hölderlin [5]:

In lieblicher Bläue

Voll Verdienst, doch dichterisch wohnet
Der Mensch auf dieser Erde. (Extract 1)

Leben ist Tod, und Tod ist auch ein Leben (Extract 2)

An unsre grossen Dichter

O weckt, ihr Dichter ! weckt sie vom Schlummer auch,
Die jetzt noch schlafen, gebt die Gesetze, gebt
Uns Leben, siegt, Heroen ! ihr nur
Habt der Eroberung Recht, wie Bacchus. (Extract 3)

The musical material derives on the one hand (concerning the generation of time-blocks) from the prosodic structure of the poems, and on the other hand (concerning pitch material) from the *cantus firmi* of the repertoire. The table below gives a general idea of theses different motets.

Motet	**Nb. of voices**	**Cantus firmi**
I	5 voices	*Series of the opus 21* by Webern
II	5 voices	*L'homme armé*
III	5 voices	*Series of the opus 30* by Webern
IV	5 voices	Choral *Wenn wir hochesten Nothen sein*
V	2 voices	*Series of the opus 30* by Webern
VI	5 voices	Choral *Christus, der uns selig macht*
VII	5 voices	Without cantus
VIII	3 voices	Chorals *Wenn wir hochesten Nothen sein*, *Christus, der uns selig macht*, and *L'homme armé*
IX	5 voices	*Series of the opus 21* by Webern

The relationships within the corpus of motets are successive transformations that, for the most part, derive from operations already described in the first part of this chapter (see Figure 39).

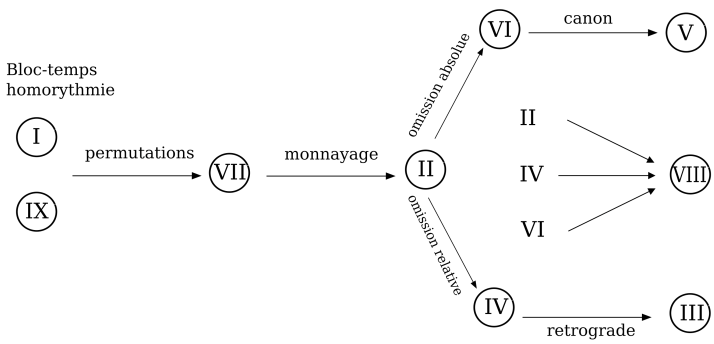

Figure 39. Transformational relationships between the motets.

Here is a brief description of the processes used in the creation of the temporal structures of the different motets, and the relationship from one motet to the other according to the order of diagram in Figure 39.

Motets I and IX

Motets I and IX are based on the prosody of an extract of Hölderlin's poem *In lieblicher Bläue*:

Voll Verdienst, doch dichterisch wohnet
Der Mensch auf dieser Erde.[19]

These motets, which form the beginning and the end of the book, have a homorhythmic structure in three sections of 2, 3 and 5 words, recalling the Fibonacci series.[20]

$$\frac{1\ 2}{3} \quad \frac{1\ 3\ 2}{6} \quad \frac{1\ 1\ 1\ 2\ 2}{7}$$

Ten time-blocks are generated from this structure:

$$13/3\ 26/3\ 13/6\ 13/2\ 13/3\ 13/7\ 13/7\ 13/7\ 26/7\ 26/7$$

Figure 40 shows the patch carrying out this first operation.

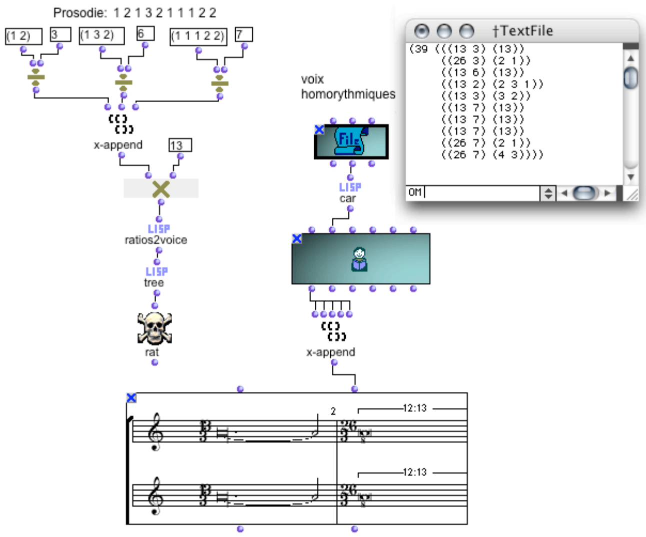

Figure 40. Generation of the structure of Motets I and IX based on the prosody of the poem.

[19] *"Full of merit, yet poetically Men dwell upon this earth."*

[20] What is more, after removing the first words "*Voll Verdienst*", there are a total of 13 syllables. This is probably not a chance occurrence given the importance accorded by Hölderlin to prosody, meter and *caesura* (c.f. *Notes on the translation of Sophocles, Grund zum Empedokles* and *Das Werden im Vergehen* [5]).

Based on this temporal structure, Motets I and IX are distinguished by the distribution of pitches (series of the opus 21 by Webern) amongst the different voices. The density and the distribution of the voices are organized according to the progression in the Fibonacci series. For instance, in Motet IX, the interval of the augmented ninth F–G sharp (*fa–sol#*) inserted between chords of densities 1-2-3-5, corresponds to the interval that separates the bass voices. Figure 41 shows the score for this motet.

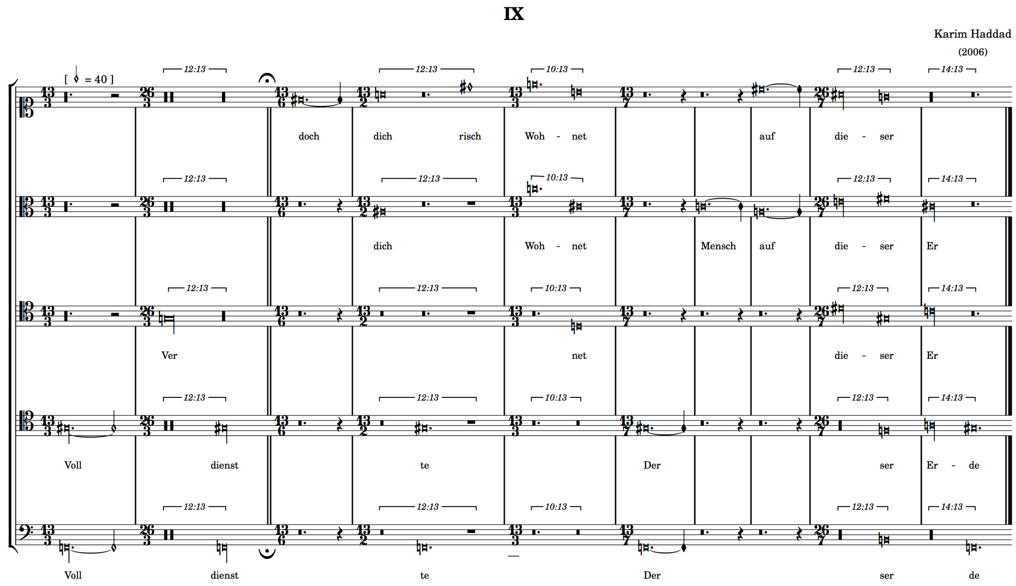

Figure 41. Motet IX.

Motet VII

Motet VII is a first transformation (variation) of Motets I and IX, using the circular permutation of the time-blocks (regrouped according to the prosodic structure in groups of 2, 3 and 5 blocks) on different voices, thus generating a polyphonic structure of time-blocks. This first generation will form the basis for new transformations in the subsequent motets (see Figure 39). Figure 42 shows the patch that generated the motet. The score is shown in Figure 43.

Motet II

Based on the rhythmic structure of the previous motet, Motet II was created by applying the technique of substitution (*monnayage*), which consists of replacing the prolations of the different time-blocks with a selection of metric proportions (long/short) from the different measures of the *cantus firmus* in *L'homme armé.* Finally, a canon at the octave and a contrary movement were used to produce the five voices of the motet. Figure 44 shows the patch that was used to perform this operation. Figure 45 shows the beginning of the score.

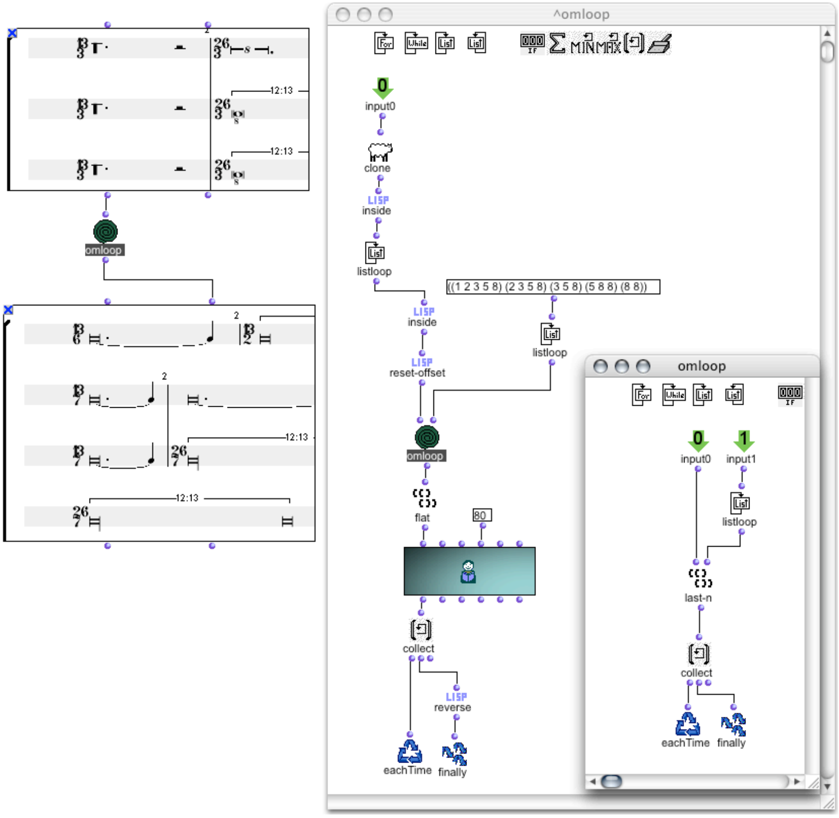

Figure 42. Implementation of the rhythmic structure of Motet VII by circular permutation of the blocks from Motet IX.

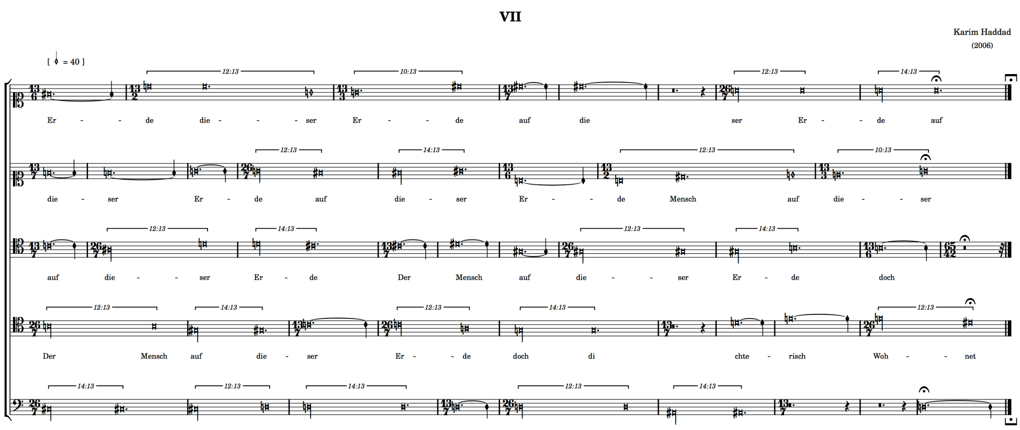

Figure 43. Motet VII.

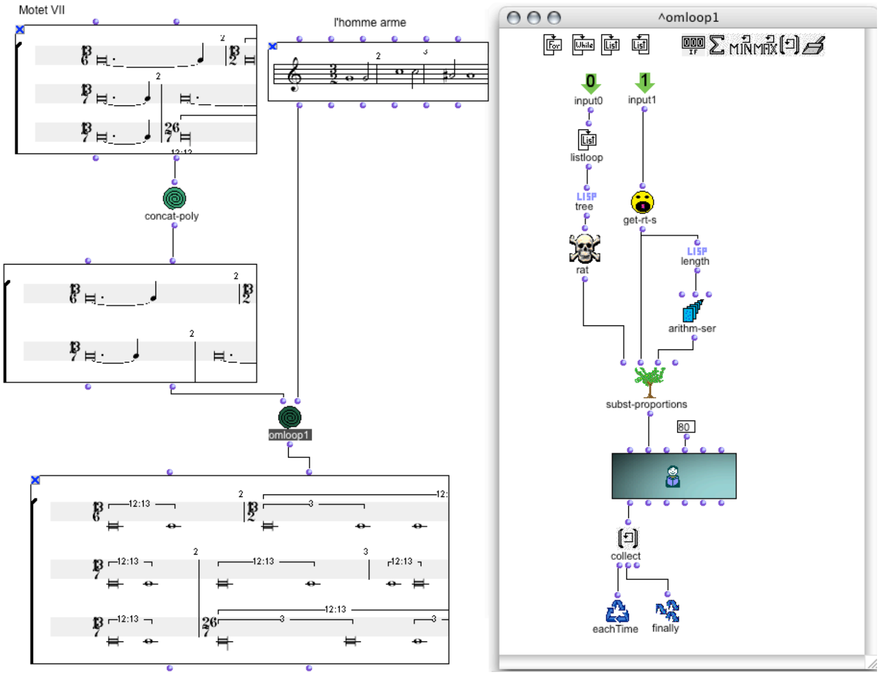

Figure 44. Creation on Motet II by substitutions in Motet VII.

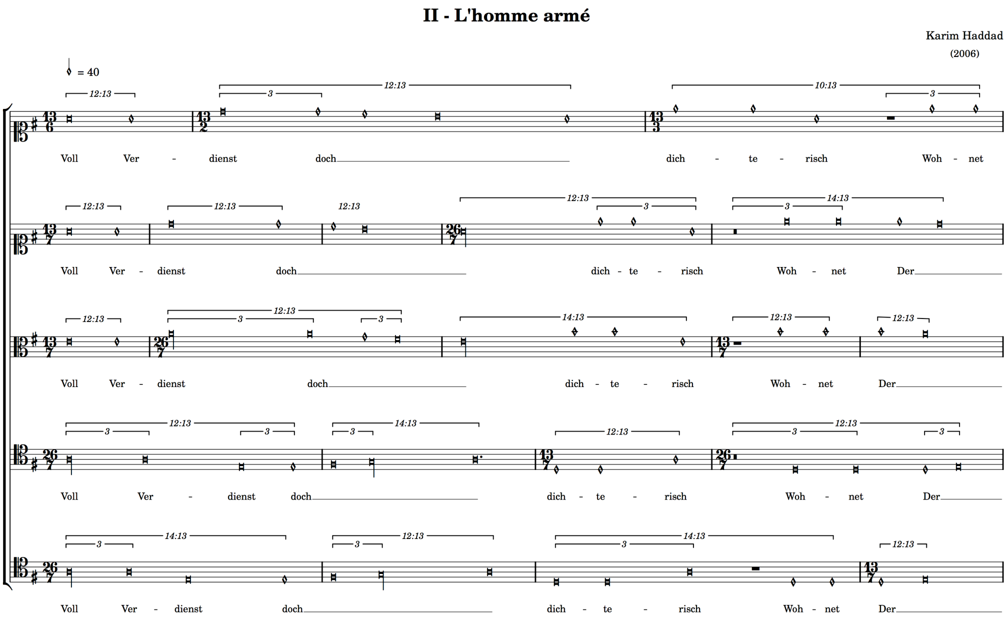

Figure 45. Motet II (first measures).

Motet IV

Iterative auto-referencing was used in Motet IV, once again using substitution (auto-substitution). A supplementary operation of relative omission was also added. The execution of these operations requires the manipulation of the different voices at the measure level, which explains the use of several overlapping *loops* (see Figure 46). Figure 47 shows the beginning of the score for Motet IV.

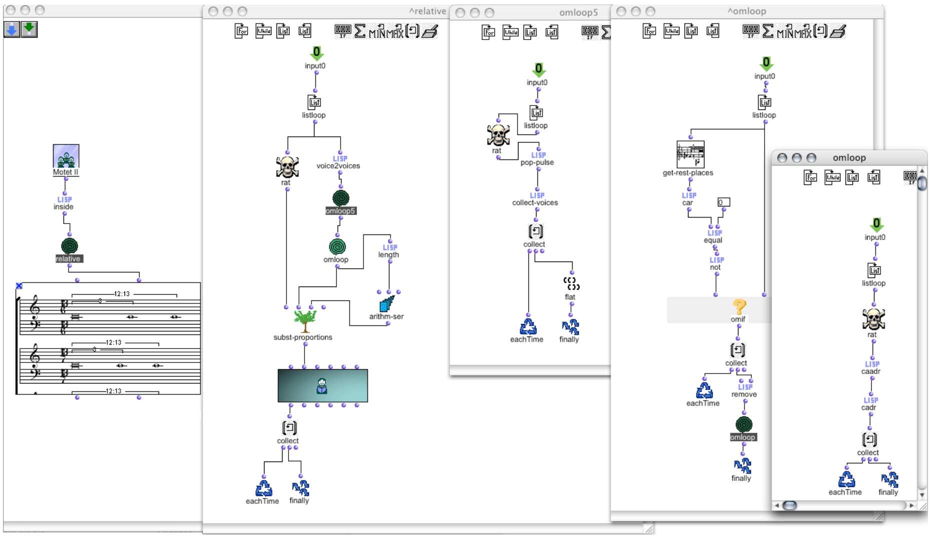

Figure 46. Patch for Motet IV.

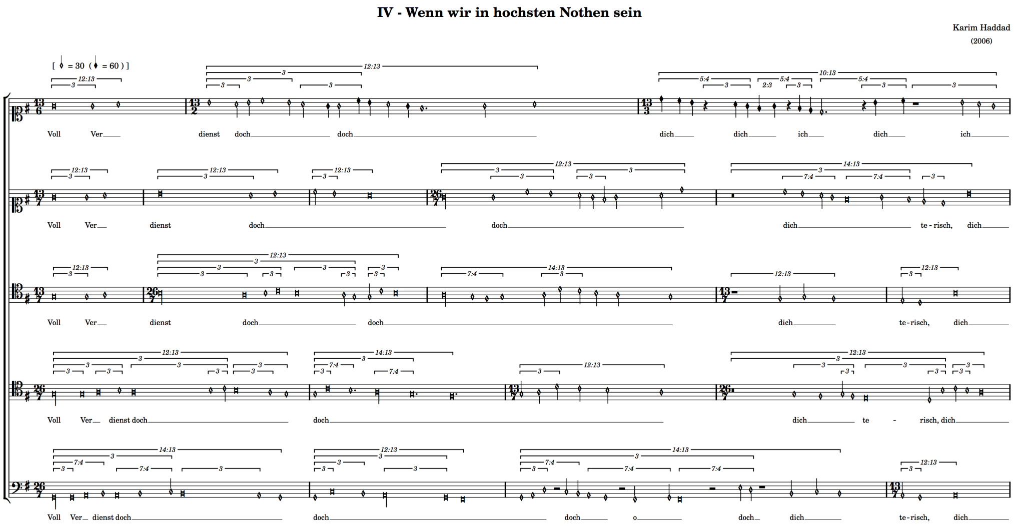

Figure 47. Motet IV (first measures).

Motet III

Motet III represents the mirror image of Motet IV; on the time-block structural level, it is the retrograde of Motet IV. The *treereverse* function was used to retrograde the structure (see Figure 48).

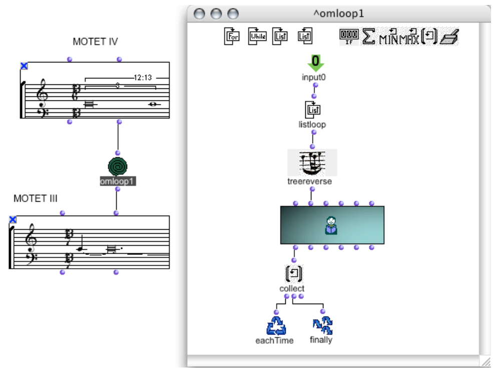

Figure 48. Retrograde structure of Motet IV producing Motet III.

As for the contrapuntal aspect, based on the series of Webern's opus 30, it was necessary (as was often the case during the composition of these motets) to create new functions for the harmonic distribution of the different voices (see Figure 49) such as the *harmonize-prosody* function which repeats the notes for each time-block (each pitch of the cantus is maintained or repeated throughout each measure – time-block – following the prosody). Here, it is the prosodic (syllabic) style that emphasizes the time-blocks.

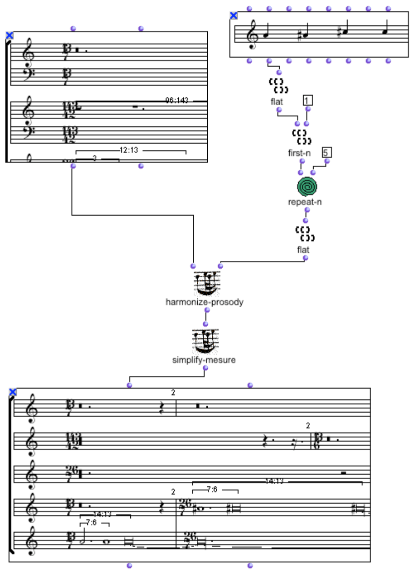

Figure 49. Construction of counterpoint for Motet III, based on the temporal structure created in Figure 48, and the series of Webern's opus 30.

Figure 50 represents an excerpt from the score for the motet.

Figure 50. Motet III (excerpt).

Motet VI

Similarly to Motet IV, material from Motet II was used for Motet VI. However, the omission is in this case not relative but absolute. An excerpt of the score is displayed in Figure 51.

Figure 51. Motet VI (first measures).

Motet V

Motet V, which is in the middle of the book, adopts the technique of counterpoint from J.-S. Bach's *The Art of Fugue*, namely counterpoint XIII for two voices, a canon by augmentation and contrary movement. The first voice takes up the superius II voice of Motet VI in retrograde. Figures 52 and 53 show respectively the patch in OpenMusic used for this procedure and an excerpt from the score for the motet.

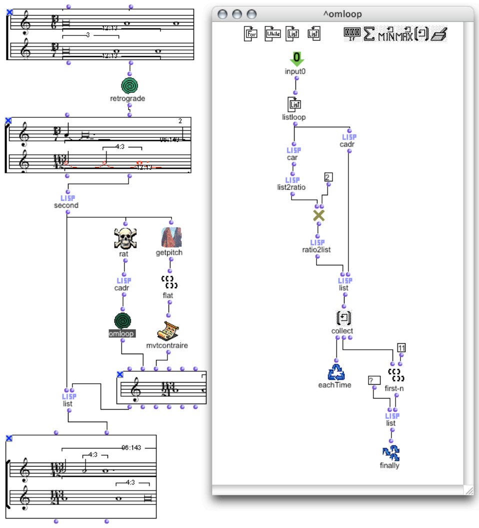

Figure 52. Patch for Motet V: making of a canon based on the second voice of Motet VI.

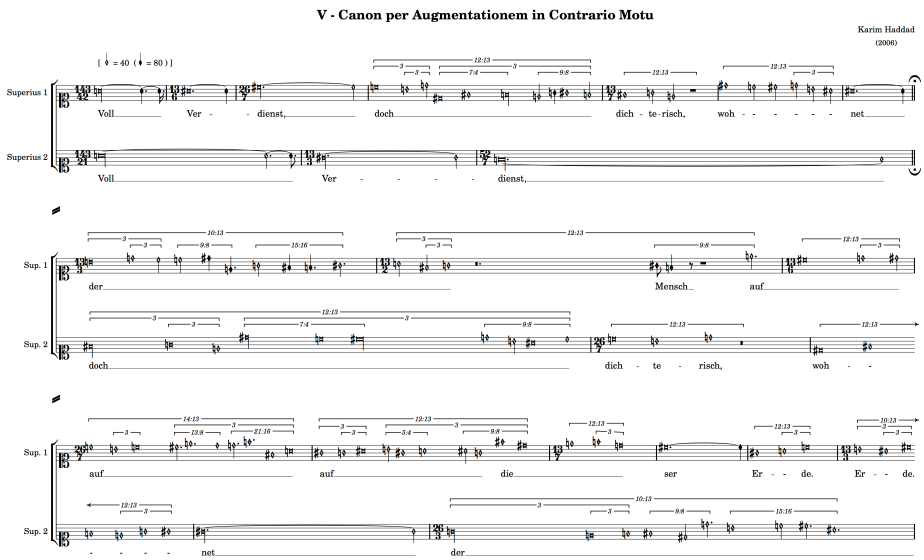

Figure 53. Motet V (first measures).

Motet VIII

Motet VIII, the penultimate motet of the book, is for three voices. It represents a synthesis using the *cantus firmus* from Motet II (*L'homme armé*) as a base, and the chorals used in Motets IV and VI for the superius and the tenor. The voices are a combination of the three motets. Figure 54 represents the beginning of the score.

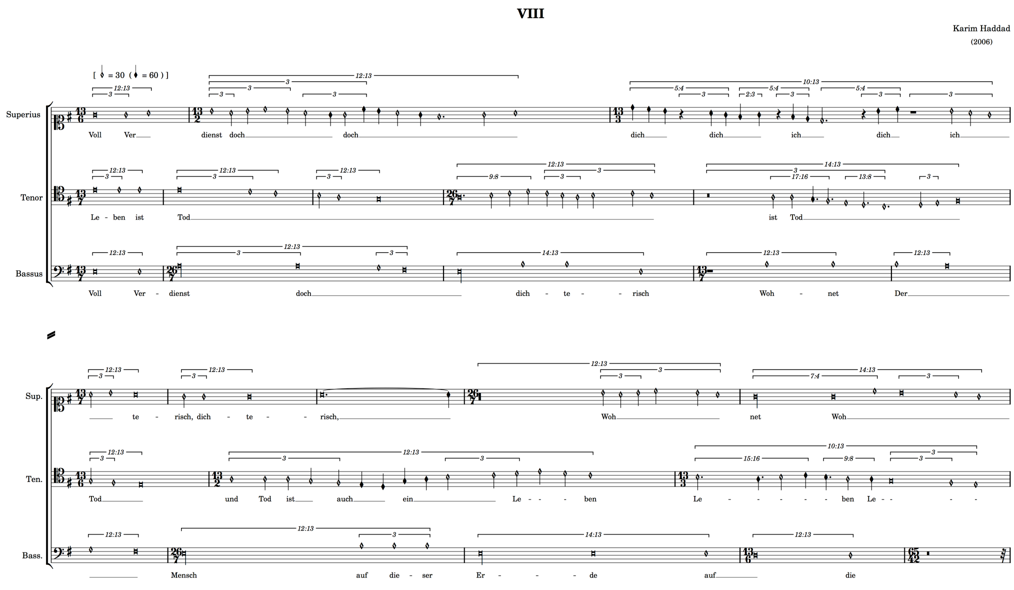

Figure 54. Motet VIII (first measures).

From representation to performance

For the moment we cannot expect from performers to submit to the compositional demands of a new grammar (*solfège*) which, furthermore, is still to be drafted. Performance habits and reflexes are based on a long tradition. Consequently, the only recourse is in transcriptions using rhythmic quantification.[21]

Quantification leads to a reinterpretation of the time-block, brought about by the necessary reinsertion of a meter, designed for performance. As was shown for example in Figure 5, this meter can play a new structural role. However, the quantification can be problematic regarding this specific reintroduction of the notion of an "agnostic measure", that is the non-structural measure, which should be avoided.

Precision is another problematic issue. We tried a number of different levels of quantifications (note values that are accepted or rejected from the quantified version). The main problem was the inevitable discrepancy between the quantified version and the original version. In a first instance, and in order to preserve the spirit of the motets, irrational

[21] It is well known that the performance of fourteenth-century and fifteenth-century repertoires is made possible today by the transcription of neumatic notations into modern notations.

numbers were excluded. Then a ternary division was reintroduced, which produced the same result, namely a delay that gradually increased as the quantification progressed in time. Thus finally, irrational numbers of order eight were used, which seemed to restore for the best the durations and the rhythms of the motets. In addition, in order to best underline the time-blocks, measure changes were implemented wherever necessary.

Figure 55 shows the patch executing the quantification of Motet IX. Figure 56 shows the beginning of the resulting score.

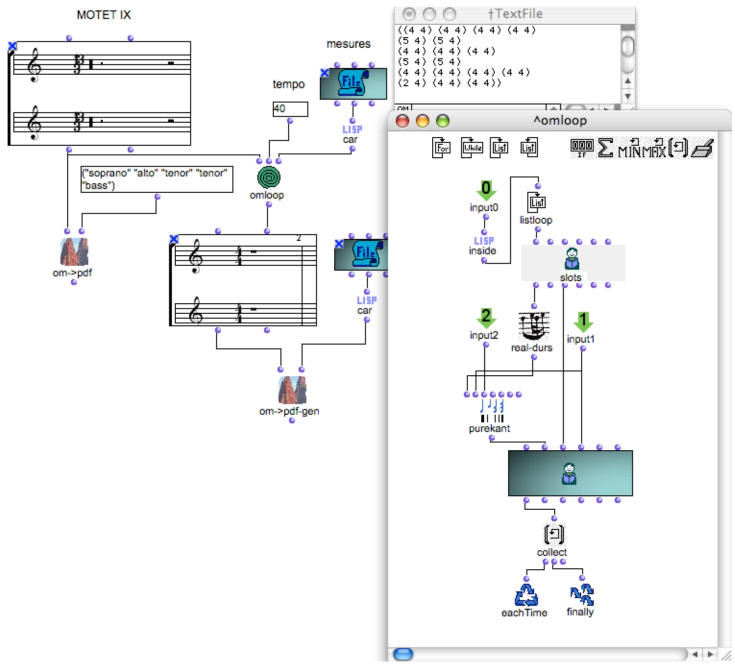

Figure 55. Quantification of Motet IX in OpenMusic.

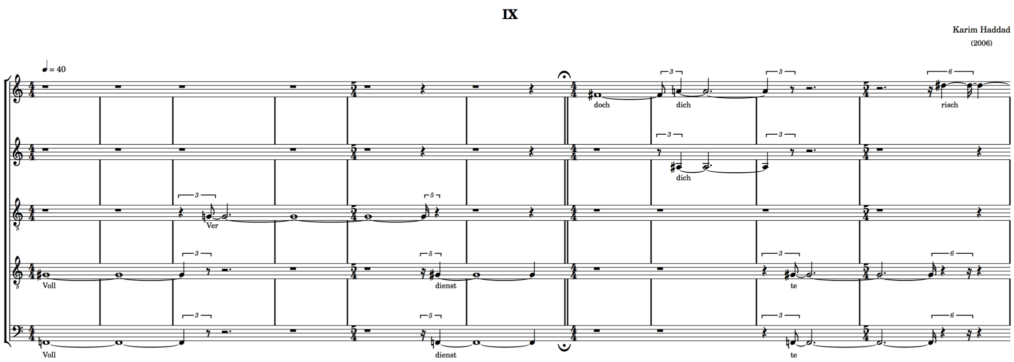

Figure 56. Beginning of the quantified version of Motet IX.

From Concept to Tool

Given the complex nature of the concepts involved, the issue of the tool (i.e. CAC) was crucial to the compositional process from the perspectives of both calculation and symbolic notation of the Motets.

With regard to the first perspective, a new class of objects was developed in OpenMusic, the *time-block*, an intermediate object between the *voice* and *measure* objects that proved indispensable. Specific methods, necessary for the handling of this new class (and presented throughout this text) were also developed. Naturally, due to the inherent design of OpenMusic, it is possible to implement new functionalities in this environment, be it in a graphic form (with visual programming), or in "hard" code, as in the present case, in the form of a library.

With regard to symbolic notation, it seemed crucial to find a solution to the issue of polymetric scores notation. It is true that OpenMusic manages polymetrics perfectly well, but since it is not a score editor, Lilypond [8] was used as a complement, and the results were quite satisfactory. This gave birth to *omlily*, an OpenMusic library which links OpenMusic editors and the Lilypond music notation format.[22]

Towards a *solfège* of time

Everything points towards the view that the time-block concept is but another artifice or trend in the arsenal of contemporary musical language. I believe, however, that far from being archaic or post-modern, this concept, when used as a compositional strategy, has become indispensable for a new understanding of time composition (*l'écriture du temps*).

Experientiam circa res sensibiles artem facere[23]
Iohannis de Muris, [7].

Acknowledgments

This article would not have been possible without the help of two indispensable persons. Carlos Agon orchestrated the presentation of the motets at the conference "Calcul dans la musique", which inspired the framework and structure of this chapter. And Jean Bresson, to whom this paper owes a great deal for its lucidity, repeatedly read and reread the text offering illuminated suggestions. I would like to express my profound gratitude to these two friends, and to thank Gilles Rico and my father who helped out with this translation.[24]

[22] http://karim.haddad.online.fr/pages/downloads.html
[23] "Experimenting with sensible things produces art."
[24] This article was originally in French.

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