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Karim Haddad

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# *Temporal poetics as a critical technical practice*

Karim Haddad

December 7, 2020

“In a manifold sense, music uses time. It uses my time, it uses your time, it uses its own time. It would be most annoying if it did not aim to say the most important things in the most concentrated manner in every fraction of this time<sup>1</sup>”. Schönberg’s statement underlines the importance of time as a founding principle in the art of composing. Beyond any hierarchical consideration of pitch, dynamics, and formal organization, musical time by its own concept and perception is to be considered the most decisive factor of them all.

This matter implies a first imperative: duration, rhythm, musical time, taking precedence over all other musical components (parameters). When considering a musical object in terms of a temporal event, it’s its own temporality which determines it as such. The other essential “components” to its identity remain important when it comes to the specificity of this object, discerning it by differentiating it in the event of a possible synchronicity of several concomitant time objects. The musical event is considered as a temporal unit inseparable from its own temporality perceived as a form (also temporal). It should be subject to certain criteria (or laws) which by their essence would dissociate what it should be from any other sound event, that is, an object characterized by a musical sense. The first reason or principle that should be pursued would be, in our opinion, and that of Schönberg, *intelligibility*<sup>2</sup>. While by intelligibility, Schönberg comprehends it under the mode of a diachronic succession of events, we see it under a multidimensional form in relation to an essentially temporal discursiveness. By the latter, we mean a generalization of a temporal intelligibility without any primacy to any given sound component, like for instance, the succession of a complex of chords, gestures, or rhythmic figures, but with a time-organized formal totality.

For Schönberg and most particularly for Webern, the necessary condition of intelligibility is coherence. Coherence might be found on any level, the choice of material, the process deduction, but above all, in the coherence of musical form.

## I Time and Form

In *Sculpting in time*<sup>3</sup> Andrei Tarkovski states:

How does time make itself felt in a shot? It becomes tangible when you sense something significant,

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<sup>1</sup>Arnold Schoenberg and Dika Newlin. *Style and idea*. Tech. rep. Williams and Norgate London, 1951, p. 40.

<sup>2</sup>“*Form in the arts, and especially in music, aims primarily at comprehensibility*” (*ibid.*, p. 103).

<sup>3</sup>Andrey Tarkovsky. “Sculpting in Time: Reflections on the Cinema, trans”. In: *Kitty Hunter-Blair* (1986).

truthful, going on beyond the events on the screen; when you realise, quite consciously, that what you see in the frame is not limited to its visual depiction, but is a pointer to something stretching out beyond the frame and to infinity; a pointer to life<sup>4</sup>.

This can be perfectly applied to the art of composition, most particularly to the formal construct of a musical work, time being essentially related to it. However, the formal conception should not rely on a stream of arbitrary patchwork and *collage* of event sequences, should it be in the field of film-making or musical composition, pasted without any reasoning, without coherence, which will jeopardize the work's intelligibility. The structural order is to be found in time coherent organization.

Rhythm, then, is not the metrical sequence of pieces; what makes it is the time-thrust within the frames. And I am convinced that it is rhythm, and not editing, as people tend to think, that is the main formative element of cinema<sup>5</sup>.

On the other hand, coherence does not necessarily imply a monolithic exclusive organization, a complete semantic compliance with the material, but could also include a very wide span of various different objects, provided that the articulation between each different material in time is considered and structured following a temporal logic transcending the work itself:

The utmost form of poetry is when the non-poetic becomes poem, when in the whole work of art, this happens at the good moment and right place. [...] Because the eternal serenity, the divine joy is to put each element at its place where it belongs to the whole; That is why, without understanding, without organized will throughout, no excellency, no livelihood.<sup>6</sup>

In order to illustrate the use of temporal poetics in a compositional scope, we will start with a brief presentation of the *Temporal Unit* principle we have developed through our compositional practice followed by some applications on this same principle.

## 2 Temporal Units , a brief presentation

A *Temporal Unit*<sup>7</sup> is a symbolic expression of duration, meter and tempo represented as a time vector. A *Temporal Unit* can be absolute or relative. In the first case, the *Temporal Unit* doesn't have any determined duration nor any tempo indication. In the second case, the *Temporal Unit* will have a duration "relative" to the tempo assigned to it.

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<sup>4</sup>Andrey Tarkovsky, "*Sculpting in Time: Reflections on the Cinema, trans*", p. 117.

<sup>5</sup>*Ibid.*, p. 118.

<sup>6</sup>Friedrich Hölderlin. *Fragments de poétique et autres textes*. Imprimerie nationale, 2006.

<sup>7</sup>For a complete study on this matter cf. Karim Haddad. "L'Unité Temporelle : Une approche pour l'écriture de la durée et de sa quantification". PhD thesis. IRCAM - Sorbonne Université, 2020.

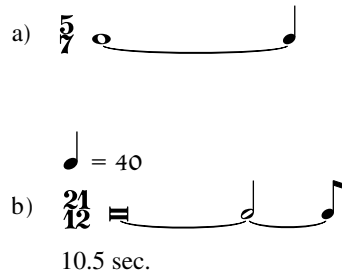


Figure 1: *absolute* (a) and *relative* (b) *Temporal Units*

A *Temporal Unit* is represented by a *tempus*, (its time signature), and by the *prolationis* consisting of the proportions of subdivisions.

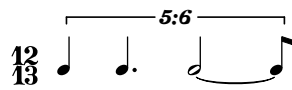


Figure 2: A *Temporal Unit* of *tempus* ( $\frac{12}{13}$ ) with *prolationis* as (2 3 5).

The *Temporal Unit* in figure 2 can be notated in a condensed style like so:

$$\left( \frac{12}{13} \right)_{(2\ 3\ 5)}$$

## 2.1 Temporal Units properties

The most important properties of *Temporal Units* are tempo and metrical modulations. These properties have the ability to modify and create new *Temporal Units* starting from others.

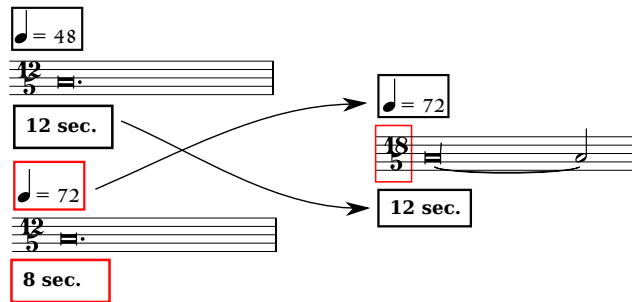


Figure 3: Tempo modulation from two different *Temporal Units*.

Autogenerativity is another property and is based on others like subdivision, decomposition, concatenation and reduction. An example of this process is shown in figure 4:



## 2.2 Operations on Temporal Units

A rich corpus of operations at hand can be applied on *Temporal Units*, such as algebraic operations (addition, subtraction, and scaling), *prolational* operations (augmentation, insertion, diminution, and extraction), *magnitude* operations (expansion, contraction, stretching, compression and segmentation). It is also possible to apply any mathematical or physical operations on *Temporal Units* such as convolutions or even Fourier transforms.

All these operations could be sequentially, recursively or iteratively applied.



Figure 5: Iterative scaling operations on a *Temporal Unit*

$$\left(\frac{12}{5}\right)_{((4 \ 1 \ -1 \ 1)) \ 5 \ -3 \ 1 \ 2)} \times \left\{2, \frac{1}{5}, \frac{3}{2}, \frac{2}{3}\right\}$$

$$\Rightarrow \left\{ \begin{array}{l} \left[\left(\frac{24}{5}\right)_{((4 \ 1 \ -1 \ 1)) \ 5 \ -3 \ 1 \ 2)}\right] \\ \left[\left(\frac{12}{25}\right)_{((4 \ 1 \ -1 \ 1)) \ 5 \ -3 \ 1 \ 2)}\right] \\ \left[\left(\frac{18}{5}\right)_{((4 \ 1 \ -1 \ 1)) \ 5 \ -3 \ 1 \ 2)}\right] \\ \left[\left(\frac{8}{5}\right)_{((4 \ 1 \ -1 \ 1)) \ 5 \ -3 \ 1 \ 2)}\right] \end{array} \right\}$$

Figure 6: *Condensed* notation of Figure ??

### 3 The logic of time structures

One cannot expect from a low resolution material, should it be pitch, duration or dynamics, to express subtle ideas. The higher the definition, the more expressive the resulting composition will be. Using limited, or constrained material may also be interesting on one condition, which is to follow the logic principle of the material itself. Therefore, the choice of a starting material is utterly critical with regard to the resulting musical construct.

#### 3.1 Time envelopes

Starting with *Temporal Units*, let us consider using their magnitude (*tempus*) as a time span containing functions of the type  $y = f(x)$  represented by multiple envelopes<sup>8</sup> of different categories. The first category of envelopes is based on piecewise linear functions.

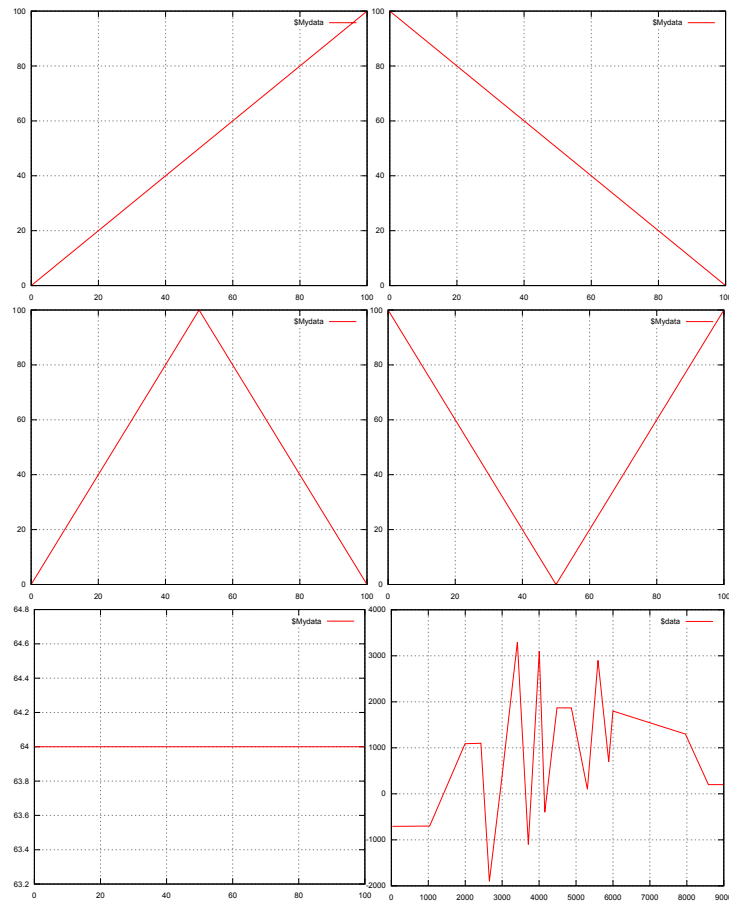


Figure 7: Different piecewise linear functions.

<sup>8</sup>The envelope concept is to be understood as described by Pierre Boulez in (Pierre Boulez. “Le système et l’idée”. In: *Inharmonique: Le temps des mutations* I [1986], pp. 1-30)

The second category is based on staircase functions.

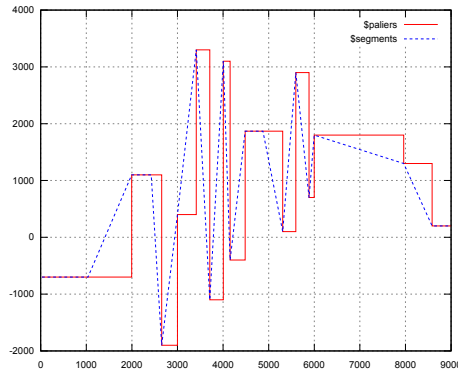


Figure 8: Staircase function.

The last category will be non-linear envelopes represented by smooth functions such as:

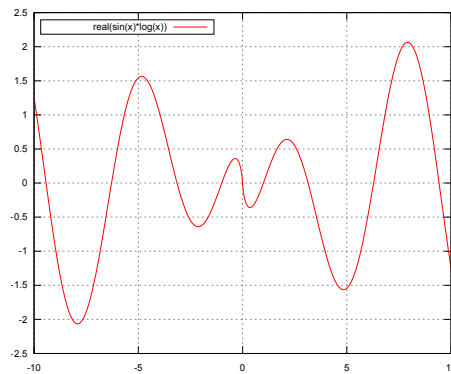


Figure 9: Non-linear envelope of the smooth function  $y = Re(\sin(x) \times \log(x))$ .

The *envelopes* will be integrated in *Temporal Units* domain, the  $x$  axis, and their given data will be interpreted following the nature and content of the required field which will be allocated in the  $y$  axis.

For instance, we could consider the following *Temporal Unit*:

$$\left(\frac{12}{5}\right)_{(5\ 6\ 3\ 2\ 4\ 1)}$$

and a function in figure 9 where the  $(x, y)$  dimensions represent respectively the temporal axis and some data in the  $y$  axis which could be allocated to any parameter in the domain of pitch, dynamic, timber, register, etc. Once these are associated synchronously to a *Temporal Unit*, the *tempus* of this “floating” unit will conform to the the *tempus* of the first. This flexibility between absolute time and relative time is one of the main characteristic of interpretation when it



comes to the time scaling of the given data, which can be read discretely or continuously. The  $y$  axis is given different parameters for scaling following the type of space we are using (pitch, dynamics, timber, etc.) in a way for the original *Temporal Unit* to contain any kind of data associated with transformational operators according to the chosen field. In order to achieve this, two operations will be necessary:

- The first operation consists in the quantification of relative time that will be scaled according to the given *Temporal Unit* following the  $y$  axis.
- The second operation will sample the useful data following the nature of the given space and if desired, transpose these data to different possible spaces (for example, from pitch to dynamics, from dynamics to register, etc.).

The resulting action of these two operations will be a data transfer of time on the  $x$  axis and a formatted data on the  $y$  axis.

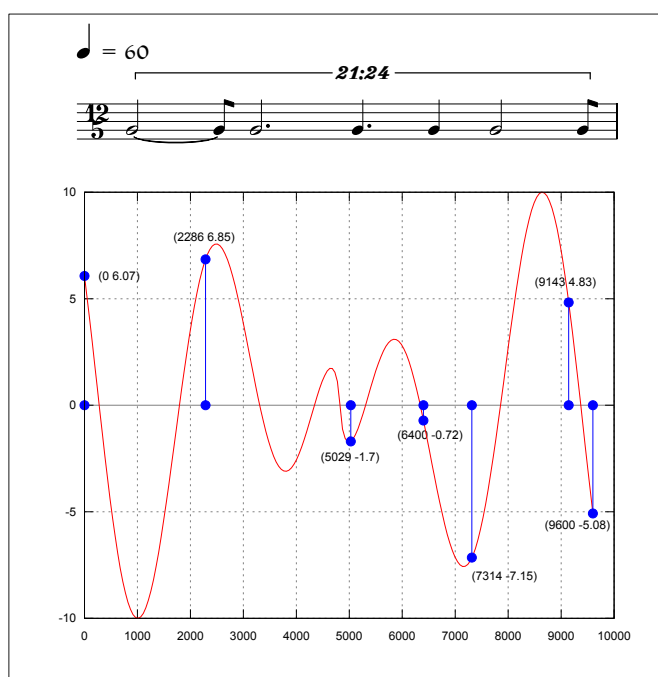


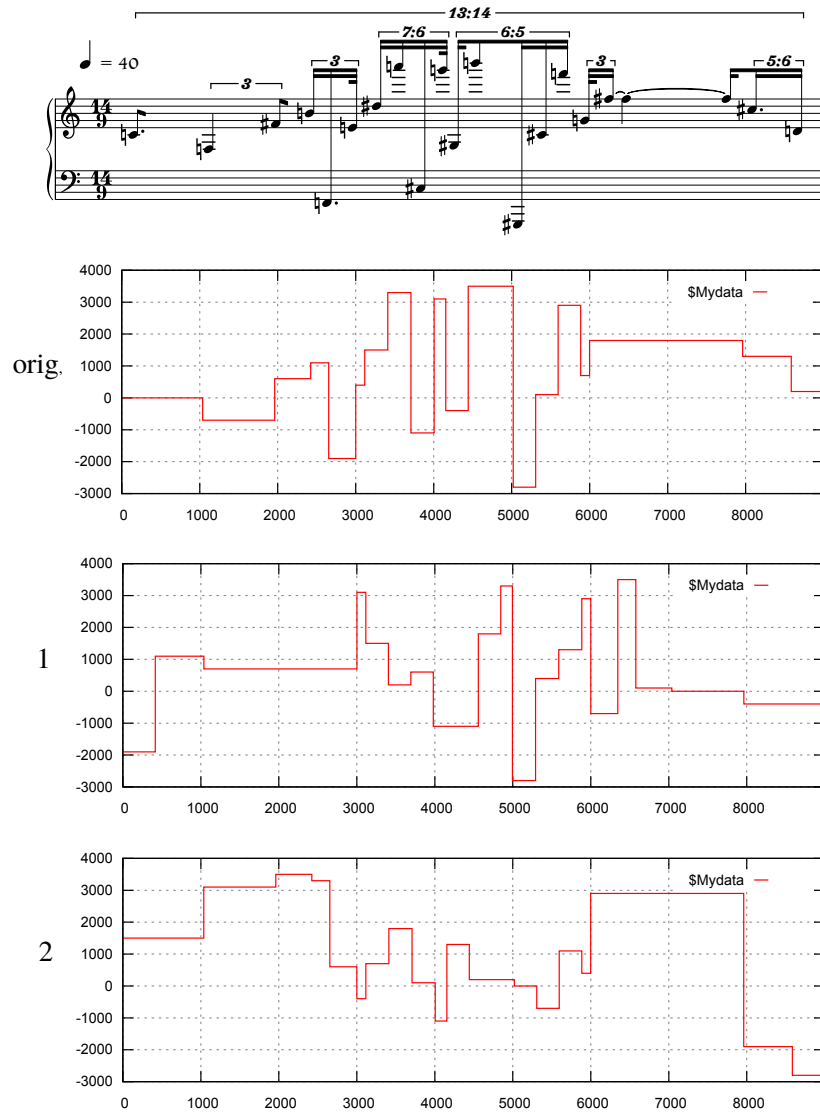
Figure 10: A *Temporal Unit* with its associated envelope with sampled time correlation.

This complex construct of a *Temporal Unit* and an envelope can be considered under the aspect of computational and combinatorial transformations starting from temporal data. This will result in an intrinsic formal potential, resulting from these same operations. Assuming that this procedure will operate on dynamics as well, let us consider a *Temporal Unit* composed of nineteen *prolationa* (proportions) with a pitch content, and a set of leveled linear envelopes generated from the following circular permutations corresponding to the pitch matrix of our *Temporal Unit*:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
5	4	16	10	7	19	3	9	17	8	13	6	18	15	2	12	14	1	11
7	10	12	8	3	11	16	17	14	9	18	19	1	2	4	6	15	5	13
3	8	6	9	16	13	12	14	15	17	1	11	5	4	10	19	2	7	18
16	9	19	17	12	18	6	15	2	14	5	13	7	10	8	11	4	3	1
12	17	11	14	6	1	19	2	4	15	7	18	3	8	9	13	10	16	5
6	14	13	15	19	5	11	4	10	2	3	1	16	9	17	18	8	12	7
19	15	18	2	11	7	13	10	8	4	16	5	12	17	14	1	9	6	3
11	2	1	4	13	3	18	8	9	10	12	7	6	14	15	5	17	19	16
13	4	5	10	18	16	1	9	17	8	6	3	19	15	2	7	14	11	12
18	10	7	8	1	12	5	17	14	9	19	16	11	2	4	3	15	13	6
1	8	3	9	5	6	7	14	15	17	11	12	13	4	10	16	2	18	19
5	9	16	17	7	19	3	15	2	14	13	6	18	10	8	12	4	1	11
7	17	12	14	3	11	16	2	4	15	18	19	1	8	9	6	10	5	13
3	14	6	15	16	13	12	4	10	2	1	11	5	9	17	19	8	7	18
16	15	19	2	12	18	6	10	8	4	5	13	7	17	14	11	9	3	1
12	2	11	4	6	1	19	8	9	10	7	18	3	14	15	13	17	16	5
6	4	13	10	19	5	11	9	17	8	3	1	16	15	2	18	14	12	7
19	10	18	8	11	7	13	17	14	9	16	5	12	2	4	1	15	6	3

Table 1: Pitch set circular permutation matrix of the *Temporal Unit* of **Figure 11**.

The first envelope's profile corresponds to that of the pitch of the associated *Temporal Unit*:



etc.

Figure 11: A *Temporal Unit* and its corresponding envelope based on its pitch profile (orig.) followed by the first two envelopes (1 2) of the first two permutations from Table 1.

If we apply the envelope related to the original profile of pitches scaled from *pianissimo* to *fortissimo*, this will comply to the logical pitch set profile, where the lowest note is dynamically the softest and the highest the loudest. However, if we use other permutations with the same *Temporal Unit's* pitch order, the logical order will be less obvious concerning the register/dynamic correlation, resulting with singular and most interesting dynamic profiles.

Figure 12: Original profile (envelope 0) applied to dynamics, followed by the second permutation envelope (cf. Figure 1).

From a larger scale perspective, the generalization of this process will provide a set of gesture material widespread on all different spaces, the referent space being duration in the form of *Temporal Units* guarantying a relative control over the form in progress.

### 3.2 Matrices and arrays: a transformational space

Other strategies are available for the reorganization and redistribution that can be thought of as a development and proliferation of the material and ideas on a local level or more widely on the musical form scale. These can be described as so:

There is a dimension proper to the virtual object that reveals concepts such as permutation, interpolation, random structures, sieves, recursivity, mapping and set of rules for rewriting, offering an open space for development. This dimension reveals itself as well as in the elements and in their own combination, in the informal<sup>9</sup>.

In this example we will start from a complex of *Temporal Units* generated from a DNA chain. Each deoxyribonucleotide composing this chain will determine the *nature* of the given *Temporal Unit*:

- *A* for a simple *Temporal Unit* (one proportion).
- *C* for a pulsed *Temporal Unit* (the number of pulsation is equal to the *Temporal Unit*'s numerator).

<sup>9</sup>Pierre Boulez and Jean Jacques Nattiez. *Falons:(pour une décennie): dix ans d'enseignement au Collège de France (1978-1988)*. C. Bourgois, 1989, p. 375.

- $T$  for a “mute” *Temporal Unit* filled with a rest.
- $G$  for a “composed” *Temporal Unit* from two *prolationis* related to the *Temporal Unit*’s *tempus* in the form of:

$$S = (\text{numerator denominator})$$

The main structure is built around twelve voices composed of *Temporal Units*. The *Tempora* are derived from two Pisano periods:

$$P(5\ 7) \text{ mod } 8 = (5\ 7\ 4\ 3\ 7\ 2\ 1\ 3\ 4\ 7\ 3\ 2)$$

for 12 elements assigned to the numerators and,

$$P(4\ 7) \text{ mod } 13 = \begin{pmatrix} 4 & 7 & 11 & 5 & 3 & 8 & 11 & 6 & 4 & 10 & 1 & 11 & 12 \\ 10 & 9 & 6 & 2 & 8 & 10 & 5 & 2 & 7 & 9 & 3 & 12 & 2 & 1 & 3 \end{pmatrix}$$

for 28 elements assigned to the denominators. Using circular permutations this will produce twelve sequences of 12 *Temporal Units* per voice.

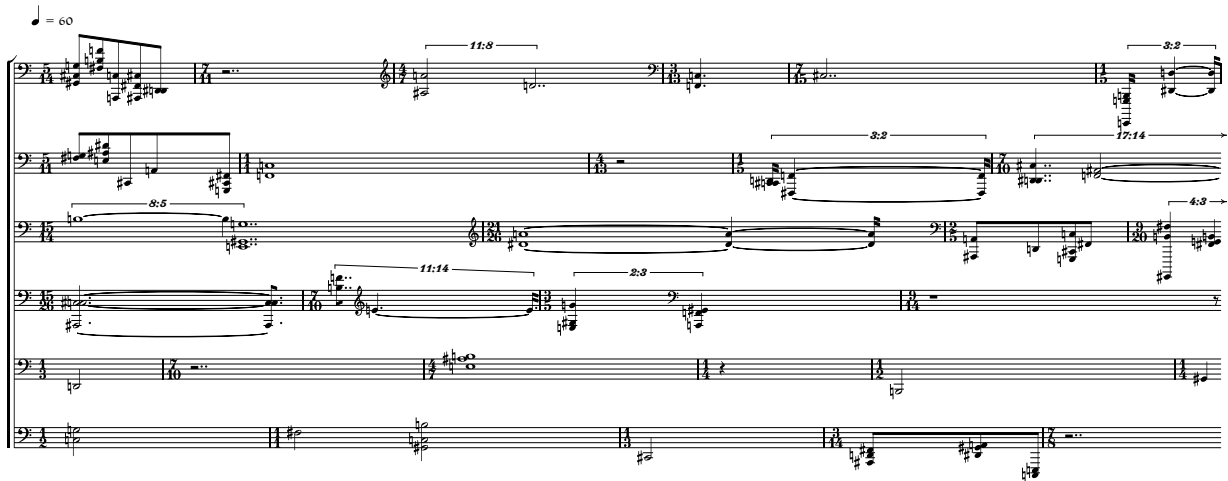


Figure 13: Main structure (first six voices).

We will construct an array with a dimension of  $12 \times 12$  filled with *Temporal Units*. Two envelopes and one row of integers will be associated to each *Temporal Unit* of the array. These will be used to respectively control the pitch register distribution, the dynamics<sup>10</sup> and instrumentation.

<sup>10</sup>Let us bare in mind that this sort of array although embedding temporal elements such as *Temporal Units* is in no way a temporal representation itself. It is a transformational potential set to be quantified in time.

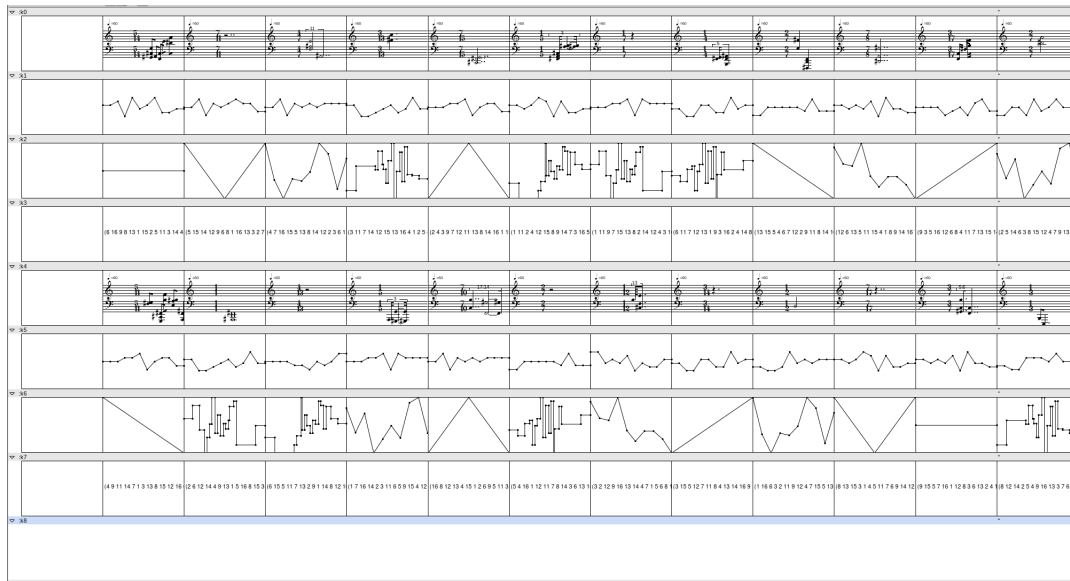


Figure 14: First two rows of the array containing *Temporal Units* and their corresponding envelopes.

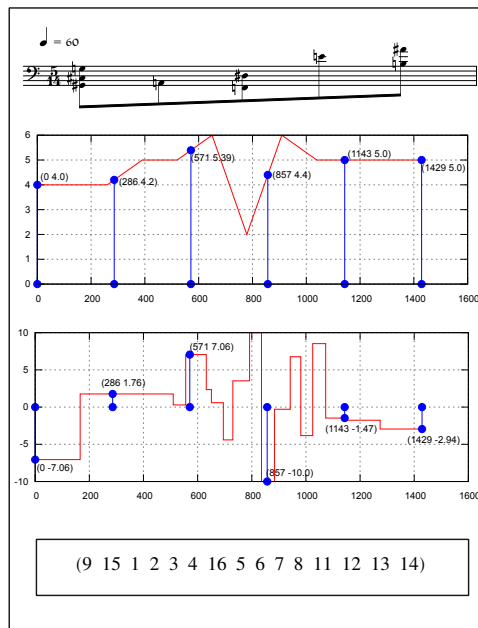


Figure 15: A cell from array of [Figure 14](#) with its four components : *Temporal Unit*, registration envelope, dynamic envelope and instrumental sieve.

We use an identical serial transformational matrix from the type we find under the example 4 in *Penser la musique*

*aujourd'hui*<sup>11</sup>, described by its author as follows<sup>12</sup>:

Let us take the case of a non-homogeneous complex formed by pitch and duration ; if I allocate the pitched durations directly – or inversely – proportional to their intervals binding them, i will obtain another form of serial generation and this by transferring the order of magnitude of the interval on the order of succession<sup>13</sup>.

In our case, the order of succession is determined by the order of magnitude of *Temporal Units*' time intervals for each voice in the array, creating a matrix of non-permutational order:

8	11	10	4	9	3	1	5	6	12	2	7
9	12	5	2	11	4	1	3	10	7	8	6
10	9	5	6	11	2	1	7	3	12	8	4
6	9	7	8	11	2	1	3	10	12	5	4
5	11	9	3	8	4	1	7	10	12	6	2
7	12	6	4	11	1	3	8	9	10	5	2
12	10	4	6	8	5	1	7	9	11	2	3
8	10	11	2	12	5	1	6	7	9	4	3
7	11	3	9	12	4	1	5	6	10	8	2
10	7	9	8	11	4	1	3	6	12	5	2
5	12	10	7	11	2	1	6	8	9	4	3
11	12	9	6	10	2	1	7	5	8	4	3

Table 2: Matrix of non-permutational order.

This matrix is applied not to the pitch/duration pair but to *Temporal Units*. Here is the first translational matrix generated from the first order:

8	11	10	4	9	3	1	5	6	12	2	7
11-7		6	8-3-2					10-4-5		9-1	12
	10	8-4-5	7	6-12-2		11	3	9			1
4-9		7		5	1-12		10-2	8-3	6		11
	8-9	3		4	11-10	2	1	12-7	5	6	
1-2	6-7		11	3	4		8-9-12		10	5	
6	1-5-12				8-2		11-7		9-3	10	4
5	4	9		10-1	7	6-12		11	8	3	2
12	3	11	9-1			10-4-5			2-7	8	6
3	2			8-11	6	9	4		1	12-7	10 5
10		1-12-2	6	7	9-5	8-3			11	4	
			10-5-12			7	6	1-2	4	11	8 9 3

Table 3: First translational matrix generated from the first order.

<sup>11</sup>Pierre Boulez. "Penser la musique aujourd'hui". In: *Ed. Gonthier, Paris (1963)*, p. 41.

<sup>12</sup>This transformational process is used in the first part of *Antiphonie*, (*Formant 1*) in *Troisième sonate pour piano* by Pierre Boulez. There is an excellent analysis of this process to be found in the article by Peter O'Hagan (Peter O'Hagan. "Antiphonie": une analyse du processus de composition". In: *Pierre Boulez: Techniques d'écriture et enjeux esthétiques [2006]*, pp. 109-31).

<sup>13</sup>Pierre Boulez, "Penser la musique aujourd'hui", p. 41.

The matrix used in *Antiphonie (Formant 1 of la Troisième sonate pour piano)* of Pierre Boulez articulates pitch and durations, while in our context, we will be using *Temporal Units* in the transformational matrix which will provide us with *reservoirs* of a complex of gestures<sup>14</sup>. Computer Assisted Composition will allow us to explore this rich material by several decisional combinatory processes<sup>15</sup>.

Having a matrix and an array at hand (we will use the terms of matrix *A* for the transformational matrix **Table 3** and array *TU* for the one integrating the *Temporal Units* **Figure 14**), we can map them both and “read” and “browse” them in different manners like so:

Let us start with the array *TU* and apply an associative reading of matrix *A* through the permutational transfer from column to row. One will be used to sort the other. Let us take for instance the third row of matrix *A* who will be used for the “re-ordering” of the *reservoirs* of array *TU* by indexation:

1	2	3	4	5	6	7	8	9	10	11	12
4-9		7		5	1-12		10-2	8-3	6		11

Table 4:

We will interpret the row of *A* starting from column 1 of *TU* by collecting the fourth and ninth element of this same array. The second column being empty, we will then move to column 3 and select the *Temporal Unit* of row 7, and so on. By this matrix-to-array “transfer” we can build a polyphonic synchronous complex as such:

<sup>14</sup>Gestures are to be understood here as an articulate grouping of all necessary parameters integrated in a *Temporal Unit* as a polyphony

<sup>15</sup>We have implemented most of our processes and compositional strategies in OpenMusic environment (cf. (Carlos Agon. “OpenMusic : Un langage visuel pour la composition musicale assistée par ordinateur”. PhD thesis. IRCAM - Univ. Paris 6, 1998) and (Karim Haddad. *Livre Premier de Motets: The Time-Block Concept in OpenMusic*. 1st ed. Vol. II. The OM composer’s book. Edition Delatour, 2008)



Figure 16: Reading of row 3 starting from matrix A of Table 3.

After removing the voices that are entirely filled with rests, we can now transform our resulting “temporal reservoir” by ordering it following a *Temporal Block* type category<sup>16</sup>:

<sup>16</sup>A *Temporal Block* is a geometrical grouping of a “field” of durations following three types of distributions: symmetrical, asymmetrical and the combination of both fields as described by Pierre Boulez in *Penser la musique aujourd’hui* (Pierre Boulez, “*Penser la musique aujourd’hui*”, p. 59-60)

The image shows a musical score for six staves. The top staff is a bass line in 3/4 time with a tempo marking of quarter note = 60. It features a long note with a dynamic of *ff* and a slur over it. The second staff is a treble line in 3/4 time with a dynamic of *pp*. The third staff is a bass line in 3/4 time with dynamics *mf* and *ff*, and a slur over it. The fourth staff is a bass line in 3/4 time with a dynamic of *mf* and a slur over it. The fifth staff is a bass line in 3/4 time with dynamics *ff* and *mf*, and a slur over it. The sixth staff is a treble line in 3/4 time with dynamics *ff* and *p*, and a slur over it. There are various musical notations such as accents, slurs, and dynamic markings throughout the score.

Figure 17: Distribution of *Temporal Units* of Figure 16 following a configuration of an asymmetrical *Temporal Block*.

For *Temporal Blocks* of asymmetrical type we use *circular concatenation* of *Temporal Units* (of type rest) appended to the beginning of each voice of Figure 16. These *Temporal Units* are the following:

$$\left[ \left( -\frac{4}{5} \right), \left( -\frac{3}{5} \right), \left( -\frac{2}{5} \right), \left( -\frac{3}{7} \right), \left( -\frac{4}{7} \right), \left( -\frac{2}{7} \right) \right]$$

So far we have “interpreted” the *TU* array through the *A* matrix in a “synchronous” way. It is also possible with the same interpretation of matrix *A* to array *TU* ( $A \rightarrow TU$ ) to map this reading horizontally by omitting empty cells. Here is a simultaneous and diachronic “reading” of rows 2 and 3 of matrix *A* mapped on *TU*:

Figure 18: Horizontal reading of row 3 starting from matrix *A* of Table 3.

### 3.3 Composition – decomposition – re-composition

It goes without saying that vertical and horizontal (synchronous and diachronic) mapping can be alternated with multiple choice of cells “read” or omitted (filtered) following a free and/or deliberate choice based on a given criteria. We can construct a free indexation like in this example where we have selected coordinates directly on the *TU* array in the form of (*row column*)<sup>17</sup>

((2 2) (2 3) (2 4) (2 5) (2 6) (2 7) (2 8) (2 9))  
 ((4 3) (4 4) (4 5) (4 6) (4 7) (4 8))  
 ((5 4) (5 5) (5 6) (5 7))  
 ((7 5) (7 6))

Figure 19: Ordering of cells following a free selection of coordinates starting from Table 3.

<sup>17</sup>Indexes starting at 0

After redistributing the voices of **Figure 19** from the longest to the shortest duration, we will “reorganize” them following a central symmetrical axis of a *Temporal Block* form of type *a* (cf. ):

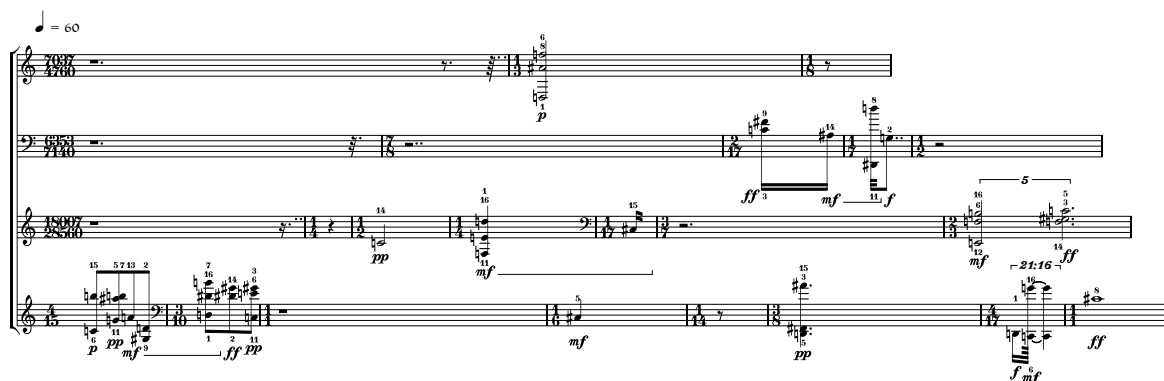


Figure 20: Rearrangement of complex in **Figure 19** into a symmetrical *Temporal Block*.

Once our complex is set in this *Temporal Block*, we can apply “global” envelopes:

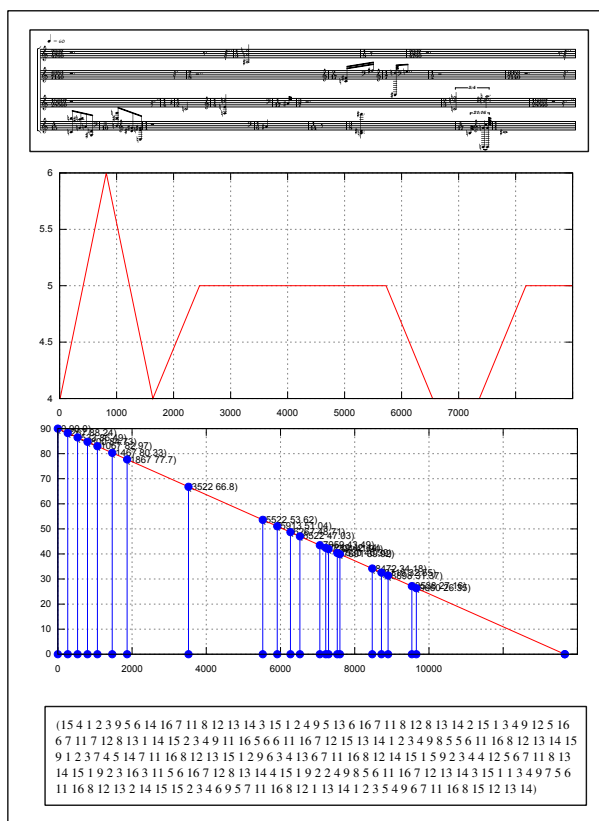


Figure 21: Global envelopes applied on the whole polyphonic structure.

Doing so, we have *redefined* the dynamic, register and timber envelopes:

Figure 22: Redefinition of envelopes (register, dynamics and instrumentation) on the whole polyphonic structure of Figure 17.

Applying envelopes on a whole *block* will result in a rigid gesture that could seem mostly obvious, particularly on the pitch registration level. However, this could be a very practical and profitable procedure to apply, in order to obtain a global dynamic gesture, which in this case, is a linear *decrecendo*.

The ordering of each cell inside a sequence of different or identical *Temporal Blocks* following a specific sequence will result in a coherently structured formal data. The numerous possibilities generated by this corpus of material based on these procedures offer us great freedom to reflect on the musical form. It is obvious that we will not use simple editing such as “cut and paste” of chosen *Temporal Blocks* sequences, but on the contrary, a formal and logical ordering based on a serial combinatorial process for choosing or rejecting elements based on a chosen *temporal density*. On freedom of choice and more specifically that of the composer, Pierre Boulez says:

Let us consider [...] the composition as a chain of rejection in the midst of large probabilities; We need to make choices, therein lies the difficulty so well avoided by the expressed desire for “objectivity”. It is precisely the choice that constitutes the work, renewing at every instant the composition: the act of composing will never be comparable to the act of juxtaposing elements found in a statistical density. Let us save this inalienable freedom : The joy of an irrational dimension<sup>18</sup>.

Once we have established consistency through all these *relational network*, some issues raised by our combinatorial processes directly related to the instrumental domain remain to be addressed, the agnostic process leading sometimes to inconsistencies and impossibilities and “absurd results<sup>19</sup>” regarding several domains:

- Registration (instrumental range) can beget non valid ranges for certain instruments, which could also happen with dynamics, leading to incompatibilities with respect to the pitch range.
- Conflictual dynamic combinations like for instance *fortissimo* against *pianississimo*.
- Vertical pitch combinations leading to octaves or tonal connotations.

<sup>18</sup> Pierre Boulez. “... Auprès et au loin”. In: *Cahiers de la Compagnie Madeleine Renaud-Jean-Louis Barrault* 2 (1954), pp. 7-27, p. 27.

<sup>19</sup> “The composer wrote under the dictation of a combinatory power, doesn’t intervene, or at most, to ensure that the transcription is faithful, to avoid that the “machine” run astray and renders absurd results.” (Pierre Boulez and Jean Jacques Nattiez, *Falons:(pour une décennie): dix ans d’enseignement au Collège de France (1978-1988)*, p. 369)

Depending on the case, two strategies can be used: locally correcting point by point contentious or unwanted issues, or radically changing the envelopes we use on the totality of the *Temporal Block* as we have done in the example of [Figure 21](#) in order to “re-transform” dynamically, either the pitch range or the timbral distribution of the whole block. This means having a supplementary structure on the hierarchical level of the system of envelopes.

## 4 On technology

Dealing with different instances, such as functions, envelopes, or any other musical contextual domains, should not lead to a hazardous *collage* or “wild” editing, but on the contrary should proceed from a deductive well-thought combinatorial process that implies mainly the coherence and intelligibility of the work, leading to an expressive and singular unique style. In general, the choice of the material preceding the transformation and deduction of elements with regard to its totality is crucial to the cohesion and logical understanding of the work.

In order to put all these elements into a viable workflow, Computer Assisted Composition seems to us the most efficient environment, and most particularly the OpenMusic CommonLisp based visual programming language.

### 4.1 OpenMusic, the language

Considering a tool dedicated for composition, where most of musical objects, computational strategies and temporal procedures are to be manipulated, assumes we are dealing with a specific “language” that should be mastered before any prior musical orientation. It assumes having at hand a functional grammar, and a symbolic representation of all musical components, such as rhythm, pitch, dynamics, form. This environment should therefore be seen as a tool for building starting from a language and dedicated to a language, musical composition.

Due to their particular audience, the music programming languages share the necessity to deal and balance between efficiency, expressive power on the one hand, and user accessibility and creativity issues on the other hand. Functional programming languages, and particularly Lisp dialects, were often used for these purposes. The interpreted characteristic of Lisp allows an interactive use and an incremental development of compositional processes, and its relatively simple syntax, its expressivity and general capacity for the manipulation of symbolic structures allow to perform advanced operations on symbolic musical material<sup>20</sup>

### 4.2 Etüde N°6 «...où ton âme en le somme gît cachée,...»

Focusing on one score in progress, *Etüde N°6 «...où ton âme en le somme gît cachée,...»* for string quartet and orchestra, we shall stress on relatively concise examples, the *modus operandi*. This piece is based on a string *continuo* and distributed fragments orchestrated using temporal blocs time organized under a *cantus firmus*. We will describe how all these articulates and are achieved using OpenMusic programming language.

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<sup>20</sup>Jean Bresson, Carlos Agon, and Gérard Assayag. “Visual Lisp/CLOS Programming in OpenMusic”. In: *Higher-Order and Symbolic Computation* 22.1 (2009), pp. 81-111. DOI: [10.1007/s10990-009-9044-x](https://doi.org/10.1007/s10990-009-9044-x). URL: <https://hal.archives-ouvertes.fr/hal-00683472>.

#### 4.2.1 The string quartet

The rhythm material of the quartet is derived from iterative circular permutations from four groups of four integers representing proportions of durations and is computed using the *loop* macro ([1] see Figure 23)

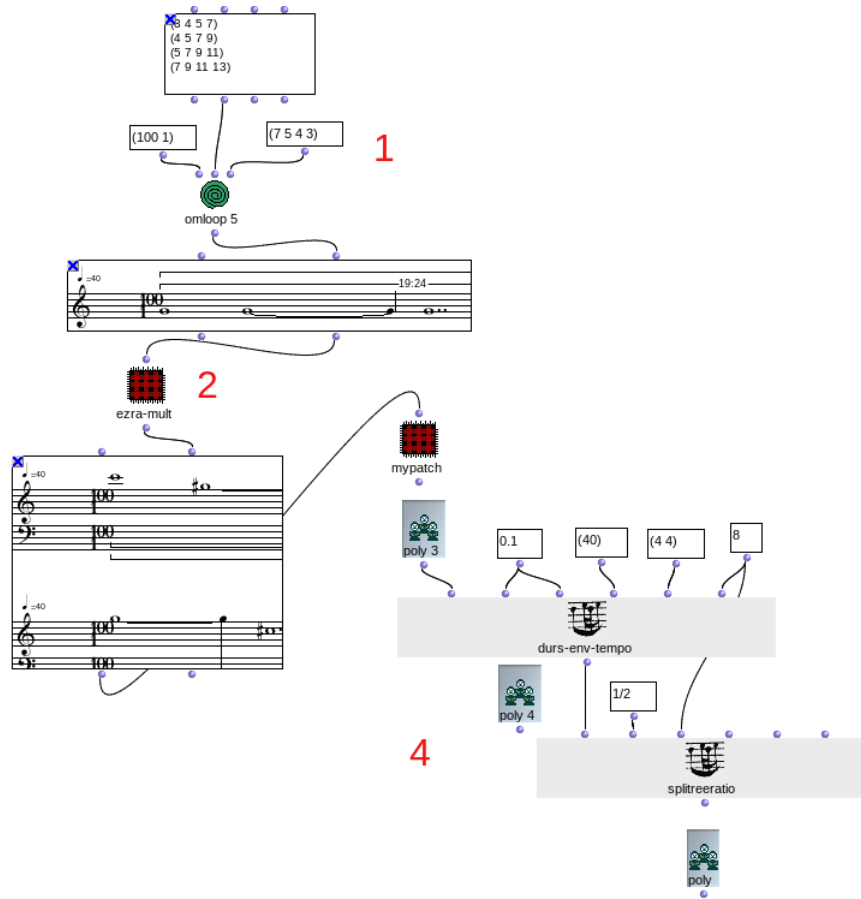


Figure 23: OpenMusic patch for rhythm and pitch generated structures for the string quartet *continuo*.

the condensed expression for the first voice (violin) is the following:

$$\left(\frac{100}{1}\right) \frac{(3\ 4\ 5\ 7)}{\left\{ \begin{array}{l} i=1, 4 \\ j \text{ in } s \\ s := (j(\sigma^i)) \parallel \end{array} \right\}} \Rightarrow \left(\frac{100}{1}\right) ((3\ (4\ 5\ 7\ 3)) \\ (4\ (5\ 7\ 3\ 4)) \\ (5\ (7\ 3\ 4\ 5)) \\ (7\ (3\ 4\ 5\ 7)))$$

The pitch is derived from duration/interval proportions ([2]) inspired by Ezra Pound's<sup>21</sup> *Antheil: And The Treatise on Harmony*. Because all proportions for each instruments are different, and these are rounded to the 1/4 tone, the resulting

<sup>21</sup>Ezra Pound. *Antheil: And The Treatise on Harmony*. Da Capo Pr, 1927.

harmony is non-tonal as we can see on [Figure 24](#)

Figure 24: Polyphonic *Temporal Units* representing the main structure of the string quartet's *continuo*.

#### 4.2.2 Temporal “orchestral” blocs

The *Temporal Units* in the orchestral part are generated starting from two *Pisano* periods<sup>22</sup>(see [Figure 26](#) [1]). In (2) of the same figure, a string of DNA is used to set the type of *Temporal Units* following this given order:

- For an *A* item, a fundamental *Temporal Unit*.
- For a *C* item, a pulsed *Temporal Unit*.
- For a *T* item, a *Temporal Unit* with a rest.
- For a *G* item, a composed *Temporal Unit* using proportions of its *Tempus*.


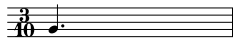




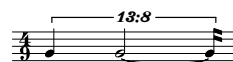
	MAT. 1	MAT. 2
A		
C		
T		
G		

Figure 25: DNA derived *Temporal Units*.

<sup>22</sup>A *Pisano* period is *Fibonacci* suite calculated with a given *modulo*.



As shown in Figure 25, there are two types of material (mat 1 and mat 2), the difference lying in their relative complexity. If we examine the *C* and *G* types of both materials, we observe a construct of *prolationis* relative to the *TU tempus*. The material 2 type *C* having a two layered pulse subdivisions according to this construct.

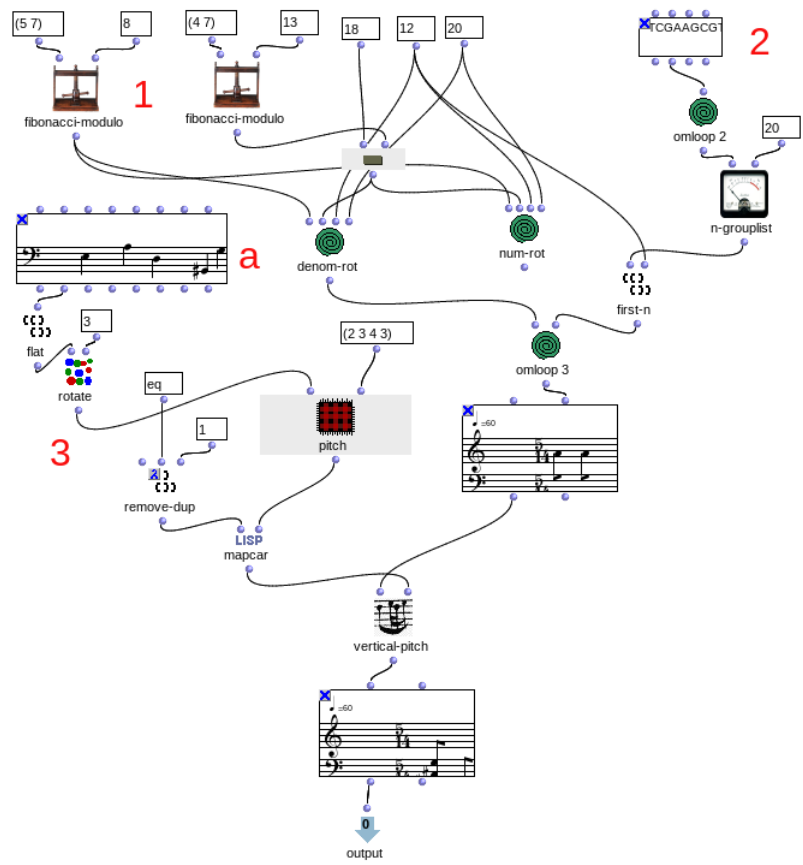


Figure 26: Patch generating *Temporal Units* starting from a DNA chain ([2]).

Once the *Temporal Units* are placed in a matrix of  $12 \times 12$  dimension ([5]), they are coupled with dynamic and registration envelopes associated with lists of instrumental timbres ([2, 3and4])(cf. Figure ??).

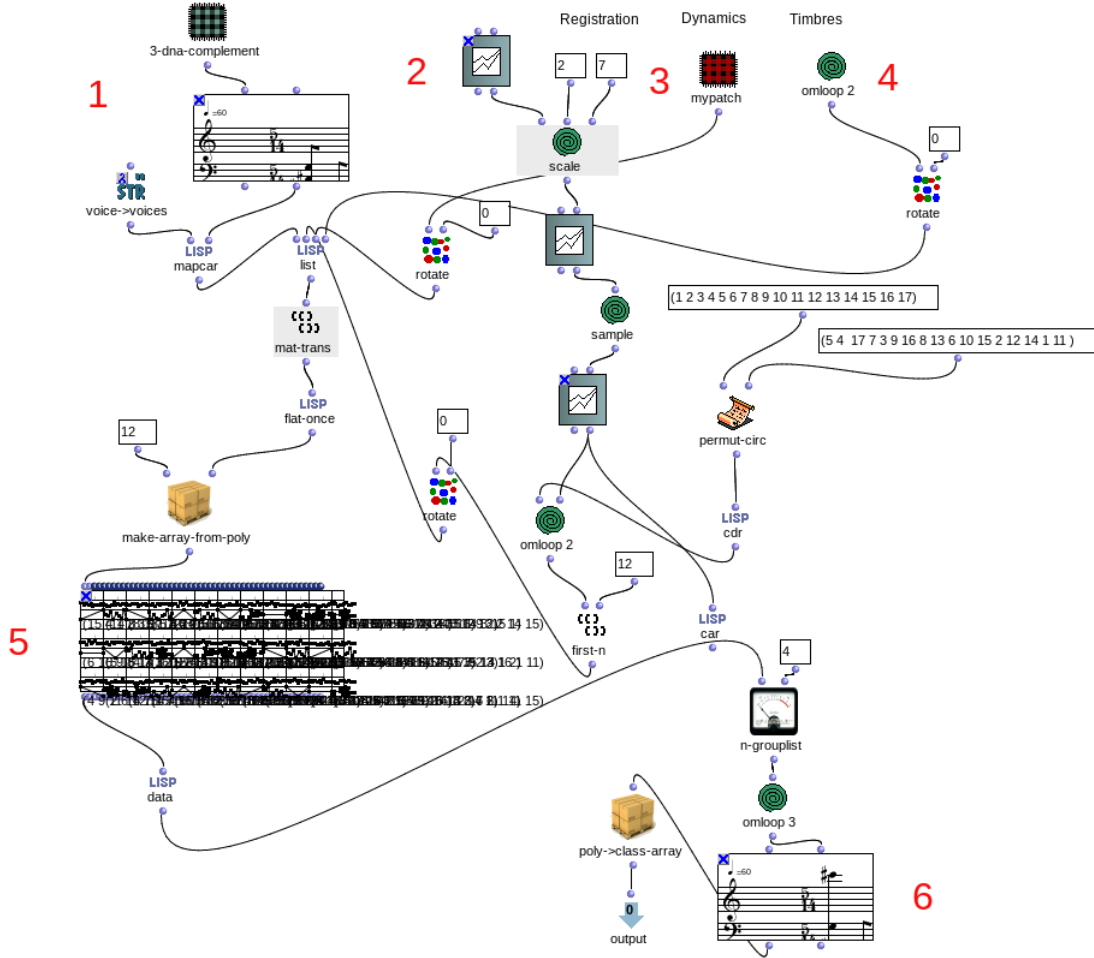


Figure 27: *Temporal Units* [1] and envelopes [2, 3 and 4] placed in a matrix [5].

The array will then be read starting from a transitional matrix such as described already in 3. Starting from here, we will derive *Temporal Blocs* (cf. Figure 16) that will be used as distributed material on top of the string quartet *continuo*.

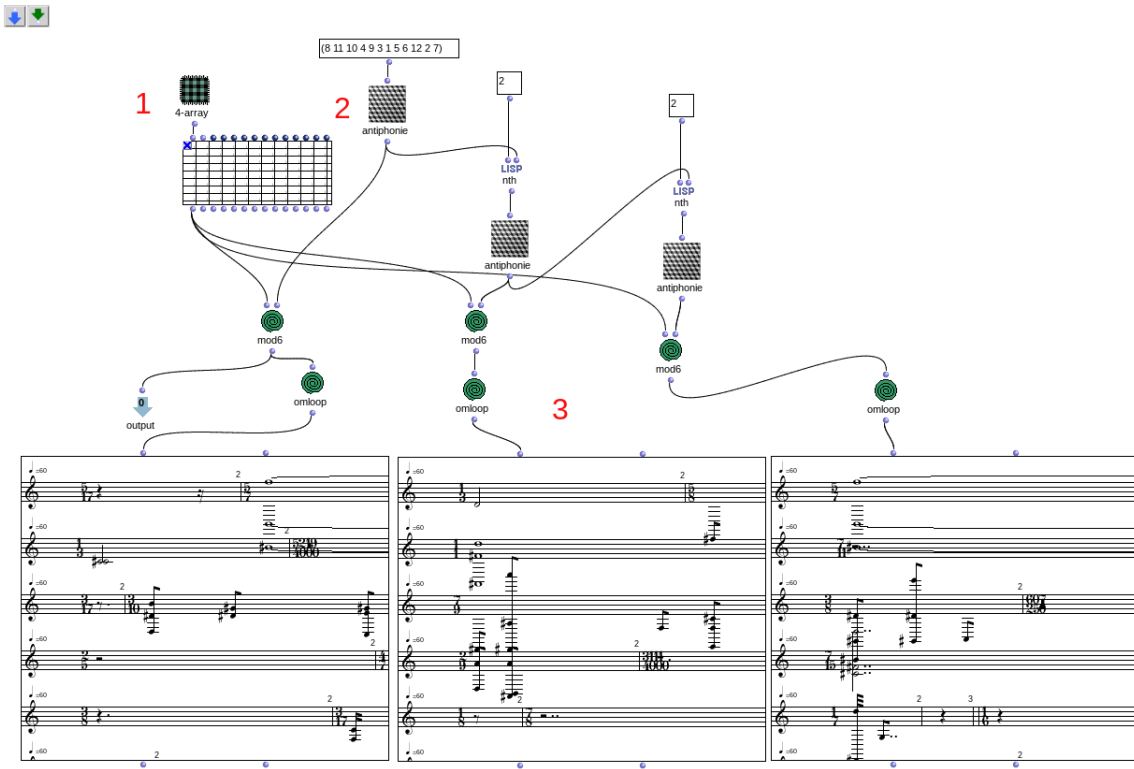


Figure 28: Derivational method used for re-ordering the *Temporal Units* in new matrices.

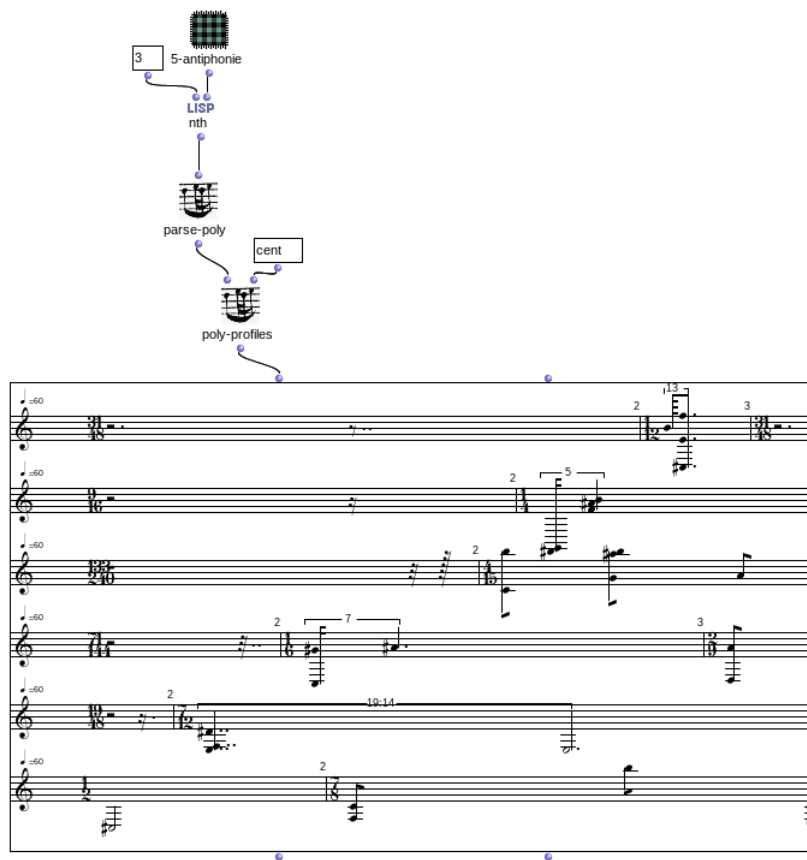


Figure 29: A *Temporal Bloc* with a centered distribution of *Temporal Units*.

#### 4.2.3 The “Form”

The Patch in [Figure 33](#) shows the organizational choice and materials part of the form. After a small introductory section (*Praeludium*) played by the orchestra section, the string quartet starts with its  $\frac{100}{1}$  *Tempus* being also the span of a *cantus firmus* (cf. [Figure 21](#)) which distributes the *Temporal Blocs* accordingly. The *cantus* is generated again by iterative circular permutation in the same manner as the quartet but with one extra iteration ([1]). It is then filtered according to chosen points of onsets [2]. *Temporal Blocs* from different derivational matrices are freely chosen starting from our two sets of types of *Temporal Units* (simple and more complex as already mentioned and shown in [Figure 25](#)). Each *Temporal Bloc* will then be organized with diverse ordering of distribution (straight, reverted, centered, axial and asymmetrical, cf. [Figure 29](#)).

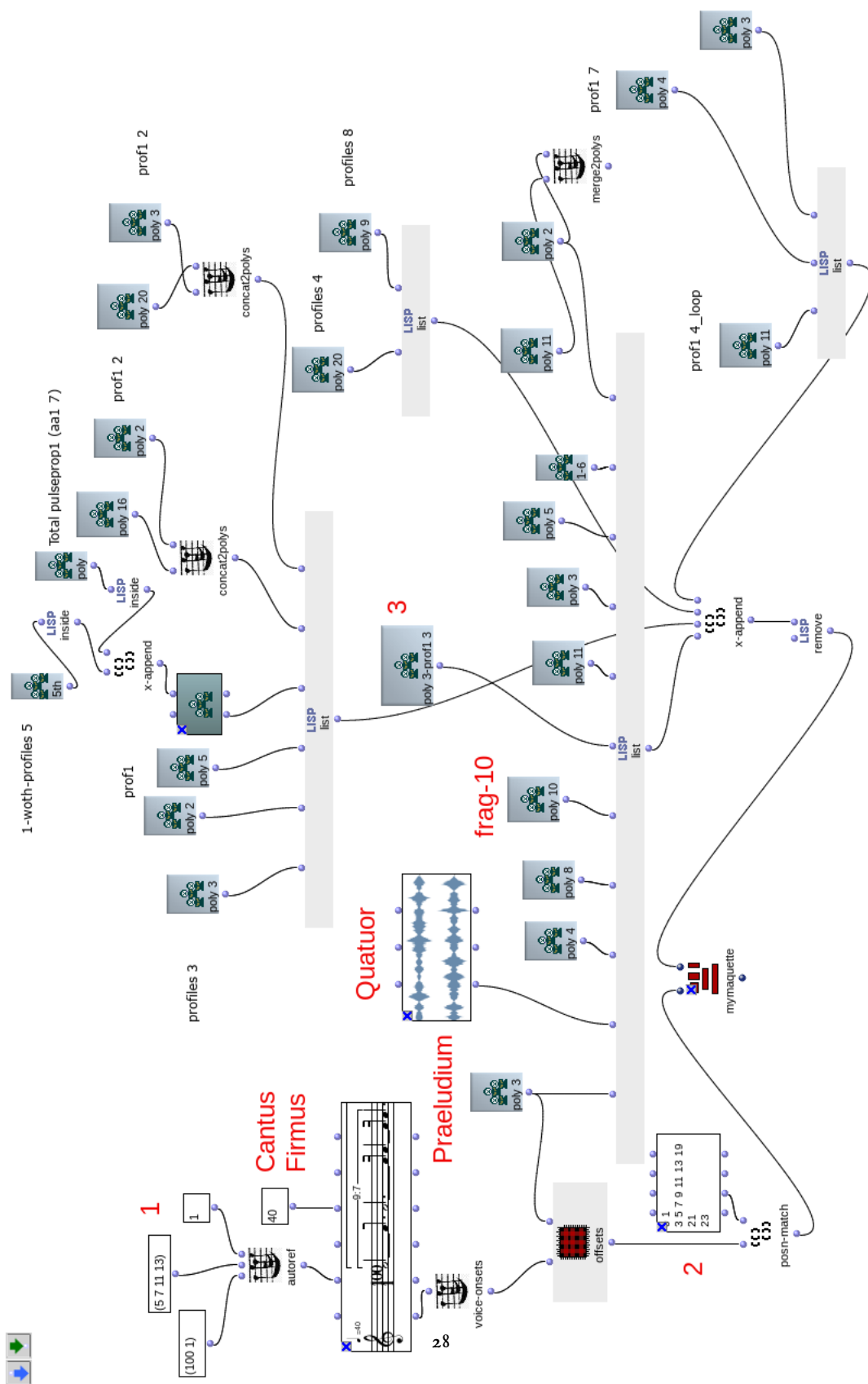


Figure 30: OM patch showing the formal structure.



Figure 31: Filtered *cantus firmus* setting the start of each *Temporal Blocs*.



Figure 32: The whole formal organization as it is displayed in OpenMusic MAQUETTE.

This musical score excerpt, labeled Figure 33, spans from page 26 to page 30. It is a sketch for Etude N°6, titled «...où ton âme en le somme gît cachée...». The score is written for piano and consists of ten staves.

The notation includes various dynamics: *p* (piano), *mf* (mezzo-forte), *f* (forte), and *pp* (piano-piano). There are also markings for *mp* (mezzo-piano) and *mpf* (mezzo-piano-forte). The score features complex rhythmic patterns, including sixteenth and thirty-second notes, as well as slurs and ties.

The page number 26 is located at the bottom left, and 30 is centered at the bottom of the page. The score concludes with a double bar line and a repeat sign.

Figure 33: Excerpt [p. 26] from the sketch of *Etude N°6* «...où ton âme en le somme gît cachée...».

## 5 Conclusion

Assuming serial and post-serial techniques as a continuation of polyphony and as a legacy from the *Ars Nova*, this approach seems to us necessary, for it leads us toward new and innovative possibilities, new combinatory practices revealing the musical inner matter itself<sup>23</sup>, rich in potentiality and “push us indeed, to reflect on the mechanisms of composition itself”<sup>24</sup>. Moreover, “in any situation in invention, it forcibly leads us to a different journey to consider events under a new approach – which results in changing our way to consider what was once forged by our education and practice”<sup>25</sup>. However, this raises the question of language as a technique and its operating mode – as a tool: notation, computation and invention, – the fundamental question being the one concerning technology itself and its relation with musical production which only can be revealed by the work itself.

Thus questioning, we bear witness to the crisis that in our sheer preoccupation with technology we do not yet experience the coming to presence of technology, that in our sheer aesthetic-mindedness we no longer guard and preserve the coming to presence of art. Yet the more questioningly we ponder the essence of technology, the more mysterious the essence of art becomes.

The closer we come to danger, the more brightly do the ways into the saving power begin to shine and the more questioning we become. For questioning is the piety of thought<sup>26</sup>.

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<sup>23</sup> “La ” technique ” n’est pas, en effet, ce poids mort que l’on doit traîner après soi si l’on veut prendre une caution de pérennité. Elle est ce miroir exaltant que l’imagination se forge, qui lui renvoie ses propres découvertes ” (Pierre Boulez, “Penser la musique aujourd’hui”, p. 167)

<sup>24</sup> Pierre Boulez and Jean Jacques Nattiez, *Falons:(pour une décennie): dix ans d’enseignement au Collège de France (1978-1988)*, p. 104.

<sup>25</sup> *Ibid.*, p. 104.

<sup>26</sup> Martin Heidegger. *The question concerning technology*. Harper & Row New York, 1977, p. 35.