GEOMETRIC NOTATIONFOR TIME-BRACKET WORKS, APPLICATIONS AND PERFORMANCE: THE CASE OF JOHN CAGE'S *MUSIC FOR___*

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ABSTRACT

The interpreter who approaches the music of John Cage composed after the middle of the 20th century is often disconcerted by a great freedom of execution, associated with a set of precise instructions. In previous work [8] we modeled these time brackets (TB) by parallelograms to build computer interfaces for interpretation assistance in the context of Cage's *Two*[5]. Over time ([9], [10], [11], [13]), we realized that the shape used to represent TB, brought important information for the interpretation and musical analysis. In this paper we apply previous research to a computer display conception of John Cage's *Music for___* (1984-87).

1. INTRODUCTION

The interpreter who approaches the music of John Cage composed after the middle of the 20th century is often disconcerted by a great freedom of execution, associated with a set of precise instructions. The result is that, each time, the musician is led to determine "a version," and to decide on a choice among the free elements proposed by the piece. A fixed score is thus created, which can be used several times. The musician interprets "his version" while thinking that it conforms to the composer's intentions. But in fact, most works of Cage composed after the 1950s should not be preconceived, prepared, "pre-generated" for several executions. Each interpretation should be unique and "undetermined." It is in this sense that the use of the computer can help the performer: a program will allow the latter to discover without being able to anticipate what and when he plays. The performance of the work thus escapes the intention of the musician to organize the musical text.

2. OVERVIEW OF EARLIER RESEARCH

In previous work [8] we modeled these time brackets (TB) by parallelograms to build computer interfaces for interpretation assistance in the context of Cage's *Two*[5]. Over time ([9], [10], [11], [13]), we realized that the shape used to represent TB, brought important information for the interpretation and musical analysis. The unusually long duration of this piece, 40 minutes, and the use of TB shows that the temporal question, and its representation, is essential in the *Number Pieces*.

The first step in the process was to model a graphic representation of each part as a succession of musical events in time. For this purpose, the temporal structure of the piece has been represented as quadruples on a timeline. $(s_l(k),\ s_u(k),\ e_l(k), e_u(k))$.

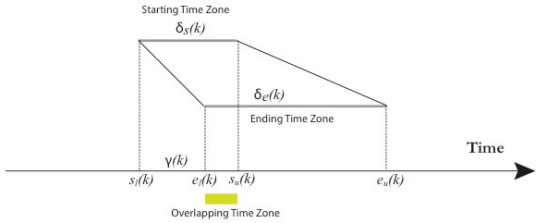

Figure 1. Graphic representation for a generic time event

To obtain a graphic representation of each event in time we consider the quadruple: $(s_l(k),\ s_u(k),\ e_l(k), e_u(k))$ where $(s_l(k),\ s_u(k))$ is the *Starting Time Zone* and $(e_l(k),\ e_u(k))$, the *Ending Time Zone*. As the two intervals have, in our case, a designed superposition, we prefer to distinguish starting and ending zones by using two parallel lines (Figure 1). In this representation we define the "overlapping time zone" the value $s_u(k) - e_l(k)$.

The graphic event obtained by connecting the four points has a quadrilateral shape. The height has no particular meaning. The *starting duration* $\delta_s(k)$ is defined as the difference $(s_u(k) - s_l(k))$, which is the time span the performer has to start the event. In the same way the *ending duration* $\delta_e(k)$ will be the time span given to end the event $(e_u(k) - e_l(k))$. In the general case, these values are not the same, and the form we get

is asymmetrical. When dealing with Cage's *Number Pieces*, one generally has: $\delta_s(k) = \delta_e(k) = \delta(k)$, both durations are the same, and the figure to represent is a trapezoid (Figure 2). We call this duration $\delta(k)$, the "Cage Duration" of the event. This is the case in the majority of the corpus we are dealing with. Special cases will be mentioned later on.

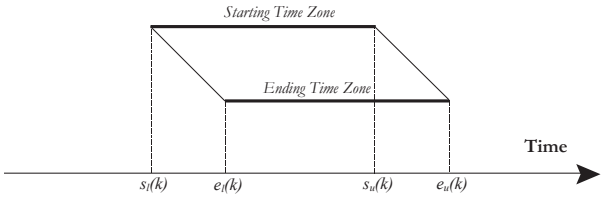

Figure 2. Graphic representation for a time event in Cage's *Number Pieces*

There is mostly an overlapping of the two time zones, $(s_l(k),\ s_u(k))$ and $(e_l(k),\ e_u(k))$ but it can happen that those are disjoined. We can define a variable $\gamma(k)$ where: $s_l(k) + \gamma(k) = e_l(k)$. In Cage's *Number Pieces,* $\gamma(k)$ depends generally on the event duration. Thus, we don't have a huge variety of forms.

An alternative way to present a quadruple will be: $(s_l\ (k),\ \delta_s(k),\ \delta_e(k),\ \gamma(k))$ where $\gamma(k)$ is the value previously discussed. This representation can easily display the regularity in the TB construction (Figure 3).

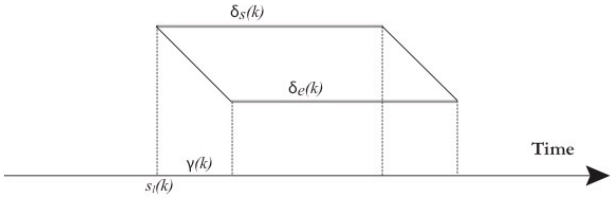

Figure 3. An event represented as $(\boldsymbol{s_l(k)}, \boldsymbol{\delta_s(k)}, \boldsymbol{\delta_e(k)}, \boldsymbol{\gamma(k)})$

Concerning the placement of two contiguous events *k* and *k*+1 we can define a variable $\varepsilon(k)$, the gap between the elements *k* and *k+1* where:
$\varepsilon(k) = s_l(k+1) - e_u(k)$ (Figure 4).

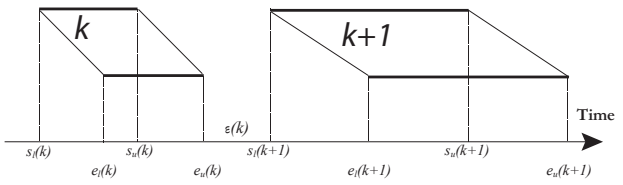

Figure 4. $\boldsymbol{\varepsilon(k)}$, The gap between the elements *k and k+1.*

The geometric presentation described here has been proved useful in the case of John Cage's *Number Pieces* [8]. A global view of the piece is available, and the time management, while performing, is improved. In these pieces, the TBs are filled with only few musical elements (in a majority of cases only one note).

3. *MUSIC FOR___* (1984–7)

3.1. Presentation

Between 1984 and 1987 John Cage composed a work (family of works) called *Music for___*. The principal of this (these) composition(s) is the same: musical events are spaced over a total duration of 30 minutes, using TB (a technic he has also used in other works, as well as in the *Number Pieces*, the works he has composed in the last period of his life).

There are 17 individual parts (flute, oboe, clarinet, trumpet, horn, trombone, 2 violins, viola, cello, 4 percussions, 2 pianos), which can be performed individually or together in any combination. The number of performers involved then completes the title. Thus, *Music for two* will be the title for any combination of two instruments from the parts (146 pieces). The principal of this construction is the same as that of *Concert for Piano and Orchestra*, an earlier work of Cage (1957–8). Versions of shorter durations can be made.

The variety of combinations that can be created, shows that we are dealing in fact with a family of works. Not only does the choice of the instruments permit a large number of realizations, but also each part individually gives the performer a lot of interpretative choices.

3.2. Brackets design and pitch material

In *Music for___* one finds two types of TB: the usual flexible ones (TB that have variable times within which the performer begins and ends playing) he calls here *Pieces*, and the fixed TB (TB that has specific start and stop times) he calls *Interludes* (Figure 5).

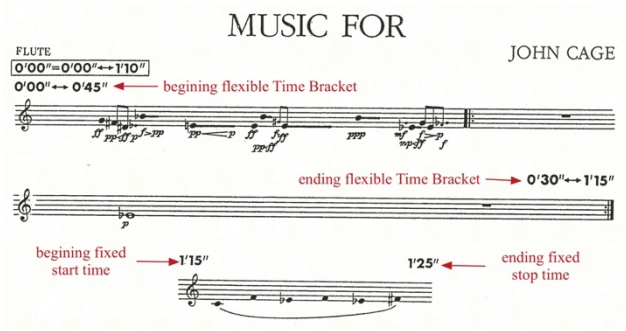

Figure 5. *Music for___*, two types of TB

Music for___ is comprised of three kinds of music. Two of which happen in the *Pieces*: repeated quiet sustained tones separated by rests, and dense spatially (proportionally) notated music characterized by a wide range of quickly shifting dynamic levels (referred later as to "A" and "B" music, respectively). The third material is the one that fills the *Interludes*, a chant-like notation free of rhythmic specificity (referred later as "C"), Figure 6.

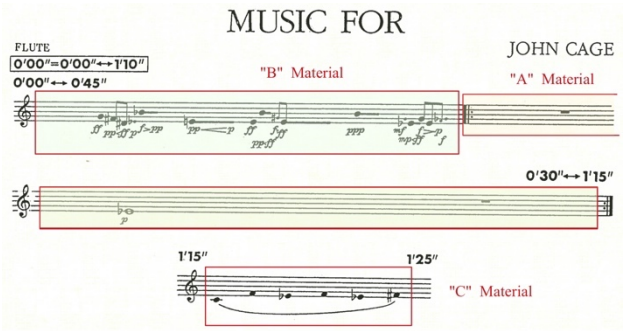

Figure 6. *Music for___*, materials used

Regardless the duration choice within TB, it is clear that a fourth category of music present must be silence (Represented as classical rest musical notation in material "A", and as proportional empty space).

The seventeen parts of *Music for__* share several characteristics. The parts use two types of TB: flexible for the *pieces*, and fixed for the *interludes*. The total number of the TB varies from part to part, as well as the type. This design is easily detected from our timeline presentation. Weisser [2] mentions the fact that in the *Number Pieces* the internal overlap (the parameter we defined as $\gamma(k)$ is closely related to it) has a proportional relationship of (1:3) to the Cage duration of an event. For example, a time bracket with duration of 60" will have a 20" of "overlapping time zone". Haskins [1] enumerates 6 types of brackets commonly occurring in Cage's *Number Pieces* lengths of it are: 15", 30", 45", 60", 75", and 90".

In the parts of *Music for__* the flexible TB falls into 4 types (Figure 7). At the time of composition Cage's sketches show hand calculations. It is only later on, with the help of the software developed by Andrew Culver [2], that the production of the *Number Pieces* became more "industrial". Observing carefully the TB used in *Music for__* shows that the durations are 30", 45", 60", and 75" (Table 1) while the "overlapping time zone" is a constant of 15". Here therefore, the inner overlap does not follow the rule of (1:3) mentioned earlier but that of (1:2), (1:3), (1:4), and (1:5).

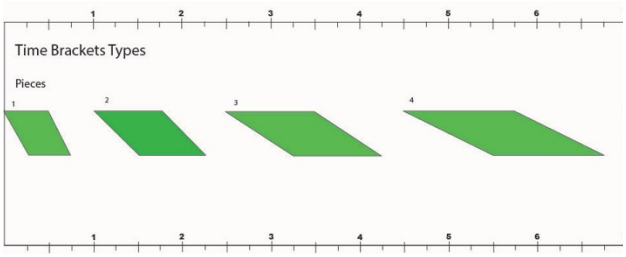

Figure 7. Geometric figures of the TB used in *Music for___*

Type	$\delta_s(k) = \delta_e(k)$	$\gamma(k)$
1	30	15
2	45	30
3	60	45
4	75	60

Table 1. Flexible TB types used in *Music for___*

The durations of the fixed TB vary between five, ten, or fifteen seconds (Figure 10). Concerning the overlap ($\varepsilon(k)$) between the events: fifteen seconds overlap occurs between successive flexible TB, but no overlap occurs between a flexible one and a fixed one.

An initial time bracket noted at the beginning of each part is in fact the time left at the end of the part, after the last event and the total duration of 30'. For example, the trombone last event (an interlude) has 29'15" as ending time. That gives a remaining 45", which will constitute the initial time bracket. This initial time bracket permits each performer to determine his own start time within this time bracket. In this way any relationship between the event's placements is dependent on this initial shift. This personal duration permits the performers to get to their placement in the hall1. The following table (Table 2) displaces the data of each of the parts.

	Initial TB	**Number of TB**	**Flexible TB**	**Fixed TB**
fl	0" <-> 70"	31	16	15
ob	0" <-> 40"	33	20	13
cl	0" <-> 20"	35	18	17
tpt	0" <-> 05"	35	19	16
hn	0" <-> 45"	26	17	9
tbn	0" <-> 45"	38	19	19
vl	0" <-> 20"	34	24	10
vl 2	0" <-> 15"	32	17	15
vla	0" <-> 30"	35	20	15
vc	0" <-> 30"	38	19	19
pn 1	0" <-> 35"	36	18	18
pn 2	0" <-> 70"	28	19	9
perc I	0" <-> 80"	32	19	13
perc II	0" <-> 05"	32	23	9
perc III	0" <-> 00"	30	18	12
perc IV	0" <-> 20"	35	23	12
voice	0" <-> 20"	38	21	17

Table 2. Data for the individual parts of *Music for___*

3.3. Time brackets graphical representation

In an analog way to our previous work, we generate (Figure 8) the timeline of each individual part with the geometric figures (parallelograms for the regular TB and straight lines for the fixed ones).

[1] …They are then to be played as though from different points in space. The players may sit anywhere within the auditorium with respect to the audience and to each other. *Music for___*, instructions for the players in all individual parts.

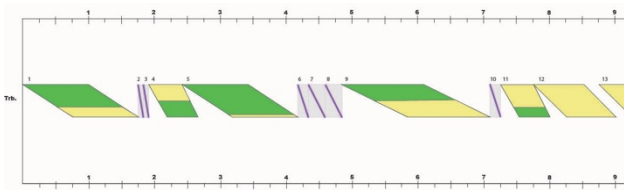

Figure 8. Timeline of the trombone part, first 8 minutes

In this case the different materials are coded by color: yellow for the "A" material (long held tones eventually repeated), green for the virtuosic one "B", and the slanted violet lines for the "C" material of the Interludes. The graphic proportions of the first two materials are respected in the sharing of the figure. Thus, before approaching the element 12 of the trombone part (Figure 4), the musician is aware of the fact that it is composed only of long tones, and the starting point can be chosen later than that of the left time bracket. On the contrary, element 5 (Cage's duration of 30") contains approximately half of virtuosic material, and choosing the starting point early situated will enable ending in a less panic way.

As with the earlier interfaces we have proposed, this timeline presentation helps time management. This aspect is more vital in this case as the events are densely filled with material (in most of the number pieces, the events contain only one note) and also the gap between the elements (the parameter we have defined as $\varepsilon(k)$) is sometimes positive, creating a lapse of time of a guaranteed silence. In the Music for___ parts, this parameter is either =0 in the case of Interludes and <0 in the case of the pieces.

3.4. Parameters deduced from representation

So, one concludes that in the *Music for*___ parts the fourth element (silence) will have smaller rate in comparison to the average *Number pieces*. For this reason, we represent a density factor for the green material ("B"). This is a positive number giving the ratio of the number of notes to be performed to the proportional time of that figure.

For example, element 5 shown here (Figure 9) will have the number 10 associated with relatively large proportion of the green material (86%). The Cage duration of this element is 60 seconds we obtain: 10: (0.86x60) = 0.19.

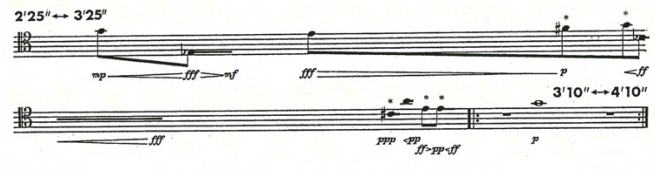

Figure 9. Event 5, in trombone part.

While the preceding element 4 (Figure 10) displays the number 29 associated with a lower proportion of green (44%). As the nominal Cage duration for this event is 30" we obtain the density factor to be 2.19.

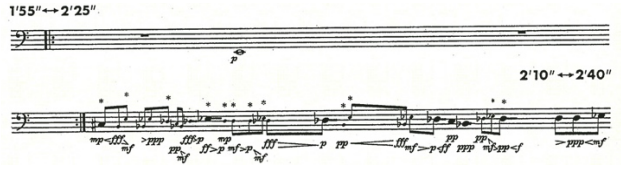

Figure 10. Event 4, in trombone part

In all the parts of *Music for*___ (except for the vocal part), the *pieces* are written on two systems. For this reason, it is hard to estimate, for the musician, the time given, and the ease to perform.

In analogue way for the *interludes*, we calculate the ratio between the number of notes to duration for the element (5, 10, or 15 seconds).

For example, for element 21 (Figure 11) we get the small value of 0.2 (there is one note for 5"). This is not the smallest one can encounter, as we get 0.06 for element 36 (one note for a 15" *interlude*), and 0 for element 37 (Figure 12).

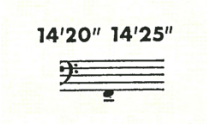

Figure 11. Event 21, in trombone part

Figure 12. Event 37, in trombone part

A higher value occurs when we have a short interlude containing many notes, as in event 3 (Figure 13). Here the density factor is 1.6.

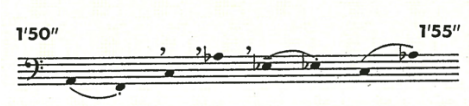

Figure 13. Event 3, in trombone part

These factors are incorporated in the data we compile for each part: a table in which the temporal data is given in seconds (Table 3). In the left part we display the TB data in an equivalent way ($(s_l(k), \delta_s(k), \delta_e(k), \gamma(k))$ and $\varepsilon(k)$, see Figure 3 and Figure 4), with both Cage's durations (which are almost exclusively equal[2]).

In the last three columns, T1 and T2 display the materials ("A", "B" and "C") that composes each event, and the last column displays the corresponding density parameter, $\rho(k)$. By its nature the material "A", one held repeated tone, does not display any density parameter useful for performance.

[2] The only exception occurs in the Percussion II part, for element 27. The starting time bracket indicates 26'15"<–>27'00" (45") while the ending time bracket is 26'45"<–>27'15" (30"). This may be a print- or calculation- mistake.

	$s_1(k)$	$\delta_s(k)$	$\delta_e(k)$	γ(k)	ε(k)	T1	T2	ρ (k)
1	0	60	60	45	0	**B**	A	0,46
2	105	0	0	5	0	**C**		0,60
3	110	0	0	5	0	**C**		1,60
4	115	30	30	15	0	A	**B**	1,58
5	145	60	60	45	-15	**B**	A	0,19
6	250	0	0	10	0	**C**		1,10
7	260	0	0	15	0	**C**		0,20
8	275	0	0	15	0	**C**		0,40
9	290	75	75	60	0	**B**	A	0,40
10	425	0	0	10	0	**C**		0,20
11	435	30	30	15	0	A	**B**	2,03
12	465	45	45	30	-15	A		–
13	525	45	45	30	-15	A		–
14	600	0	0	10	0	**C**		0,80
15	610	60	60	45	0	A		–
16	715	0	0	10	0	**C**		0,30
17	725	45	45	30	0	**B**		0,42
18	800	0	0	10	0	**C**		0,20
19	810	30	30	15	0	**B**	A	1,40
20	855	0	0	5	0	**C**		1,00
21	860	0	0	5	0	**C**		0,20
22	865	45	45	30	0	A		–
23	940	0	0	10	0	**C**		0,70
24	950	45	45	30	0	**B**		0,71
25	1010	75	75	60	-15	A	B	0,69
26	1130	45	45	30	-15	A	B	0,48
27	1205	0	0	15	0	**C**		0,20
28	1220	0	0	5	0	**C**		0,60
29	1225	60	60	45	0	**B**	A	0,02
30	1330	0	0	10	0	**C**		0,60
31	1340	60	60	45	0	**B**		0,33
32	1445	60	60	45	0	**B**		0,75
33	1535	60	60	45	-15	**B**	A	0,38
34	1640	0	0	5	0	**C**		0,80
35	1645	45	45	30	0	**B**		0,58
36	1720	0	0	15	0	**C**		0,07
37	1735	0	0	15	0	**C**		0,00
38	1750	0	0	5	0	**C**		1,20

Table 3. Numerical data for trombone part in *Music for___*

4. GEOMETRICAL FORM AND PARTS PROOFING

We have been using the graphical time line of Cage's Number pieces, to notate the part in a different space, different from the printed page. The events are prepared as score stripes (the events) and are displayed in connection with the cursor and his advancement in the timeline.

In the case of Music for___, this formal form permits the detection of anomalies. Playing the part of the original presentation, and the display of the TB as numerical data on the timeline, does not permit to grasp particularities, and especially when overlap occurs. For example, when we perform the events 25, 26, and 27 in the viola part (Figure 14. **Events 24, 25, 26, and 27 from the viola part, *Music for*___**) we simply have difficulties to use all the material. But seeing the form (Figure 15) explains the origin of this difficulty. Not only the element 26 has an "abnormal" form (Cage wouldn't have dared bother the musician, while his instructions show respect) the overlapping created makes the passage very hard to play.

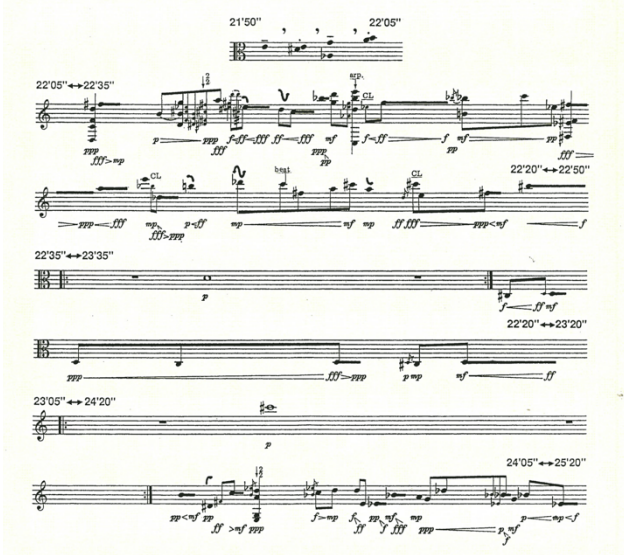

Figure 14. Events 24, 25, 26, and 27 from the viola part, *Music for___*

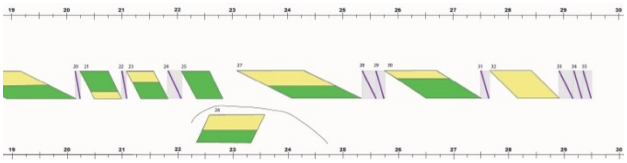

Figure 15. Timeline of the viola part, last 10'

A proper solution will be changing the duration of event 25 (whose density is quite high) and disregard the abnormal event 26.

As another example one has the violin 1 part, where different impossibilities occur (Figure 13). Event 6 overlaps with event 5, event 8 with event 7. Here a solution should be found before the performance. One could simply omit events 6, and 7 or generate more elaborate solutions.

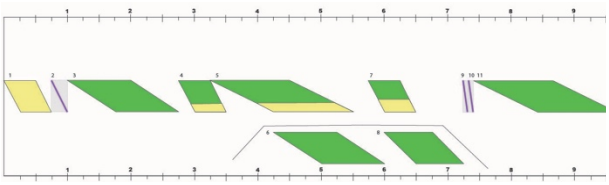

Figure 16. Timeline of the violin 1 part, the first 8 minutes

5. DISPLAYING THE DENSITY FACTOR

The density factor is rather graphically displayed. The digital information is hardly perceived during performance. The eye grasps a tendency without having to get the right number involved.

As a matter of fact, for the moment we display the density factor (only for B material) as saturation parameter for the filling color. This is a display option for the musician. There are different ways to take advantage of this knowledge and to anticipate the handling of a musical event while performing. Purely filled pieces ("A" or "B" type) generally won't create performance conflict. They could be handled by choosing an adequate starting time, taking advantage of the TB. In compound pieces, ("AB" or "BA" type) one could use the information on density in order to anticipate, manage time and resources for the performance. The parameter enhances the preparation of the part.

It is interesting to note that John Cage, consulted different performers and their knowledge when composing the parts. But he also gave the procedure for preparing the parts for performance:

Each player should prepare his part by himself and learn to play it with his own chronometer. There should be no joint rehearsal until all parts have been carefully prepared. [14, instructions for the players]

6. CONCLUSIONS

At the present time we work to offer the musicians a way to approach other pieces from the same family, constructing a generic interface. The task may be somewhat complicated. The works called Number Pieces, share the same principal described earlier, but often contain particularities and exceptions in the instructions for performance. The interface then has to be adapted to cover these.

The interface is a substitute to the printed score. It reveals the structure of the work and provides the performer with the tool to achieve the "meditative concentration" needed. The few instructions given by Cage are integrated in the interface.

Considering the graphic representation, we presented above, our main goal was to find geometric properties and strategies to enhance the performance of these pieces through computer interfaces. John Cage's works have been the target of our work for several years now. We have developed computer tools for the interface, and used it in practice. Both concerts and recordings have been the tests for the usefulness of the approach towards performance. The modeling process is transformed in a pragmatic analysis of the musical phenomena that leads us, step by step, to model some of Cage's concepts. Mentioning first the Concert for Piano and Orchestra (1957), an earlier work that has become important step of his output [7]. Followed by two of his number pieces for a small number of performers [8]. These works were also the object of a recording and performance sessions ([9], [10], [11]).

7. REFERENCES

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