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INTERPRETATION AND COMPUTER ASSISTANCE IN JOHN CAGE'S *CONCERT FOR PIANO AND ORCHESTRA* (1957-58)

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ABSTRACT

Conceptual musical works that lead to a multitude of realizations hold a particular interest. One can't talk about a performance without taking into account the rules that lead to the existence of that particular presentation. After dealing with similar works of open forms by Iannis Xenakis and Karlheinz Stockhausen, the interest in John Cage's music is evident. His works are "so free" that one can play any part of the material; even a void set is welcomed. The freedom is maximal and still there are decisions to consider in order to perform the piece.

The present article focuses on the *Concert for Piano and Orchestra* of 1957–58 [1], and it is part of the *Cagener* project, intended to develop a set of conceptual and software tools, which generates a representation of the pieces, intended to assist the performers in their task. The computer serves as a partner in making choices of multiple possibilities, mix together sounds of different sources and of various kinds and following compositional ideas clearly stated.

1. INTRODUCTION

The performer approaching John Cage's music composed after the middle of the 20th century is often surprised to encounter a large amount of freedom mixed with a set of precise instructions. As a common result, the musician will determine "a version" in which he will decide on the free elements included in the score. A fixed score is thus created and used repeatedly. The performer will play it without any doubts of the composer's intentions. In fact, most of Cage's scores composed after the fifties are not to be pre-generated. Each performance should be unique and undetermined. Using the computer helps one to perform, ignoring what and when he is going to play.

2. COMPUTER-AIDED PERFORMANCE

The musical world offered itself a multitude of tools with the evolution of computer technologies. At first, dedicated to an employment in musical composition, they were oriented and adapted to a use in musical analysis and as aid tools to interpretation.

Several practices concerned with the interpretation field were developed. One can mention:

• The use of audio and MIDI sequencers as "super metronomes". It is common today that interpreters enter complete scores in sequencers as a way to work out difficulties in the performance (concerning especially contemporary pieces). The musician can thus progressively work the problematic passages by varying the speed; he can approach comfortably various tempi changes in combination with eventual rallentandi and accelerandi.

• The use of sequencers or notation programs to practice playing in ensemble. This is a logical extension of the "Minus-one" idea.

• The use of dedicated tools capable of correcting the player's interpretation.

An increasing number of composers prepare interpreters' oriented computer programs in order to help them perform with the computer before starting with the actual musical piece.

There are other examples of computer tools created by or for interpreters, but our concern here is to show a new field developed in the last twenty years.

In our topic here, the interpretation of a category of Cage's work, in which the concepts of liberty and indetermination are predominant, it seems that the paper aspect of the scores is an obstacle in the realization. The wish that the player could navigate freely, non-determined and without restraint, through the musical material seems not helped by the fact that the music is presented on paper, and thus in a determined order. Computers may bring a solution to that particular difficulty for Cage's and also other composers' music. The actual playing prevents the musician from doing other tasks to orient his choices in "real-time". For example Iannis Xenakis in *Linaia Agon* (trio for horn, trombone and tuba, 1972) asks for a passage where the different instrumental choices are directed by a "gain matrix". The choice is computer-aided in order to enable a smooth interpretation [2].

One aspect of the tools proposed here is that they are oriented towards interpretation. In that concern, the interface should "contain" implicitly or explicitly all the instructions, constraints and concepts defined by the composer, as they will establish an "experimentation

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field". For the construction of Computer-aided performance (CAP) tools, the careful study of the pieces of John Cage and its formalization is necessary. The final interface will be, in a certain way, a computer model of the particular piece.

3. THE *CONCERT FOR PIANO AND ORCHESTRA.*

3.1. Musical Context

The *Concert for Piano and Orchestra* (1957–58) marks a decisive step towards the definition of the notion of « indeterminacy » and appears to be one of the more important works of John Cage, a milestone in his path.
For the first time, control over decisions regarding all aspects of music is given to interpreters. Each execution may well sound differently from one another, and duration may vary each time. It is no "Concerto" for piano and orchestra, but a chamber ensemble piece whose instrumentation is to be defined at each performance. There are parts for thirteen instruments (three for violin, two for violas, one for cello, one for contrabass, one for flute who doubles on a piccolo and alto flute, one for clarinet, one for bassoon doubling on the baritone saxophone, one for trumpet, one for trombone and one for tuba), solo for piano and conductor. The individual parts are all "Solos" meaning that there is no relationship or coordination between them. Any portion of it (also void) may be chosen to be played. A version of *Concert* may thus have any number of these instruments including none, which will, in that case, be a silent version as in *4'33"*.

3.2. Score Description

In *Concert for Piano and Orchestra* there is no full score. There are 2 conductor's score pages, 63 pages for piano, and 184 instrumental pages score (Table 1)

Violin 1: pages 1–16
Violin 2: pages 17–32
Violin 3: pages 33–48
Alto 1: pages 49–64
Alto 2: pages 65–80
Trumpet in Bb: pages 81–92
Violoncello: 93–108
Tuba in F and Bb: pages 109–120
Clarinet in Bb: pages 121–132
Flute, Piccolo, Alto flute: pages 133–144
Bassoon, Saxophone: pages 145–156
Double Bass: pages 157–162
Sliding Trombone: pages 173–184

Table 1: Instrumental parts

3.3. Instrumental Scores

Each instrumental part (each Solo) is composed of one page of detailed instructions to performance and of a collection of pages containing musical events, called "notes" by Cage. Figure 1 shows the third page of the trombone score.

Each instrument page is a collection of punctual musical events, (see Figure 2 and Figure 3), displayed on 12 to 16 music sheets. Each event is a compound one, having relative pitch, dynamics, playing modes, and other indications.

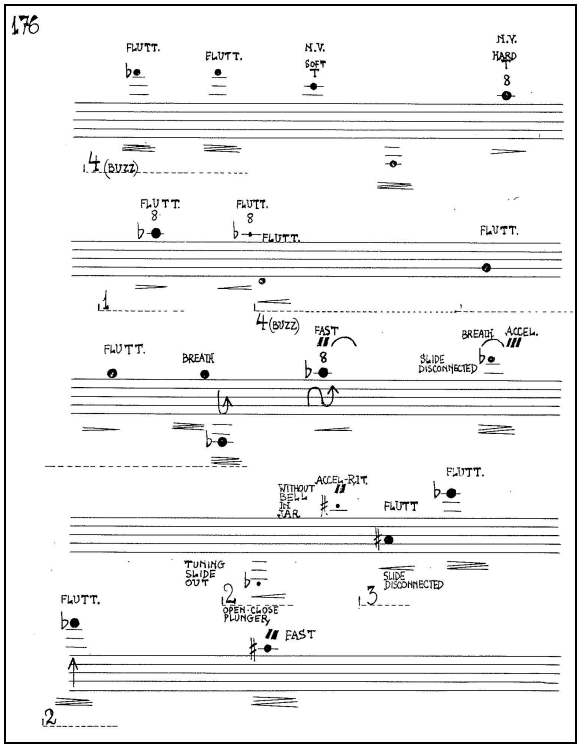

Figure 1: Page 176 of trombone score

The events are distributed variously on each sheet, from extreme density (music system with around 10 events) to empty staves (i.e. trombone score [1, p. 178]).

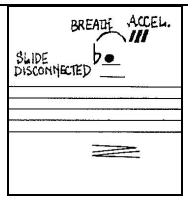

Figure 2: 5th event 3rd system of page 176, from trombone part.

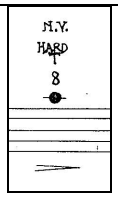

Figure 3: 5th event 1st system of page 176, from trombone part.

3.4. The Piano Score

The piano part consists of 63 pages; "each page is one system for a single pianist". The elements of a page are musical structures that were generated using different composition techniques, some varieties of same species or altogether different (Figure 4). Sometimes one structure is too long and continues on several consecutive pages, as for example, the structure "B" in page 1 [1, p.4] (Figure 4).

3.5. The Conductor's Score

Cage has also planed a conductor's score, but not in the traditional way. A conductor, providing the function of clock may participates in the performance of *Concert*. He turns his arms like a clock. The time shown by the conductor may be compressed, widened or literal physical time (His arms may not turn with the same velocity of a regular clock). Cage provides a table with what he calls "clock time" (the time shown) and the "effective time", from which the conductor prepares his conducting score.

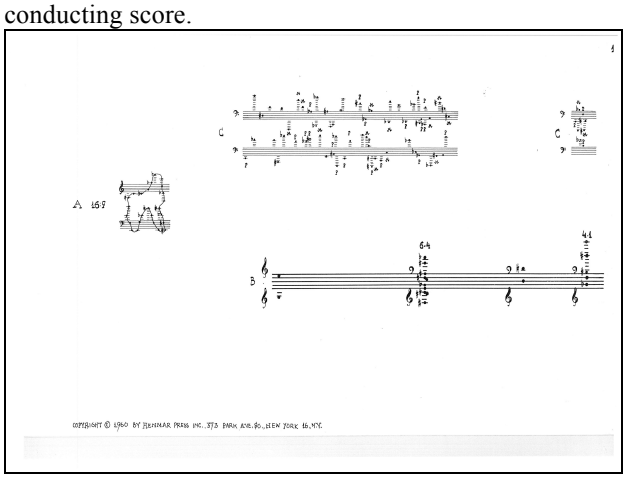

Figure 4: Page 1 from the piano part.

3.6. "Concert" model

Even if each instrument has his own "instruction page" some elements are common to all. Each player is free to play any elements of his choice, wholly or in part and in any sequence. In this manner, each presentation is unique, and Cage considers the piece as "in progress" [3].

4. PERFORMING CONTEXT

4.1. The main concepts in John Cage's early pieces

In the John Cage's *Concert* performance four concepts are highlighted: Silence, Chance, Indeterminacy and Unintentionality.

4.1.1. Silence

In connection with his encounter with Zen Buddhism [4], Cage rethinks his understanding of music. As a result, he composes *4'33"* [5], a work whose abandonment of intentional sound production drew controversy to his compositions. Cage spoke of silence in a new and positive way. Not only has it an importance in the creation of structure but one has to think of it not as an absence of sound but as a presence to fill an acoustical space.

At first, Cage developed a structural concept of silence, considering it as an absence of sound helping to structure the music by its alternation with sound. The silence between the notes gave the work its cohesion.

"Formerly, silence was the time lapse between sounds" [6, p. 73]

In the *Concert* instrumental parts instructions Cage asks:

"All notes are separated from one another in time, preceded and followed by a silence (if only a short one)."

Later, Cage adopted a spatial concept of silence, in which it was composed of all the ambient sounds that together formed a musical structure. Finally his concept evolved towards viewing silence as non-intention. Both sound and silence would exist only in the non-intention manner of nature [7]. As we will show further, this concept will appear clearly in the instructions given to the performers. It will be considered as an esthetic object as well as a concept not be forgotten in the computer solution presented.

4.1.2. Indeterminacy

The principal of indeterminacy allows the performers to work independently from each other. In this way, the musician ignoring the output of his fellow musicians will concentrate on his own part and the set of instructions, which imposes concentration even if degree of the freedom involved is high [8].

« Bringing about indeterminacy is bringing about a situation in which things would happen that are not under my control. » [9, p. 109]

Another meaning of indeterminacy is the fact that the final result is not controlled by the composer himself and the result is partially produced by a chain of performer's un-intentional choices.

4.1.3. Chance

For John Cage, "chance" is the set of random or non-determinate processes used in the composition itself. In this way he applied the concept of non-intention in the musical material choice in his own composition process.

"Variation in gongs, tom toms, etc. and particularly variation in the effects on pianos of the use of preparations, prepared me for the renunciation of intention and the use of chance operations." [11, p.91]

While *chance* is related to the compositional process, indeterminacy is related to the composer's lack of control of the performance.

"James Pritchett provides a succinct distinction between indeterminacy and chance: while chance "refers to the use of some sort of random procedure in the act of composition," indeterminacy "refers to the ability of a piece to be performed in substantially different ways."[16, p. 61]

This clearly shows the difference between these two concepts.

4.1.4. Unintentionality

We could find the genesis of the unintentionality concept in this Cage's quote:

> *"Improvisation . . . that is to say not thinking, not using chance operations, just letting the sound be, in the space, in order that a space can be differentiated from the next space which won't have that sound in it. I'm perhaps too young at this work to know how to describe it."* [10, p. 582]

The unintentionality concept is the idea that a performer produces sounds, musical events without intention, aim, purpose, reason or given meaning. As Cage tell us, it comes from his Zen Buddhism studies:

> *"…, it was rather my study of Zen Buddhism. At first, my inclination was to make music about the ideas that I had encountered in the Orient. The String Quartet [1950] is about the Indian view of the seasons, which is creation, preservation, destruction, and quiescence; also the Indian idea of the nine permanent emotions, with tranquility at the center. But then I thought, instead of talking about it, to do it; instead of discussing it, to do it. And that would be done by making the music nonintentional, and starting from an empty mind. At first I did this by means of the Magic Square."* [11, p. 94]

4.1.5. Cage and improvisation

« … I have avoided improvisation through most of my work. Improvisation seemed to me necessarily to have to do with memory and taste, likes and dislikes. » [10, 581]

The improvisation for Cage seems to be related to the unintentionallity :

> *"Improvisation . . . that is to say not thinking, not using chance operations, just letting the sound be, in the space, in order that a space can be differentiated from the next space which won't have that sound in it. I'm perhaps too young at this work to know how to describe it."* [10, 581]

4.2. Performance Problems

Analyzing the Cage instructions and his musical and aesthetical points of view, we realize that the traditional scores make the players performance difficult, especially regarding the "Unintentional" choices of different musical objects. The material and sequential aspect of paper scores is an obstacle to the realization of the Cage's main idea, that the player could go thru, freely, without constraint and without intention through the score.
As it is not always easy to jump quickly between two musical elements found on separate pages, one will tend to an interpretation privileging the grouping of objects belonging to the same page.

5. COMPUTER MODELING, MODELS DESCRIPTION

5.1. From concepts to reality

How could one help the player, as well as possible, to perform the score in a context of "indetermination" and "not-intentionality"? In what manner could one enable him to represent the Cage's musical thought?
It is the freedom relationship pre-determination that gives the player the main problem. Even if we find very hard instrumental passages, the main difficulties are: making the choice of when and what is to be played, what order to choose for the elements, the amount of silence to insert between the events, and all this while ignoring the output of the other musicians involved. It has to be kept in mind that by the absence of intention, one should also ignore what he himself is about to perform. This means, that the entire score should be at the player's disposal, and that he will make up his mind intuitively and spontaneously. One possible solution was to provide an adapted interface. Here the choice is not only of timing but concerns the material itself.

5.2. The three interfaces

Three kinds of interface, ways displaying music, were proposed.

5.2.1. Interface A

Here (Figure 5, Figure 6), the pages are displayed as Cage conceived them originally. The interpreter may turn pages sequentially or skip randomly between them. The music to his disposal may contain the entire score or a subset of it. The choice of what to play is made during performance. The interpreter may play or not these musical events, and it is up to him to manage the time allocated to each page or sequence of elements.

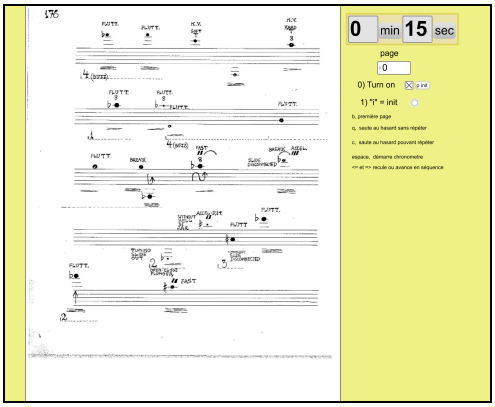

Figure 5: Interface A (trombone score)

The main advantage is the fact that the performer can navigate easily through the score. The graphic disposition of the various events in the paper score space may influence the performer. Does there exist a

cognitive weight related to their position in the original page, which would influence the choices? Do there exist "hot" and "cold " zones "in the graphic space of the partition? Some questions remain.

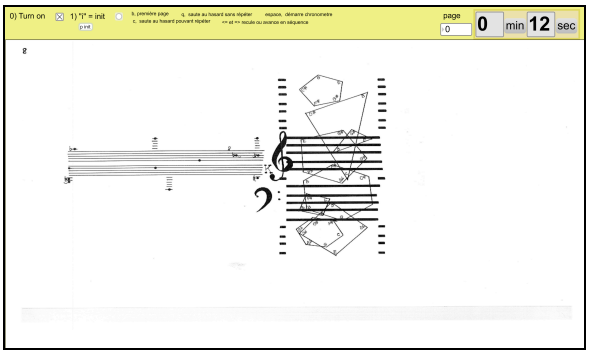

Figure 6: Interface A (piano score)

5.2.2. Interface B

Here (Figure 7), one event at a the time is displayed. The interface proposes two modes. In the first one, the event appears "at time" it is to be played. The performer is in a position of concentration, waiting for the event display, without knowing which one will appear. The event remains displayed during a short time (which can be parameterize). In the second mode, the player is notified of the next following event. He ignores though when this one will appear. In this way it helps him to be prepared (instrument change, remove or insert a mute, tune or detune the instrument, etc).
This interface leaves little control to the player. However, it has the advantage to embody the "Indetermination" and the "Unintentionality" asked by Cage, and to free the interpreter from the "physical" limits of paper score.

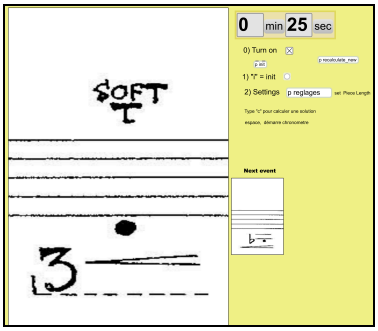

Figure 7: Interface B

5.2.3. Interface C

Here (Figure 8), we look for displaying the events in time. With this interface, it is possible to build scores generated algorithmically, the "elements" of the score being reorganized according to various calculation modes. Calculation procedures are based either on the "instructions" given by Cage to the performers or on other methods enabling to reorganize and give "directions" to the musical material.

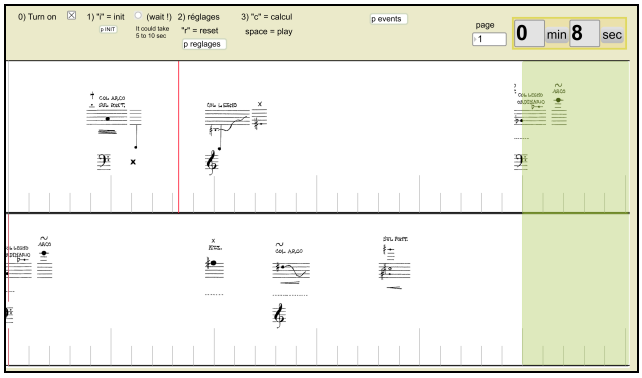

Figure 8: Interface C (violoncello score)

The setting window (Figure 9) allows changing the time displayed by page and some parameters for the score generation like the total length of the piece. Cage indicates: "given a total performance time-length, the player may make any program (including additional silences or not) that will fill it".

In addition to the idea of freeing the player from the physical constraints of the paper score, and of taking in account the "Indetermination" and "Unintentionality", this interface also makes it possible for the player to prepare himself more efficiently for the various changes of instrument configuration and the various playing modes. Besides this, it enables the interpreter to use his own will at the moment of the execution, by choosing to play or not the proposals presented.

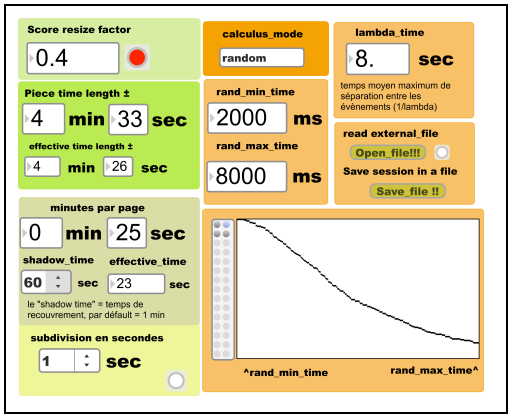

Figure 9: Setting window for the interface control

5.3. The conductor's interface

The conductor's interface is perhaps the easiest interface to build. Actually it consists of a clock interface (Figure 10). The data coming from this interface will be sent to the player's computers to drive their chronometers.

5.4. Score Calculus

To construct a computer version, two main dimensions were calculated: the punctual events order and an events distribution in time.

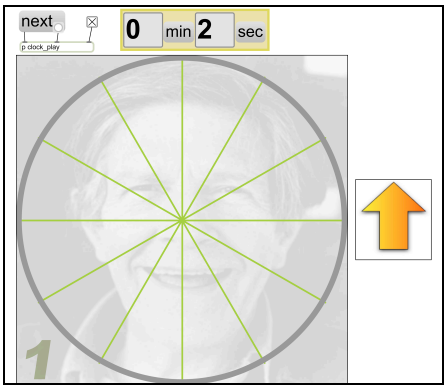

Figure 10: Conductor's interface

5.4.1. *Cournot model of chance*

The first mean of calculus was based on a "unintentional choice" modeling, based on a "Cournot concept of chance"[1], as an aid to the performer to avoid intentional or conscious choices. From this point of view a sequence will be a combination, a juxtaposition (a coincidence) of two independent and deterministic values sequences. In our specific case, it means that a computer calculated version would consist of a sequence of events and a sequence of time positions. Each one of these sequences will be calculated independently.

For the events organization we used a "uniform random choice" with or without event repetition allowed, and for the time structure three methods:

1) A "uniform random choice" of time intervals between the events (Times between events distributed uniformly in the interval {*Rand_min_time*, *rand_max_time*})

2) An "exponential random choice" of time intervals between the events (Times between events distributed according to exponential distribution of parameter "λ")

3) A "random choice" of time intervals between the events (According to a probability distribution function built by the user with boundaries {*Rand_min_time*, *rand_max_time*})

To determine the temporal positions of each cell we based our calculations on time "between" the cells rather that directly on the positions in time. This decision enabled us to model more efficiently and to take in account one of the main instructions of Cage concerning the need for "silences" between the events (4.1.1).

5.4.1.1 The "time" models

As a time model, we explored three ways. The first one was a single uniform stochastic distribution scaled between a minimum and a maximum time interval {*Rand_min_time*, *rand_max_time*}.

The second one, inherited from Iannis Xenakis's experiments at the end of the 1950s [13, p. 26, 169, 171, 243-246], where a time model based on the exponential distribution to calculate the probability of a musical event having a given time length.

$$f(x) = \begin{cases} \lambda e^{-\lambda x} & ; \ x \geq 0 \\ 0 & ; \ x < 0 \end{cases} \qquad (1)$$

Where:

λ: is the average density of events by length unity.

To implement this we did a javascript *Max/MSP* object using the expression:

$$\delta(\lambda) = \frac{\ln(\sigma).-1}{\lambda} \qquad (2)$$

with σ being the result of a uniform random variable between 0 and 1.

The third way was using self-made distributions using the <itable> *Max/MSP* object (Figure 11), where different curve shapes are investigated.

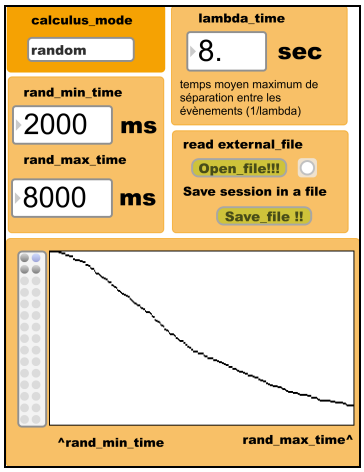

Figure 11: interface for building our own probability distribution

5.4.2. *Deviations and Variations*

It was clear to us that modeling the *Concert*, is a pragmatic way to study and to try to understand the Cage's musical mind. It is why we propose to analyze score calculus ways that are the complete opposite of the first one. Instead of generating an unpredictable score, we try to determine one, using (if possible) all the implicit information given by Cage. Our main purpose is to try to answer the question "how far could we get away from Cage's instructions without breaking the original model". How "intentionality" could change the score? How it could change the Aesthetic.

As for the first way of calculus, two main dimensions were calculated: the punctual events order and an events distribution in time.

[1] « Les évènements amenés par la combinaison ou la rencontre de phénomènes qui appartiennent à des séries indépendantes, dans l'ordre de la causalité, sont ce qu'on nomme des évènements fortuits ou des résultats du hasard ». [12, p. 73 ¶40]

5.4.2.1 Ordering events according with a description vector space

The instrumental parts of *Concert* give more elements to model. Looking closely at each event we have attached it to a set of characteristics. For example in the trombone part (also known as *Solo for Sliding trombone*) we identified:

1. Placement (position in the score staff)
2. Nature of event (played normally, tuning slide out, mouthpiece in bell, spit valve open, without bell, without bell in jar, with slide disconnected, conch, mouthpiece with mute, and conch with mute)
3. Pitch, represented as a MIDI pitch.
4. Head Size of notes (small, medium, or large)
5. Dynamic profile (nothing, crescendo, diminuendo, both)
6. Articulation (nothing, breath, soft Tongue, hard Tongue)
7. Vibrato (with or without)
8. Formant (coloration of the sound when sustained: nothing, fluttertongue, double and triple tongue, trills etc.)
9. Formant speed (rit., accel., rit.-accel., accel.-rit., fast, slow)
10. Mute (without, straight, plunger, cup, buzz, hat, plunger open close)
11. Arrows & curves (smaller microtonal slides, no arrow, curve down, curve up, arrow down, arrow up, etc.)

From this information we built a "descriptor vector space" where each component vector had the follow structure:

$$V_{BD_i} = \left(s_i, p_{BD_i0}, p_{BD_i1}, p_{BD_i2}, \ldots, p_{BD_i10}\right) \quad (3)$$

where

s_i is a symbol identifying a particular event

$p_{BD_i\ j}$ is the value of the "*jth*" descriptor for the "*ith*" vector.

At the same time we built (in the *OpenMusic* composition assisted computer environment) a sequence of "target vectors" in the form $V_c[t]$, with t representing time, where each vector has the follow structure:

$$V_c[t] = \left(s[t], p_0[t], p_1[t], p_2[t], \ldots, p_{10}[t]\right) \quad (4)$$

with each parameter descriptor having a dynamic evolution in the time.

For each discrete time value $[t]$ we calculate the vector

$$V[t] = \min\left\{dist\left(V_c[t], V_{BD_i}, \omega[t]\right)\right\} \quad (5)$$

where

$$\omega[t] = \left(\omega_0[t], \omega_1[t], \omega_2[t], \ldots, \omega_{10}[t]\right) \quad (6)$$

it is a weight vector. As distance functions we used weighted Euclidian and Chebythchev distances.

$$dist_{euclid}(p,q,\omega) = \sqrt{\sum_{i=0}^{10} (p_i - q_i)^2 * \omega_i} \quad (7)$$

$$dist_{euclid}(p,q,\omega) = \max_i \left(|p_i - q_i| * \omega_i\right) \quad (8)$$

Obtaining, in this way, a sequence $V = \{V[0], V[1], V[2], \ldots, V[n]\}$ of $V[t]$ vectors (equation 4). From this sequence a symbol sequence $S = \{s_0, s_1, s_1, \ldots, s_n\}$ is obtained. Each s_k being the first dimension of the correspondent $V[t]$ vector (equation 5).

Chebythchev distance showed results where the vector derived from equation 5 contains almost one parameter p_i that corresponds to one of the parameters of target vector (equation 4). This will lead us to sequences that map better with the target vectors evolution. With Euclidian distance, as the minimum distance returned is a sort of mean distance from the target vector, without any need to contain explicitly a p_i parameter, the vectors obtained, could be very far (from a musical point of view), from what is asked in the target vectors evolution.

5.4.2.2 Time evolution

As for the first way of calculus we used basically the exponential distribution (see equation 1) but with a lambda parameter as a time function, $\lambda = \lambda[t]$.

5.4.2.3 Exporting data

These calculi were made in the *OpenMusic* environment and exported to be read in our Max computer interface.

In that way, one can generate punctual event organizations according to one or more constraints on the different characteristics. One may give it as input curves or functions that describe temporal evolution characteristics, or as textual constraints represented as logical expressions. This part of the work represent a lot of interest, as the player is unable to deal with such tasks during a performance. The computer output can still be regarded as a proposition of a "version" from which the performer still has his choice. This logical part of the project is actually implemented in *OpenMusic* environment, but it will be ported very soon in the *Max/MSP* environment.

6. PERFORMANCES

Two performances where given. "Triton" (Les Lilas, France, May 2th 2009), with Fabian Fiorini (piano), Guillaume Orti (alto sax), Benny Sluchin (trombone),

Eric-Maria Couturier (violoncello) and Mikhail Malt (computer and video improvisation).
“Hateiva » (Jaffa, Israël, October 29th 2009) Amit Dolberg (piano), Yonatan Hadas (clarinet), Benny Sluchin (trombone) and Eric-Maria Couturier (violoncello).

7. CONCLUSIONS AND PERSPECTIVES

The construction of computer models of musical pieces is not a neutral process. It is fundamental to know well the works under study, understand the constraints left by the composer, as well as the historical context of its creation. But these are still insufficient in the modeling process. Every musical work has a part of liberty and ambiguity. These “holes” must to be filled up to enable the modeling process. One has to take decisions as a function of a work assumption, founded on musical and musicological bases. The necessity to represent the score or the processes suggested by the composer on numerical, symbolic or graphic spaces has great importance. Changing the representation of an object permits one to see, to consider, to observe and finally to understand it in a different manner. The modeling process is transformed in a pragmatic analysis of the musical phenomena [14] leads us step by step to a model of Cage’s thinking
Concerning the player, in pieces as different as *Solos* from the *Concert for Piano and Orchestra*, the player can concentrate on performing when using the CAP interface. After determination of the duration, he does not have to prepare his personal version, and will ignore completely what music he is going to perform. The player may be involved in determining the setting of the performance: relative density of the audio elements (length of silences), orienting the choice of the elements, using characterization of the material given (i.e. pitch, timbre, dynamics etc.) on a local or a global criteria. One might wonder: when all decisions regarding the order of the events of the scores and the timing etc. are made by a computer, what remains to be done by the performer/interpreter? Firstly, these calculations need to be defined by several parameters, which are personal choices. The result of the computing process is highly dependent of the interface choice and organization, therefore is part of the interpretation. Secondly, the performer can react and decide if and when an event is played, regardless of the fact that it is scheduled and displayed by the software. In this way, the computing result is a proposition that could be modified by the performer, which is in conformity with Cage’s original instructions.

We are looking forward to provide a "Full" version of “Computer Assisted *Concert*“, including a Computer “conductor” and 14 computers for players. Performers’ interface with 3 different displaying modes, metadata on some sequencing events impossibilities, and expanding score generation models according to time constraints evolution of various “descriptors”.

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