GEOMETRIC-BASED EXTENSIONS TO TIME BRACKET NOTATION, JOHN CAGE AND BEYOND…

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ABSTRACT

In the last period of his life, John Cage used time brackets in order to define musical event placement on a timeline. In previous work we modeled these time brackets by parallelograms to build computer interfaces for interpretation assistance in the context of Cage's *Two*[5] and *Five*[3]. Over time, we understood that the shape, used to represent time brackets, conveyed important information for the interpretation and musical analysis. The main purpose of this paper is to generalize this time bracket parallelogram representation as a tool for musicological analysis, performance enhancement and compositional notation.

1. INTRODUCTION

In his works, John Cage used time brackets in order to define musical event placement on a timeline. The large variety of works he composed in the last decade of his life is surprising. This technique permitted him to pursue his usual indeterminate compositional model while giving the performer ways to exhibit his or her skills in real time situations. John Cage used only a few types of time brackets, and almost exclusively symmetrical ones. He also filled them with very little musical material (generally only one note). In Cage's *Number Pieces* each individual part contains musical events with time brackets. Generally, an event consists of a score endowed with two pairs of numbers: time brackets (**Figure 1**).

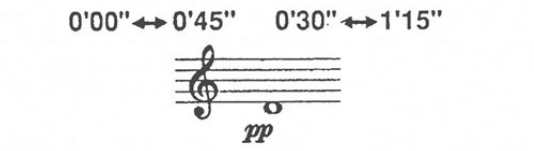

Figure 1. John Cage's *Two*, flute, first event.

This gives the interpreter lower and upper-time bounds to begin and end each event. The composition has a defined total duration and the events are placed on a timeline with a degree of freedom, depending on the performer. Although there are only individual parts, a score for the group is implicitly present and leads to a form.

2. EARLIER RESEARCH

In previous work [7] we modeled these time brackets by parallelograms to build computer interfaces for interpretation assistance in the context of Cage's *Two*[5] and *Five*[3]. Over time [3], [4], [5], [6], [8][2], we realized that the shape used to represent time brackets, brought important information for the performance and musical analysis. As for example, managing time in an efficient way to perform the given musical material within the time constraints defined by the time brackets. We permitted the choice to shift or position some materials in order to create musical relations with other performers, even if we are aware that this was not Cage's intent.

The unusually long duration of these pieces, 40 minutes, and the use of time brackets show 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. $\left(s_l(k),\ s_u(k),\ e_l(k), e_u(k)\right)$.

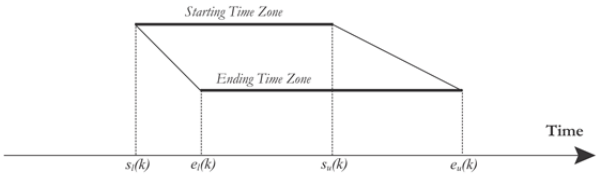

Figure 2. Graphic representation for a generic time event

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 $\left(s_l(k),\ s_u(k)\right)$ is the *Starting Time Zone* and $\left(e_l(k),\ e_u(k)\right)$ 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 2**)

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 $\left(s_u(k) - s_l(k)\right)$, which is the time span within which 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 $\left(e_u(k) - e_l(k)\right)$. In general, these values are not the same, and the form we get is asymmetrical. When dealing with Cage's *Number Pieces*, one generally has: $\delta_s(k) = \delta_e(k)$, both durations are the same, and the figure to represent an event is a trapezoid (**Figure 3**). This is the case in the majority of the corpus we are treating. Special cases will be mentioned later on.

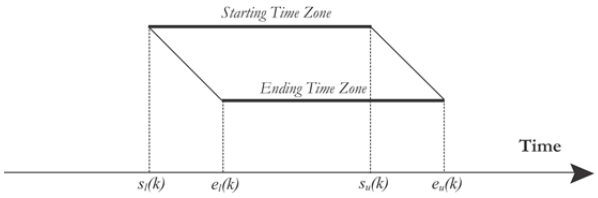

Figure 3. Graphic representation for a time event in Cage's *Number Pieces*

There is mostly an overlapping of the two time zones, $\left(s_l(k),\, s_u(k)\right)$ and $\left(e_l(k),\, e_u(k)\right)$ but it can happen that those are disjoined. We have defined a variable $\gamma(k)$ where: $s_l(k) + \gamma(k) = e_l(k)$ [8]. In Cage's *Number Pieces,* $\gamma(k)$ depends generally on the event duration. Thus, we don't have a big variety of forms in this case.

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 time brackets construction (**Figure 4**).

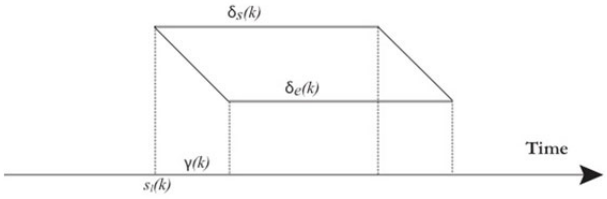

Figure 4. An event represented as $(\boldsymbol{s_l(k)},\ \boldsymbol{\delta_s(k)},\ \boldsymbol{\delta_e(k)},\ \boldsymbol{\gamma(k)})$

We make a distinction between a *generic musical event* and a *real* (or determined) *musical event*. A real musical event is the one whose starting point (s) and end point (e) are defined, that is, where there is a concretization of choice. One could represent this by a straight line from $s(k)$ to $e(k)$ (**Figure 5**).

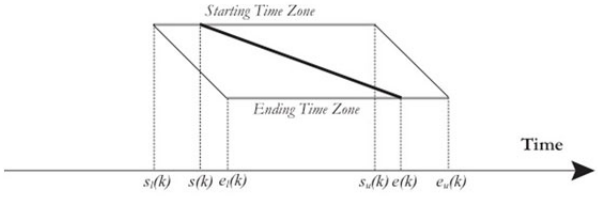

Figure 5. A real music event represented by a straight line, joining the *starting to ending time zones*

3. MUSICAL SCORE, AN APPLICATION

A musical score is a timeline representation of a musical composition. Each source of sound gets a "track," on which the particular elements are represented. In its classic form, a stave (usually a five-line musical staff) is used for the "track," but any graphical representation can serve for that. The tempo indications and the measures help in the horizontal organization, but also time indications can be used to specify the relationship between the instrumental tracks. A vertical scale on each track represents by means of specific conventions the precise pitch.

The musical score is necessary in order to understand, analyze and perform a musical work. While each performer generally uses an individual part for the actual performance, the full score gives all of the relationships between the elements of the composing tracks. (**Figure 6**)

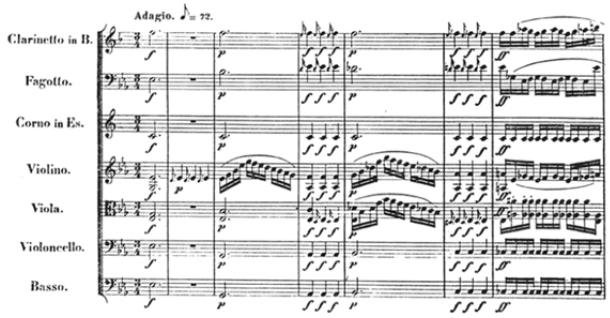

Figure 6. Beethoven septet op. 20, opening measures.

John Cage deliberately omitted a score on many occasions, as for example *Concert for Piano and Orchestra* (1957-1958) and *Atlas Eclipticalis* (1961-1962). Not only were the parts composed separately and independently to include parameters fixed by the performer in real time, but his objective was for a performance to be a unique event that the public as well as the performers discover together. For the sake of studying the composition, a score representation is needed, even if the precise relationship of the tracks must take into consideration the flexible parameters the composer incorporated into his work. For this reason, we have developed a score-like presentation to cover John Cage's Number Pieces and related works. (**Figure 7**)

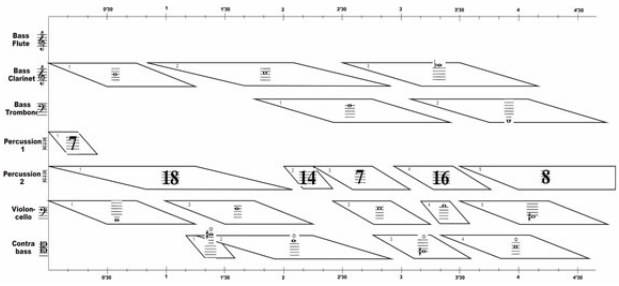

Figure 7. Cage, *Seven²*, first 4 minutes.

This "score" presentation permits us to determine pitch relationships and event particularities (as the first two events in contrabass part) [1].

4. EXTENDING THE NOTION OF TIME BRACKETS

The idea to generalize comes naturally when one is first presented with the geometrical figures presented earlier. The composer will have in his or her disposition a larger variety of forms, which could enhance the graphical approach to the composition. A large variety of tasks for the performer will thus be available. The filling of the figures could also be approached in different ways. See example in the end of this text (Fig.17).

4.1. Positioning the starting and ending time zones

In Cage's works, the two time zones are symmetrical, the values are equal, and the overlap is positive, as for example **Figure 3**.

From here on we consider the asymmetrical case. The first generalization consists of shifting these zones on the timeline. By the definition of $\gamma(k)$, its value is smaller than $\delta_s(k)$ in Cage's works. This fact creates the above-mentioned overlapping (which is in fact $\delta_s(k)$ - $\gamma(k)$) as in **Figure 8**.

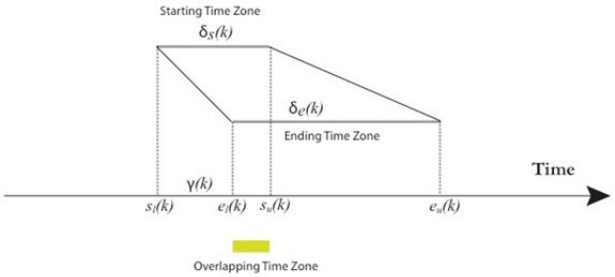

Figure 8. A generic non-symmetric music event

Another case is "no overlapping", when $(\delta_s(k)$ - $\gamma(k)) \leq 0$ (**Figure 9**). An event of this kind must occur, as there is no way the ending point will be earlier than the starting point. $\gamma(k)>\delta_s(k)$.

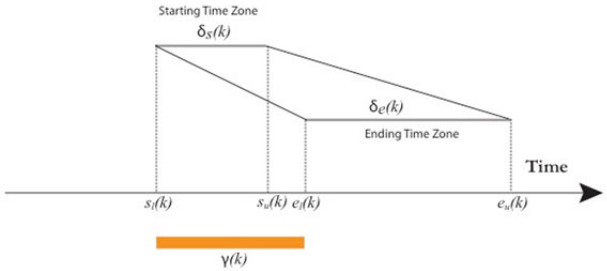

Figure 9. A music event with disjoint *starting and ending time zones*. No overlapping.

A last case implies $\gamma(k) < 0$.

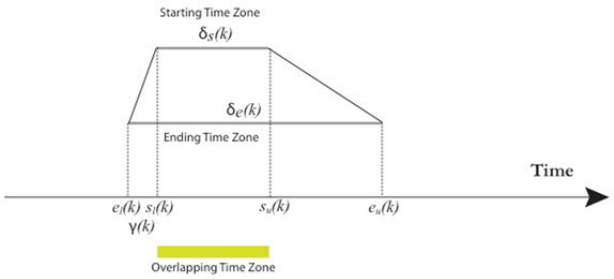

Figure 10. A music event represented as a trapeze form. $\boldsymbol{\gamma(k)}$<0.

All of these considerations are geometrically oriented, the figures being considered abstractly. The practical implications will follow later. For example, in the last case (**Figure 10**), the trapezoid's far-left, right-angled triangle is superfluous unless the event won't occur.

4.2. Combining fixed and flexible time brackets

The *Music for___* corpus presents two types of time brackets: the usual flexible ones (called pieces), and the fixed ones (called interludes). See **Figure 11**.

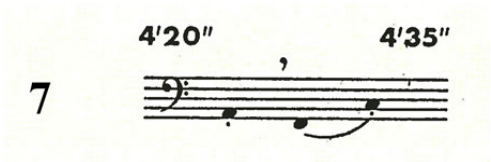

Figure 11. Interlude from *Music for__*, trombone part.

In what follows we consider generalizations consisting of a combination of the two-time brackets' types, leading to a triangle rather than a parallelogram.

The musical consequences are multiple. If we start from a graphical conception of a musical work, we have a lot of geometrical figures to use. If we start from the musical material we want to align on the timeline of the composition, we can be more precise and obtain a planned organization, which will depend on the performers' skill. This will be illustrated later (**Erreur ! Source du renvoi introuvable.**).

4.2.1. Fixed start

In this case, we have: $s_l(k) = s_u(k)$. Thus $\big(s_l(k), s_u(k)\big)$, the *Starting Time Zone*, is one fixed point on the timeline. The *Ending Time Zone* is a positive time interval, and the geometric figure to represent could be one of the following **Figure 12**.

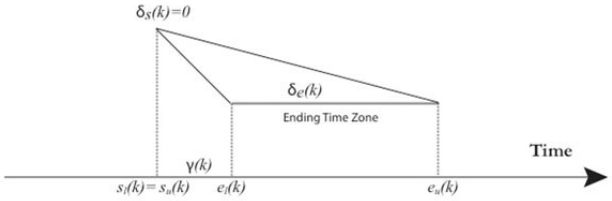

Figure 12. A music event represented as a triangle form. A fixed start.

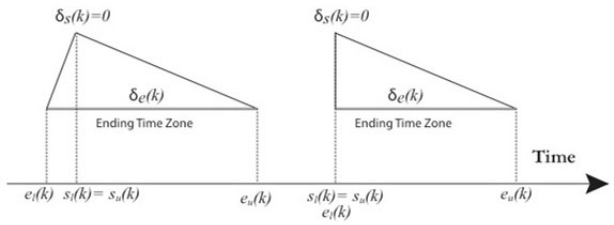

Figure 13. Particular cases. A fixed start.

Naturally, the actual arrival time can't be smaller than the starting time (at least if we want the musical event to exist). In these cases, the minimum event duration will be equal to $\gamma(k)$, for $\gamma(k) > 0$.

4.2.2. Fixed ending

In this case we have: $e_l(k) = e_u(k)$. Thus $\left(e_l(k), e_u(k)\right)$, the *Ending Time Zone*, is one fixed point on the timeline. The *Starting Time Zone* is a real-time interval, and the geometric figure to represent could be one of the following **Figure 14**.

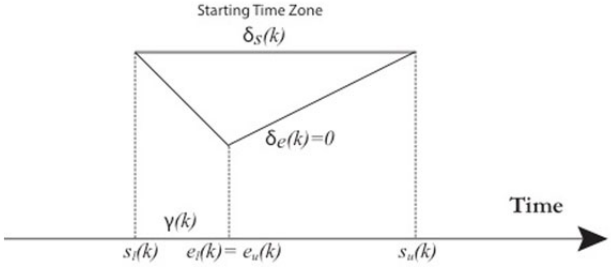

Figure 14. A music event represented as a triangle form. A fixed ending.

In this case, the starting point can't be chosen later than the ending point. The event simply will not occur.

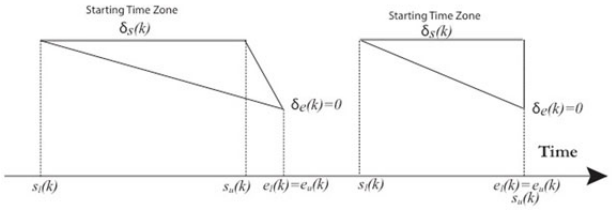

Figure 15. Particular cases. A fixed ending.

From a practical point of view, when $s_u(k) > e_u(k)$, either the event won't occur or the effective figure will be a right-angled rectangle, with $s_u(k) = e_u(k)$ (**Figure 14**).

This case is tricky to perform. When a musical event is a held tone, the fixed ending could be easily executed. But when an event is composed of diverse musical material, the planning of a fixed arrival is not a simple task.

The following images illustrate this point (**Figure 16**).

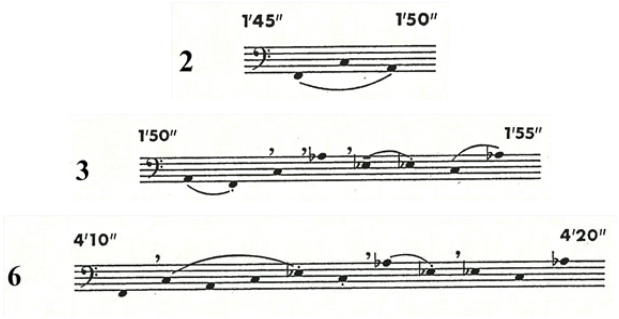

Figure 16. *Interludes* from *Music for__* trombone part.

In this case, the duration of an event is 5, 10, or, 15 seconds. It is easier for the eye to grasp a graphical indication of the duration than to read time indications, and be aware what the real duration is. This is done in real time, once the playing of the figure has been started. In event 3, the musician has 5 seconds for 8 notes, which indicates a high speed. On the other hand, event 7 (see **Figure 11**) has three tones for 15 seconds, which also require time to phrase.

5. CONCLUSIONS

We use here a graphical representation of Time Brackets notation, in order to generate a score of John Cage's Number Pieces, works conceived individually, having only separate parts. This is done aiming at performing, studying, and analyzing the works in consideration.

John Cage's use of just a few types of Time Brackets, leads to the idea of generalizing the figures, creating a large variety of geometrical figures, thus creating musical tasks for the performers that extend the time management indicated by Cage. At the same time, the compositional techniques involved are not limited. One could use various graphical figures and different filling methods (**Erreur ! Source du renvoi introuvable.**).

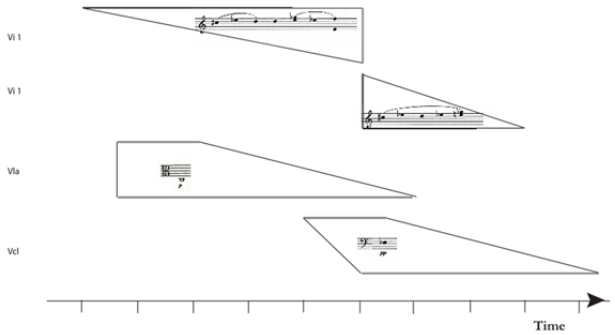

Figure 17. Example of a theoretical string quartet.

This last example is a compositional exercise using geometric figures to extend those of John Cage. However, the material to fill the figures is taken from different John Cage's pieces. The two violins represent musical material passing from one to another in a precise way dependent on the performer. The low strings form a background whose start and end times are not strictly defined.

This example was conceived in the traditional way: starting from a score (for string quartet) and then extracting individual parts using time brackets.

6. REFERENCES

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[2] Malt, M., Sluchin, B. « Geometric Notation for Time-Bracket works, application and performance The case of John Cage's *Music for___* », Proceedings of International Conference on Technologies for Music, Notation & Representation (TENOR 2020), Hochschule für Musik und Theater, Hamburg, 2020, p. 114-119.

[3] Rappaport, S., Sluchin, B. « Liner notes » *Two*[5] [CD], Ut Performance, Paris, 2013.

[4] Rappaport, S., Sluchin, B. « Liner notes » *Music for Two* [CD], Ut Performance, Paris, 2014.

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[8] Sluchin, B., Malt, M. « John Cage's Number Pieces, a geometric interpretation of "time brackets" notation », 14th International Symposium on Computer Music Multidisciplinary Research (CMMR 2019), Marseille, 2019, p. 25–37.

Texte édité par Tom Mays