

Use of Pseudo Functions in Digital Creation

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Abstract

Temporal semiotics is iconic of movements. It was found in music but seems to be applied in all kind of media. The paper briefly reminds its nature and displays a mathematical model of the signifier of the temporal semiotic units. This model uses classes of equivalence of functions. These classes are named “temporal functions”, they can be qualified of pseudo functions. The paper gives the characteristics of these pseudo functions from the point of view of a non mathematician. They can be used for creation, both in music and the visual. The paper introduces some experiments made in a digital poem, which implements some of them.

Temporal Semiotics

Since 1984, the Laboratoire Musique et Informatique de Marseille (MIM) puts together composers and other creators that are interested in temporal semiotics. The initial researches of the laboratory have permitted to detect a set of 19 temporal semiotic units (UST) in music [1]. A UST is a fragment of sound that feels like a specific movement independently of any other consideration. The name of a UST is often a linguistic term of movement. For instance: *Chute(Fall)*, *Élan (Run Up)*, *Qui tourne (That is Turning)*... (examples of USTs can be heard on <http://www.labo-mim.org/site/index.php?2008/08/22/44-liste-des-19-ust>, accessed on 04/06/2010). The MIM found these Units in all kind of occidental music, from the Middle Ages to electronic music.

Since 2004, other laboratories joined the MIM to study the USTs in a pluridisciplinary project gathering creators (composers, a painter, an author of digital poetry), cognitive psychologists, neurophysiologists, a musicologist and a specialist in hypermedia. Xavier Hautbois and I made within this project a mathematical model based on pseudo functions in order to describe these USTs [2]. Unlike previous descriptions made by the MIM, this model, called model of *Parameterized Temporal Motifs* (MTP), do not directly refers to music, neither in its vocabulary, nor in its grammar. It is a model of the signifier of USTs, whereas composers in the MIM focused on the morphological description of the UST.. Our point of view is not the same because the signifier stays inside morphology but does not cover it entirely. For example, it is obvious that the morphology of a written text greatly differs from a person to another (graphology is even based on the study of these differences) but the linguistic signifier, words and sentences, is the same in every manual occurrence of this text. Same here, the sound morphology of a UST refers to its musicality rather than to its temporal signifier, even if the fundamental characteristics of this signifier are inscribed into it.

The MTP model can easily be implemented in computer algorithms. Based on that, Xavier Hautbois created programs with open music to transform whatever music in whatever UST, on the understanding that music has not a too specific temporal semiotics before the transformation. An experience of

categorization mixed these generated sounds with musical fragments of the same UST. Subjects in this experience had to put together elements that they thought having the same temporal behavior. This experience showed that elements of the same UST were put together 4 to 10 times more often than other groupings together, whether they were generated or not. This result both validates the existence of USTs and the fact that the MTP model is sufficient to describe their signifier [3].

The Model of Parameterized Temporal Motifs

A Parameterized Temporal Motif (MTP) is defined by a set of *temporal functions* acting on 2 abstract variables, called F and I. In the sound, F is relative to the main frequency perceived and I to the main sound volume or brilliance. These functions have a fuzzy behavior and are defined by only some properties:

- Their characteristic duration. The duration of a temporal function is not well defined. It is included inside a range of values that is called characteristic duration. 3 characteristic durations are observed. They are written T1, T2 and T3. T1 lasts typically some hundreds of milliseconds, T2 lasts some seconds and T3 is longer than about ten seconds. The function can, or not, be periodic or pseudo-periodic. In this case, the characteristic duration is the duration of the periodic or pseudo-periodic element.

- Their general form, called *profilem*. The exact value of the function at a given time does not play any role in the signifier of the UST. Only the general form of this function is important. 13 *profilems* were defined and grouped in 6 families: constant shape, linear shape, curved shape, bell-shaped curve and 2 specific families (pulse, Dirac comb and ordinate sequence). The Dirac comb acts as an operator of periodization by convolution with another *profilem*. A *profilem* of the constant shape family can be mainly approximately constant of the characteristic duration, or strictly constant, that happens in a silent or a held note. The linear and curved shapes are monotone, increasing or decreasing. It is also an average perceived evolution and not the real instantaneous temporal evolution of the sound. Curved shapes add a sensation of acceleration that does not appear in linear shapes. *Profilems* of the bell-shaped family are increasing then decreasing on their characteristic duration. The exact form of the functions has no importance. That is why we choose the generic bell-shaped form to represent the *profilème* in the bell-shaped curve family. The pulse represents a pulsation. It can always appear on sound volume and not on frequency. The ordered sequence represents any function, differing from the previous, typically a sequence of notes that constitutes a musical gesture.

A MTP can be represented by a conventional graph due to its semi quantitative characteristics. As example, figure 1 shows the conventional graph of 2 USTs. The indication “principal” means that this variable is solely responsible for the UST. The other must be only neutral (generally a constant) in order not to perturb the UST. A vertical dotted line ends the graph of a motif. Another dotted line is drawn after the *profilème* and before the symbol of the end, if the motif is periodic or pseudo periodic. This dotted line conventionally represents the period. The range T1 or T2 of the period is indicated upon it. The indication Me is written above the *profilem*. If the temporal function is pseudo-periodic, the indication # is also added above the *profilem*. When the temporal function is monotone, and if it can be indiscriminately increasing or decreasing in the UST, the draw of the *profilem* contains an arrow at each end. All MTP are detailed in [2].

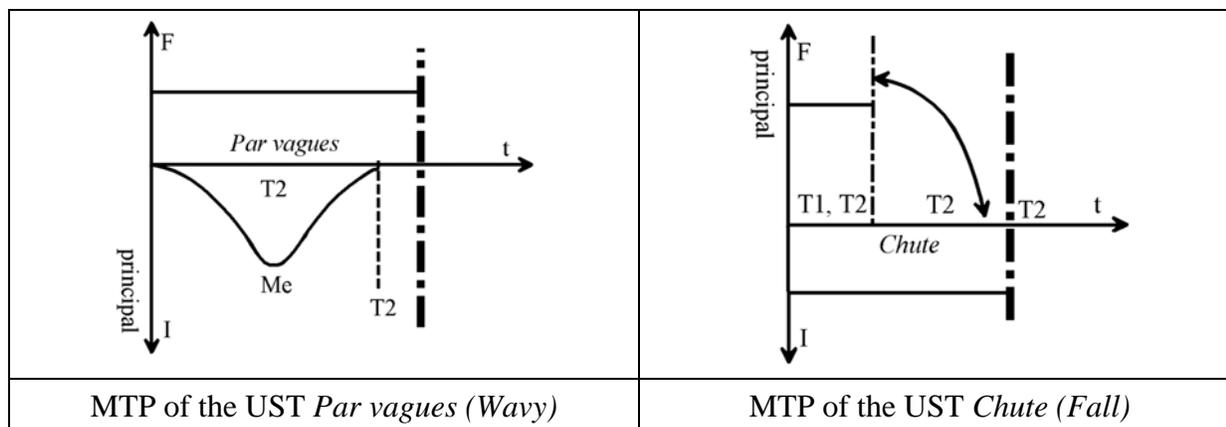


Figure 1 : *exemples of MTP*

The MIM created the UST model to analyze music. Furthermore, by observing works of experimental cinema, video and multimedia, we found in these works temporal behaviors very similar to those of the USTs in music, giving the same temporal feeling. Therefore, several researchers analyzed visual and multimedia works using the UST and MTP models. You can find some of them on the web-site of the MIM (<http://www.labo-mim.org>) and in the 5th issue of the on-line review *musimediane* [4]. The morphologic description of the UST does not allow an analyze in non-musical domains, whereas the MTP model does. The correspondence between the variables F and I in the sound and the physical properties of the visual-like luminance, chrominance, saturation, size, etc. has just to be found. A general model that would allow finding these correspondences in all cases does not yet exist. We just know that luminance can play the role of I. When this happens, every other media property seems to be a correspondent for F if the temporal behavior is not too complex.

The Use of MTP in Digital Creation

The MTPs can also be used in conception. Temporal functions can be mathematically implemented as true functions into algorithms. Their semi-quantitative nature is an asset because it is possible to add functions inside the MTP, that create local variability around the main function. Furthermore, it makes possible to manage media as data and to create an adapted morphology out of the MTP generation process. In this case, creativity, variability and ordered construction can be reconciled.

The creative use of the MTP model is not limited to music. We think that it can also be extended in any media. Hence, “temporal synonymous media” can be created, i.e. temporal behaviors that are coherent in several media as relevant of the same UST, without being redundant as long as they have different instantaneous temporal variations. Marcel Frémot and I experimented temporal synonymy inside the 2009 version of the digital poem *passage* [5]. These experimentations are documented in the 3rd issue of *Les Cahiers du MIM* [6]. This issue is under translation in English at the time of writing this paper and will soon be accessible on the web-site of the MIM. In a section of the work, a UST begins in music and ends in the visual. In other parts, a music file plays while a computing program running in real time generates the visual. In order to ensure the coherence of the whole, music was analyzed in USTs and their MTPs were implemented in generator of visual events. It gives the impression that music always seems written for the visual, whatever solution is generated. We choose the exact same duration for the MTP in the sound and in the visual in order to enable synchronization between them.

Research on temporal semiotics is not developed enough to certify that creative experimentations in *passage* realize true temporal synonyms in the music and the visual. But, they show that this way is promising. It opens the way up to a new way of making relationships between music and the animated visual based on mathematics description of significant properties. Nowadays, the MIM begins an interactive work called *In Darwust* to test this hypothesis [7]. This work will associate a generator of music and another of visual animation. A third generator will manage these two ones. The latter will edit the work on the base of the MTP model.

Conclusion

USTs are true signs and not only formal structures. The difference between a sign and a formal structure is the existence of a specific meaning. We are sure that a UST has a meaning and does not only constitute a formal structure because electrophysiological measures of event-related potentials (ERP) have shown the existence of N400 waves that are typical of the presence of meaning [8]. It was not probable that mathematics could be used to describe signs and not only formal structures. It is the case in the MTP model and it creates many reticences among the composers of the MIM. Mathematics has always been used to create formal languages or to manipulate natural languages. The MTP model may open the door to use mathematics as a metalanguage to associate formal and natural languages.

The exact nature and mathematical properties of MTP should also be examined. It would certainly help to deduct useful features for their usage. A mathematician who would be interested to work on this aspect would be welcome.

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