

# ON NOTATIONAL SPACES IN INTERACTIVE MUSIC

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## ABSTRACT

This article presents a reflection on the nature of notational spaces in interactive musical works using digital devices. It builds on the author's experiences in *Toucher*<sup>1</sup> (2009) for theremin and computer and *Virtual Rhizome*<sup>2</sup> (2018) for Smart Hand Computers<sup>3</sup>.

In interactive music, notational spaces are correlated to the spatial structure of the *dispositif*<sup>4</sup>, a notion that must be understood in the sense of an extension of the traditional instrument. That's why composing a work is equivalent, at least in part, to composing the instrument. The notational spaces — in other words: the places making possible a writing, and thus a musical interpretation — are distributed among the different components of the *dispositif*. The way in which its digital devices are interconnected (the mapping), the algorithmic logic of the “if-then-else” and the notion of openness play a fundamental role for the composer and the performer.

However, in the case of miniaturized (or embedded, or embodied) *dispositifs*, this spatial structuring of its components seems to be absent and, consequently, questions the existence of a place for composition and interpretation. One of the solutions explored here is to conceive the work as a virtual architecture that recalls a “world” in the field of video games. This architecture, open to a plurality of courses, then assumes the function of a notational space by calling, paradoxically, on techniques of memory specific to orality.

## 1. WHAT IS THE PURPOSE OF NOTATION?

Since its invention at the end of the Middle Ages, Western musical notation has fulfilled three important functions that should be distinguished:

- (1) It offers the composer a “field of operations” making it possible to relate certain types of objects (the

signs of notes, chords, rhythmic or intervallic structures) and the hierarchy of ideas. In so doing, it constitutes a sort of heuristic map, or navigation map, allowing thoughts to move. The score is like a workbench where (2) the composer manipulates symbolic objects [1] bearing musical values and with which he carries out rational operations. This operative function was particularly important for the composers of the Second Viennese School and their post-war successors, and it can be found today in musical formalisms [2][3] influenced by the work and writings of Xenakis.

(3) At the same time, notation is the support in which the results of these operations are fixed, memorized. This means that it possesses a physical consistency (as a paper surface) and a spatial configuration (the staves), where the information is recorded, which will then allow the work to be projected in time. The importance of this function is evident in music known as “music for support” or for “fixed sounds” [4], but it can easily be extended to software in the case of digital works or “computer music” [5].

(4) For this information to be expressed acoustically, it must also concern the way in which the instruments will be activated, or at least describe the conditions necessary to produce musical sounds. From this point of view, it is possible to affirm that notation has a prescriptive function: it is an instruction manual or a user's guide. One manifestation of this function is the tablature. Variations of it can be found in the indication of the gestures that the musician must make on his instrument in contemporary scores (cf. Lachenmann's scores for strings).

### 1.1 Operativity of the notation

In fact, the purely symbolic, referential function of musical signs, that is to say their capacity to aim at an external reality, independent of them and which they represent,

<sup>1</sup> <https://www.vrcarinola.com/toucher>

<sup>2</sup> <https://www.vrcarinola.com/virtual-rhizome>

<sup>3</sup> The conception of the Smart Hand Computer is due to Christophe Lebreton. It describes and generalizes one of the important characteristics of everyday tools, such as smartphones, which combine a gesture capture interface and a computer in the same object. <https://www.lisilog.com/shc/#:~:text=Cr%C3%A9ation%20d'une%20application%20Smart,instrument%20stable%20pour%20l'interpr%C3%A8te>.

<sup>4</sup> We keep the French term of *dispositif*, which contains a polysemy (device, apparatus, machine, plan) and an etymology important for us (cf. the proximity of *dis-ponere*, which means “to arrange”, to distribute objects in the space, and *cum-ponere*, that to give “to compose”, to put in relation objects between them).

appears as secondary to the capacity of notation to be at the same time (a) the support of logical operations allowing the production of new musical forms and (b) a manual of instructions intended to transform a spatial object (a “score”) into a temporal object (an “interpretation”), instructing sometimes on what to do (the tablature, the fingerings) and sometimes on what to hear (the note, the intended pitch). This distinction between the representative function of musical signs and their operative function is essential to understand the role of notation in the new dialectic between composer and performer that appeared during the 20th century, as witnessed, among others, by the open forms [7], the graphic notations [8] or the lexicons, sometimes very extensive, describing the extended techniques of numerous contemporary productions [9]. We will see that this notion of openness is essential in the conception of interactive works. Let us add for the moment that in these works, the three functions of notation that we have just described are assumed by the different technical objects that compose the *dispositif*.

## 1.2 Composing the instrument

We must consider the notion of digital *dispositif* as an extension of the *instrument*. This is because, unlike traditional configurations, in which the score is clearly distinguished from the instrument, and where the link between gesture and sound obeys deterministic laws that organology studies, in interactive works the conception and construction of the *dispositif* is an essential part of the elaboration of the work, and therefore of the writing, because of the contingent relation existing between the interfaces, the synthesis devices, the samples, the spatialization system and the different technical objects used. The notation is then distributed among the various components of the *dispositif* which thus assume the function of support to a writing, their arrangement being able then to be assimilated to a composition. For this reason, understanding the mechanisms by which the different components of the *dispositif* are arranged is essential to situate the places and the different functions of the notation. Let’s see this in the example of *Toucher*.

## 2. NOTATIONAL SPACES IN *TOUCHER*

*Toucher*<sup>5</sup> *dispositif* consists of a theremin, a pedal, a microphone, a computer and a set of speakers, the sound being diffused on six channels (Figure 1).

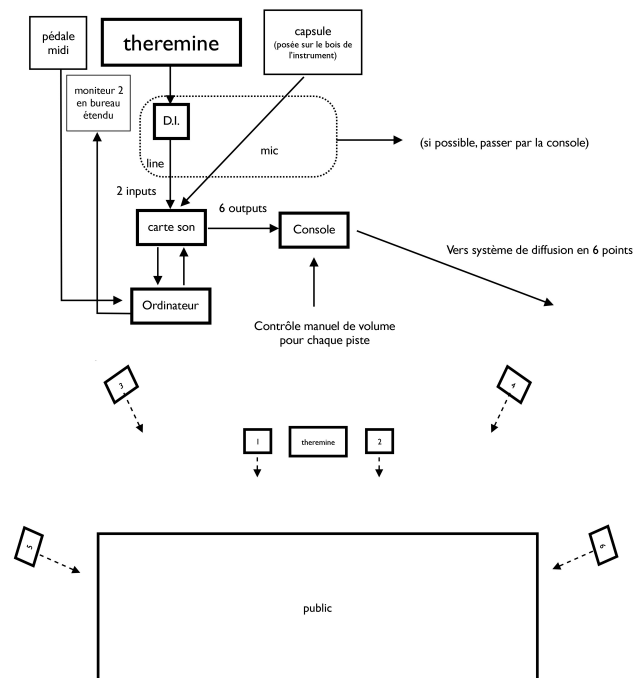


Figure 1. Dispositif's diagram of *Toucher*.

The audio output of the theremin is connected to the computer, which transforms the pitch and intensity data measured in the received signal into control data for the various sound processing modules used in the work. The theremin is thus a part of the *dispositif* that has a gestural interface function, the audio signal variations being the transduction of the musician's action, in other words, their imprint. The electronic sound of the theremin is only directly audible in two strategic places - from a formal point of view - in the work.

## 2.1 Mapping

An important part of the process of writing consisted in structuring the performer's playing space around the theremin's antennae, by cutting it into different concentric zones. When the hand evolves in one or the other of the zones, crossing them from one to the other, when it does so by approaching or moving away from the antennae, when it modifies its speed of displacement or when it combines this movement with that of the other hand, each of these movements thus differentiated produce a specific sound result and contribute to the definition of a gestural syntax which, with its sonorous equivalent, will condition the structuring of the musical discourse.

Let us note that it is the characteristic of any instrument to offer a structured space (a keyboard, a neck, a pipe), in other words an interface, imprinting its logic on the gesture of the instrumentalist [10]. Even in the absence of a physical object, the existence of this space, described in software form, is essential to give meaning to the musician's playing. Thus, in *Light Music* (2004) by Thierry de Mey

<sup>5</sup> *Toucher*, for theremin and computer, was premiered by Claudio Bettinelli on August 13, 2009 in Les Échelles (73), during the Festival Les Nuits d'été.

(1956), there is a close link between the structuration of the “wall of light”, which one could assimilate to a virtual matrix, its evolution and the form of the piece [11][12]. This link is all the clearer that the structuring of the space gives to see in *Light Music*, very concretely, a calligraphy projected on the screen behind the musician which reminds the first cheironomic notations. The relation between instrumental *dispositif* and the support of a notation is then, literally, evident.

In the case of *Toucher*, the structuring of the space around the antennae is closely correlated to the functioning of the different audio processing modules contained in the software made with the computer software environment Max. We have seen that the control of the parameters of these different modules comes from the data of the analysis of the audio signal produced by the theremin. The connection between the interface and the parameters to control it was the second step of the process of writing. It was then a question of defining the “mapping”, a term which refers directly to the function of cartography or navigation map and to the meaning of the notation. It is this structuration that will give each of the musician's gestures its audible equivalent.

The mapping evolves throughout the piece and thus participates in its formal conception. It is a privileged space of the writing, in which meet the structuration of the musician's playing space, the software description of the processing modules, and the algorithms determining the forms of interaction between them.

## 2.2 Graphic score

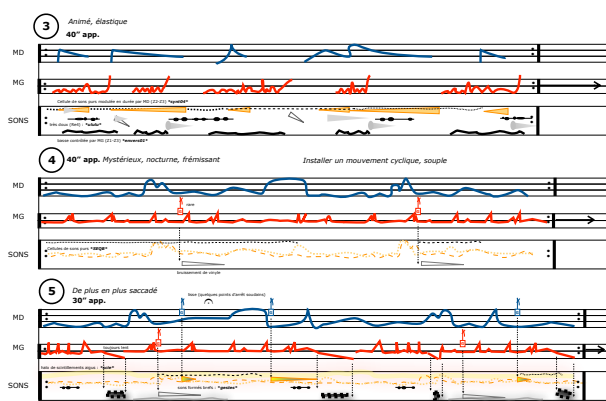


Figure 2. Excerpts from the score of *Toucher*.

The notation used in the graphic score (Figure 2) shows in part this double aspect: the two upper staves indicate the global movement that the hand must make between the different zones, represented by the lines of the staff; the lower staff represents the sounds produced.

<sup>6</sup> Except in the case of Live Coding, where the notational space, that is the computer code, becomes not only visible but is the very object of the performance.

<sup>7</sup> This aspect is perfectly assumed in the script proposed at the very end of the score of *Toucher*, which describes in a few lines the functioning of each sequence of the piece.

However, this score containing the musician's gestures and a graphic representation of the sounds correlated to them, is only a part of the totality of the “score” that the musician will have to interpret. A part of it escapes the graphic notation and is contained in the software.

## 2.3 Automaticity of *dispositifs*

It is important here to emphasize a characteristic of digital *dispositifs*: their ability to function automatically, following the instructions contained in the software. This means that the performer plays an instrument that, at least in part, functions independently from his or her action.

This has two important consequences. The first is that, unlike with traditional instruments, the musical sound is not always the product of the performer's gesture or intentionality. He extracts from the depths of the algorithm a sound material “already there” in virtual form, which he sculpts while keeping a listening presence at each moment of his performance, in a hand/ear correlation of great requirement. The second is that the musician must then know this space of notation, invisible during the performance, encoded in the computer program<sup>6</sup>, because it is in this program that the logical characteristics of the functioning of the instrument are contained, in particular in these two components: (a) the information fixed in the program, concerning for example the samples or the evolutions of the parameters of synthesis, which make the instrument a robot, and (b) the modalities of interaction emanating from the external data which characterize the space of play of the interpreter.

From then on, the sound material given to be heard is the simultaneous product of the musician's action and the software computation. The musical sound, one could say, results from a meeting between the logic of bodies and the logic of algorithms [13]. For this reason, the graphical score remains in *Toucher*, as in *Virtual Rhizome*, relatively open. It instructs on the type of movement that the musician must perform and on what must be heard, but it is also coupled with an indication of character (*Mysterious*, *Nocturnal*, *Oriental*, *Saccadic*, etc.) whose primary function is to induce the intentionality necessary for any form of musical expression, correlated here with the exploration in time of a sound content that is already there, present in the functioning of the software<sup>7</sup>.

## 3. NOTATIONAL SPACES IN *VIRTUAL RHIZOME*

The possibility of an interaction between the performer and a notational space escaping from a symbolic representation was the object of a singular reflection in *Virtual Rhizome*<sup>8</sup> because of the original nature of the *dispositif*.

<sup>8</sup> *Virtual Rhizome*, for a performer and Smart Hand System was premiered on March 3, 2018, at the Auditorium-ONL in Lyon by Jean Geoffroy as part of the Biennale Musiques en Scène. *Virtual Rhizome* benefited in 2018 from an Aid to the writing of an original musical work from the French Ministry of Culture. It responds to a proposal by Christophe Lebreton and Jean Geoffroy to compose a work for the original Smart

### 3.1 Dispositif *apparatus* and dispositif *device*

The visual artist Samuel Bianchini distinguishes two types of interactive *dispositifs*: *apparatus* and *device* [14]. Extrapolating to the musical domain: the first refers to *dispositifs* external to the performer, occupying a physical space with which the latter interacts, as we have seen in *Toucher*. In contrast, the *dispositifs devices*, to which *Virtual Rhizome* belongs, are closer to the embedded systems.

The miniaturization of the device poses an interesting problem for the composer and for the interpreter because there is no more any physical space to be structured and, consequently, there is no place for the elaboration of a cartography (mapping), from where a notation can be relevant. Consequently, there is no place allowing the deployment of a musical discourse and the expression of a legible intentionality clearly translated in audible form. The spatial support which, as in any instrument, constrains the musician's gesture, charges it with tension, practically no longer exists. The danger is then that the interface becomes a sort of primitive rattle, capable of producing such an infinity of sounds that the audience is left with a profound feeling of arbitrariness and formlessness.

### 3.2 Memory palace<sup>9</sup>

The solution adopted here was to introduce a technique that takes its source in orality. The formal structure of *Virtual Rhizome* can be compared to a “memory palace” [15] [6] that the interpreter goes through according to a certain number of constraints to which we will return. In other words, the interface, contained here in the smartphones, fulfils the function of a rudder that the interpreter handles to navigate inside a virtual architecture. It is virtual in the sense that it is comparable to a “world” in a video game whose images would be totally internalized by the musician and would have no other appearance than sonorous. In *Toucher*, a certain instrumental virtuosity was still readable in the musician's gestures thanks to the existence of a physical instrumental space. Unlike, the *dispositif device* of *Virtual Rhizome* produces an almost total internalization of the performer's action. The performer is constantly listening to the state of the system, the slightest movement of the hands being able to produce changes in the timbre, figures, emergences which are simultaneously the object of his contemplation. The memory of the system, the intuition, the intimate memory of the musician, are intertwined and embodied in the performance.

The score made available to him contains two types of information: the precise description of the functioning of the *dispositif* and the graphic statement of a possible conduct which is, in fact, only an example of projection in time of the spatial form of the work.

### 3.3 Operation of the Virtual Rhizome's *dispositif*

The piece is structured in twenty-three *situations* which correspond to as many states or configurations of the system, giving rise to as many musical sequences that can be combined with each other. Each *situation* is described in terms of the type of motion capture, the audio processing modules, the samples used and the control parameters. The *situations* are isolated from each other, like Leibnizian monads, “without doors or windows”. This was one of the constraints linked to the technology, which did not allow the stacking of different processing modules. A musician's gesture of the lateral impact type allows to pass to the next *situation*, another one to return to the previous. The performer plays with two smartphones whose outputs are directly addressed to two stereo pairs forming a quadraphonic. Each smartphone has the same application - but they do not communicate with each other. It is the performer who decides on the succession and combination of *situations* according to the model proposed by the score, in a sort of two-voice counterpoint that gives rise to a multiplicity of possible paths.

In the example of Figure 3 (H), the musician alternates between *situations* 7 and 8 with the two smartphones. He can go forward, then backward, then forward again, obtaining each time new sound combinations and always renewing the musical discourse.

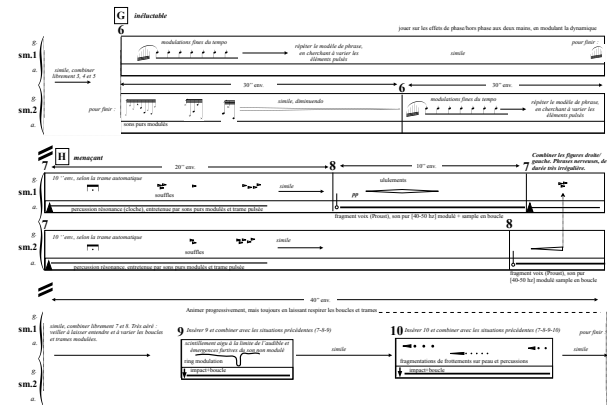


Figure 3. Excerpt from the score of *Virtual Rhizome*.

Each *situation* is composed of three elements:

- (1) An impact-type articulatory element triggered when the situation is entered. These are samples of the same family taken from a repertoire specific to certain *situations*.
- (2) An interactive module whose parameters are controlled by the musician's gesture. For example, a sound file transformed by a granulator whose volume, grain size or playback pointer position is controlled.

Hand Computer system, developed at GRAME-CNCM from the FAUST language and allowing to play smartphones as a musical instrument.

<sup>9</sup> The Memory Palace refers to the “method of loci” (*loci* being Latin for “places”) is a strategy of memory enhancement which uses visualizations of familiar spatial environments in order to enhance

the recall of information. This method is a mnemonic device adopted in ancient Roman and Greek rhetorical treatises. See [https://en.wikipedia.org/wiki/Method\\_of\\_loci](https://en.wikipedia.org/wiki/Method_of_loci)

- (3) Loops of samples or frames of evolving synthetics generated live from various automated stochastic controls.

Elements (1) and (3) are characterized by an amount of indetermination that fulfills a triple function: to create a listening tension on the part of the performer, on the lookout for unexpected events; to produce a rhythmic environment that induces tempo, phrasing and conduct in the interaction described in (2); to renew each recurrence of the same *situation*.

### 3.4 Openness and “if-then-else” model

The automatic behavior of these indeterminate elements constitutes in fact an important reference for the musician's play, a sort of background through which the figures he draws take shape. This background and these figures, if they were fixed and predictable, would transform the performer into an operator whose main role would be reduced to the activation of a system thus entirely determined. This is because, unlike instrumental or mixed works, in digital devices the interaction between the musician's gesture and the perceived sound can only be described in an algorithmic form. This means that this interaction is governed by what can be called the “if-then-else” logic model specific to computer languages.

Now, so that the interpreter will not be reduced to one of the terms of the algorithm fixing the modalities of the interaction, so that this logic will not impose itself on him, it is necessary to create a space of interaction which escapes the determinism of the “if-then-else”. This, theoretically, is not possible in the case of digital devices, except by using a complexity that makes their behavior unpredictable, in whole or in part—for example, by means of stochastic functions—thus creating the illusion of a certain capacity for initiative by the computer. This is the solution adopted in *Virtual Rhizome*. This complexity associated with the automaticity of the device requires from the musician an attentive listening and an ability to react “in real time”, at each moment, as a gamer does when he is confronted with unexpected situations. It is a process that generates constraints that push the performer to make choices. Therefore, it constitutes a notational space (because of its prescriptive function) at the same time as the equivalent of the force feedback characteristic of traditional instruments, fundamental element for expressiveness.

The relationship between the performer and the work is in some ways close to the one existing in open works. The instrument produces a background in perpetual evolution to which the performer reacts according to the constraints inherent to the musical material that himself generates and which is partly unpredictable, inside a formal architecture which, in its software fixation, lends itself to an infinity of parcourses.

### 3.5 Graphic statement, trace, direction, script

It is thus in the conception of the automatic functioning of the *Virtual Rhizome's dispositif* that the possibility of an expression and a musical discourse is considered, in the sense that expression and discourse are the emanation of the singular intentionality of the performer. To accompany and orient the direction of this discourse, to the division of the work into twenty-three *situations* comes to be added a second division expressing by evocative terms indications of play, thus inviting the interpreter to work out his own script: *threatening, ghostly, ineluctable*, etc.

It should be noted that the graphic score is proposed as a model of form among others, resulting from the proposal of the first performer and co-author of this article, who participated directly in all the stages of elaboration of the work. Naturally, the meaning of “model” is not the same as that of the classical score containing the essential information for the performance of the work. The status of the notation here is close to that of a “trace” and a possible path.

### 3.6 Product, process and composition kit

In *Virtual Rhizome*, perhaps more than in *Toucher*, the performer must know the technical functioning of the device, here practically reduced to the dimensions of the two smartphones, while keeping in mind the global architecture of the work. This architecture is virtual in the sense that it does not manifest itself in a fixed temporal or symbolic form, but has in fact a content, a consistency, a certain logic induced by the nature of the sound samples, of the digital audio processing modules, by the software ordering of the *situations*, the different mappings or the expression indications. The whole of these contents, partly explained in the score and completed by other traces which are the video recordings of the various interpretations, constitutes in fact a kind of “composition kit”—another manifestation of a notational space—of which the interpreter appropriates to make the work emerge. From then on, this work is both an identifiable product (the “kit”, in its concrete components) and a work in progress [16]<sup>10</sup>.

## 4. CONCLUSION

The interactive *dispositifs* induce a dialectic between composer and performer that is reminiscent of open forms. This openness was most often reflected by a notation that sometimes questioned the linear representation of time, leaving the performer the choice of constructing his or her own path—for example in the André Boucourechliev's (1925-1997) *Archipels* series—and, sometimes, by means of graphic notations, delegated to the performer a more or less important part of the definition of the musical material

<sup>10</sup> Apart from the versions recorded by Jean Geoffroy, two other interpretations, that of Martin Malatray (Lyon, CNSMD, June 25, 2019) and of Meng Fu (Moscow, Tchaikovsky National Conservatory, October 13,

2021) are now available. The function of the video recording has also been of great importance in the different interpretations of *Toucher*.

—a common approach in the John Cage's (1912-1992) works<sup>11</sup>.

In interactive pieces, the notion of openness stems from the need for a space for interpretation that existed in symbolic notation and that must be found in works governed by the algorithmic logic of “if-then-else”. The interpreter plays an instrument which is characterized by automatic processes which are independent from him actions. Without this openness, which implies a certain degree of indeterminacy in the interaction with the device, his role would be reduced to that of a simple machine operator.

*Toucher* and *Virtual Rhizome* provide two examples of the proximity between these new notational spaces specific to digital devices and the open works. But if in *Toucher* the notation still reflected the temporal form of the work's performance, in *Virtual Rhizome* it only exemplifies a possible path among an infinity. The notational space exists above all virtually, in the form of a labyrinthine memory palace, algorithmically conceived, that the performer roams at will and embodies.

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<sup>11</sup> For example, in *Variations I* (1958) and *Variations II* (1961). The *Song Books* (1970) and the *Concert for piano and orchestra* (1958) compile numerous other examples of Cage's research on notation.