Digital Music Instruments: an approach to some of its conceptual implications

Paulo Ferreira-Lopes, Mailis Rodrigues
Research Center for Science and Technology of the Arts (CITAR)
Portuguese Catholic University - School of the Arts
Rua Diogo Botelho 1327, 4169-005 Porto, Portugal
pflopes@porto.ucp.pt
mailisr@gmail.com

Keywords Digital Music Instruments, Instrumental Gesture, Music Epistemology, Design of Digital Music Instruments

Abstract

Designing a digital music instrument is a sorely interdisciplinary activity, where we find a merging process between scientific and artistic subjects. Consequently, the idea of digital music instrument cannot be reduced only to technological skills and innovations. In this sense, when addressing the notion of digital music instrument it is essential to consider its sociologic and epistemological determinants. The concept of a digital music instruments, involves a different approach to sound since it dissociates the sound controller from the sound generator, and thus it severs the causal link between gesture and sound. This condition implies new ways of thinking about sound and music composition, particularly because it provides new ways of accessing sound by surpassing the note and working directly in the spectral layer, at different time scales. In this paper, we reflect on the conceptual issues raised when designing new digital music instruments: how can the search for new musical expression imply the birth of new music instruments and the emergence of new instrumental techniques?; and how do the new digital instruments contribute to changing relations between composer, performer and *luthier*?; and how are they situated in view of these new roles? The paper focuses on the concepts of time and space in this new reality of interaction between the musician and the digital music instruments, particularly through the analysis of determinants such as latency and non-causality, which contributes to the creation of a new space in this relationship between performer and instrument.

1. On the concept of music instrument

A music instrument is an object that produces sound or perceptual phenomena to which our ear is sensitive. This conception of musical instrument is, however, very general since the concept of musical instrument is closely linked to cultural and sociological thought of each era, and consequently it has constantly been revised over centuries.

(Kartomi, 1990) argues that the way each culture classifies its music instruments is connected with the concept that culture has of music instrument and its use. It is easy to find examples of this thinking in many historical classifications or, and in non-western context, e.g. in India, where music is bound up with religious ceremonies (Stoichita and Lortat-Jacob, 2008). Likewise, Chadabe (1997) expands this concept to technical developments of each historical period, so that the electrical period is naturally associated with electric music instruments, and the digital period with digital music instrument. However, the emergence of new music instruments reflects the need for new sounds and new music techniques (Jordá, 2001; Chadabe, 1997). Digital music instruments (DMI) bring with them new features, and as (Chadabe, 1997) understands them, they can have any form, be played in anyway and play anything. This is, of course, an idealization of the digital instrument. DMI open new dimensions of sounds we can use to produce music, and but they also imply new situations radically opposed to those experienced by the performer until now. The nature of a DMI is substantially different from the traditional music instrument (TMI): the former separates the system of sound generator from the control system of sound, while the latter joins the two systems. This element, in the DMI, has two direct consequences: first it breaks the causal connection between gesture and sound (Cadoz, 1999; Miranda and Wanderley, 2006) that exists in traditional music instrument, and secondly it releases the sound production of a mechanical action, or rather frees the sound from the sound source[1].

2. Access to sound and categories of interaction

DMIs bring with them two new features: access modes to sound generation and categories of interaction. If sound is not immediate gesture, and the relationship between the human action and the sound parameters is built on mapping strategies (Miranda and Wanderley, 2006), then we enter in a relationship quite different from that experienced until now. Partly because now we have access to sound through a different kind of representation (we don't have the same kind of abstraction in the spectrum or even in the *objet sonore*, as defined by Pierre (Schaefer, 1966), as in a traditional score) and this allows us to leave the score level and control the sound even at the granular level; it

[1] Jean Claude Risset in a talk of a PhD in Science and Technologies of Art- specialization in Computer Music, Computer Music II class at Portuguease Catholic University, Oporto, Portugal, 2010

thus becomes possible to work not only on the sound but also on its shape through the direct manipulation of the sound spectrum (Jordá, 2005). The DMI, then, can be thought as an intelligent instrument (Jordá, 2001): its can control various processes allowing the composer to work directly with a high-level language (Jordá, 2005) and also to shape, or control this language via live coding (Sorensen and Brown, 2007). While freeing the composer in one way, these processes make him more and more involved in the designing of musical instruments, as he now delegates tasks to the instrument that he once delegated to the performer. Hence the role of composer, performer and *luthier* blend increasingly; composing becomes more and more designing a new instrument, since it is the composer who defines the mapping between the gestural controller and the sound generator. This individualization of the music instrument brings new composing and performance techniques that escape traditional music notation. Toeplitz (2002) believes that the design of DMI should be left to the performers. He argues that the misunderstanding of the computer as a music instrument in traditional music is related to the fact that the traditional score proves to be completely obsolete because it does not comply with his two basic functions: transmission and abstraction. Firstly, because we are in a medium in which the sound itself becomes easily transmissible and secondly the computer already performs an abstraction, DMI implements a language of representations. To solve this situation the composer must apply new methods of transmission adapted to this new reality; however, Toeplitz concludes that the patch should not replace the traditional score, since filtering parameter in his view, are not at all guarantors of musical interest. He then proposes to amend the type of information contained in the score: instead of using gestures to serve a musical end, making explicit the musical idea of the composer. In this scenario the performer would be responsible for building his own instrument, with no restrictions except the formal ones imposed by the composer. The vision of the performer as the responsible creator for designing the DMI is not shared by most authors in computer music (Ferreira-Lopes, 2008, Jordá, 2005, Miranda and Wanderley, 2006), since they believe that this design already involves a series of conceptualizations that will compromise the musical result. The mapping clearly establishes the conceptual limits of the instrument: the possibilities of creation that a DMI allow do not tend to infinity as in traditional instruments[2], and in this sense the white pages of modular software are an illusion, because behind each module there is an algorithm that always imposes structural limits. We have to understand that the situation here is different from the *luthier*/composer relationship for traditional musical instruments, the TMI do not imply conceptual boundaries, only mapping implies it. Thus it is

---

[2] João Pedro Oliveira in a talk of the PhD in Science and Technologies of Art- specialization in Computer Music, Computer Music II class at Portuguease Catholic University, Oporto, Portugal, 2010

understandable why we so often have this contribution of musical idea to the design of the instrument. As the composer becomes the *luthier* and performer of his own music instrument, the score itself becomes more individual.

Concerning the complexity of the DMI and the quantification of its functionalities, these are founded basically on the interaction rules, implemented trough the code (software) and material access (hardware) of the instrument. In this field the level of interactivity accomplished by DMIs is defined by the categories of interaction. As we explain (Ferreira-Lopes, 2008), it is possible to define the typology of the interaction processes – with regard to the interaction between DMIs and TMIs- in two different categories: kind and directionality. Each of these is divisible into two subcategories: discrete and continuous for kind, and one-way or two-ways in directionality. The first one concerns the internal way the interaction is produced: in the discrete mode, the DMI controls the sound by impulses for example; in the continuous mode the simplest example is the one where the DMI acts as a DSP by continuously processing the sound signal. Directionality refers to the sense of communication in the interaction process. The one-way category is a particular case since the concept of interaction implies an action/reaction of the two constituent parts; here we will consider that there is an impossibility of response from one of the elements of this relationship. Two situations are present in this category, one where a performer or performers influence the response of the DMI, and one where the DMI influences the behaviour of the performer. The two-way category includes all the interactions that are made in both directions, in which both elements influence each other.

3. Time and space

DMIs, as explained above, bring a discontinuity between gesture and sound; consequently, the flow of energy to generate the sound does not have to be provided by the performer. This situation generates new conceptions of time and space that are particular to this reality. Since there is no immediacy between gesture and sound, it introduces real and non-real time. Real time is when the generation of sound happens at the same time as the sound control; this situation occurs mostly in machine performance and mapping strategies. According to Jordá (2005), this is the only way we can consider a DMI as a music instrument, as it allows control in real-time. Non-real time is when there is a time lapse between the generation and the control of sound; we could relate the non-real time situation with the composing action. These time characteristics are part of the latency of the system; when the level of latency is very low one is in the presence of real-time systems; when it is very high one is in a non-real time situation. The latency system has been studied especially for

collaborative music where there are high levels of latency due to networks (Barbosa et al, 2005). The DMI allows the performer to work at different time scales with sound, at the macro temporal level (above the musical note level) and at the micro temporal level (below the musical note level). The possibility to operate in several temporal dimensions implies the need to include a new validation parameter through perception, the so-called "variable listening" (Vaggione, 2001a; Vaggione, 2001b), which allows perception to adapt from one temporal level to another.

In relation with space, the DMI makes access to space as a possible music parameter. Traditionally, the performance space such as the concert hall, is conceived as the acoustic space which reinforces or cancels certain frequencies. During the early part o the 20th century, however, we see a new way of thinking about space, not anymore as an acoustical dimension but as a musical dimension. We can think of space as an "hyperinstrument" that we can only access through a DMI, bringing to music composition the idea that underlies Alvin Lucier's work "I'm sitting in a room" (Fölmer, 2006). This idea of space as a musical parameter, however, is not a novelty brought by the DMI, but it clearly facilitates this process, especially because it allows us to leave the classic concert hall and think about fresh ways of presenting music.

With the discontinuity imposed between gesture and sound, the performer and the instrument are no longer in a continuous space: there is a third, middle space, which is mediated by the machine – the mapping space.

4. Instrument of musical expression or Instrument of sound expression?

What differentiates a musical instrument from an art piece in a sound installation? Can we consider, for example, that an object that allows creating sound in an art installation is comparable to a music instrument? Isn't a piano in an art installation still a piano?

The concept of music instrument is closely linked to the use one makes of the instrument. Kartomi (1990) emphasizes that the context in which the instrument is presented contributes to the identification of the object as an instrument of music. This means that an object producing sound in a gallery is different from the one producing sound in a concert hall. In the first case, it functions as a sound expression medium and in the second as a medium of musical expression. This view is, however, too categorical, since we agree that a piano in an art installation - if played - is still a piano and it is a music instrument; but we can argue that as the piano has a historical use as music instrument one cannot deny this social burden so easily. DMIs we do not have this social and historical luggage; in fact, we can find a large number of DMIs classified as musical instruments without the need of this luggage, especially within electronic and pop music.

What distinguishes an instrument of musical expression from an instrument of sound expression is primarily the intention. In music, we should have an intention and a structure, therefore a DMI becomes a music instrument the moment it starts to exhibit an instrumental technique, which is more or less shared by everyone allowing the transmission of this technique and the creation of musical pieces dedicated to that certain instrument. In a sound installation the status of the DMI is completely different: here there is no such pre-defined musical intention; instead the DMI acts as a sound generator that appeals to spontaneous intentions or an experiential category based on enjoyment of the sound (Ferreira-Lopes, 2004).

We can compare this distinction to the difference Cage posited between music and silence: music is continuous and stops only when the listener ceases to pay attention to it, i.e., ceases to have intention to listen.

5. Conclusion

There are a number of factors that allow us to classify a music instrument as such, namely the introduction of a repertoire, the existence of a group or groups of composers interested in it and the introduction of a systematized instrumental technique. Traditional music instruments have a historical background that lead to their consolidation as music instruments in the society. Digital music instruments are newborn into this scenario, and as we have seen that they present a completely different approach to sound, especially in allowing us access to sound itself (to work on in it, change its shape, control it in a granular precision); and they allow us to define the interaction, increasing its possibilities. But they also present conceptual limitations that do not exist in relation to traditional music instruments, and they can be easily played to the extreme that anyone can be a musician or a composer (this is of course an illusion, but the digital brings the idea that everything is possible. The “white page” however does not mean what Malevich saw in his “White on white”; instead the blank page hides “A conceptual limit on white”. We can find, nevertheless, examples where a DMI can truly be considered a music instrument.

Starting with the early electronic music instruments, such as the Théremin used by Varèse in *Ecuatorial* (1934); and played astonishingly well by Clara Rockmore. Some other similar instruments are the Ondes Martenot or the Trautonium, which Chadabe recognized as “an instrument sophisticated enough to inspire Paul Hindemith to write his concert for Solo Trautonium and Orchestra.” (Chadabe, 1997). We could, in fact, extend this statement and propose that a music instrument should allow a great number of expressive possibilities to the performer if it is to be anything more than a toy. The Waisvisz's Hands are an example, although it is an individual

instrument it allowed Waisvisz to explore it to the point of virtuosity. Oliveira[3] argues that music making is cyclical: there is first a period of research, then a period of of crystallisation (where original solutions start to became models) and a third one, the academic period (where the models are generalised and start to be taught in music schools). Can we apply this same model to the consolidation of music instruments? Do they also have to go through these three phases to be considered as music instruments? Janer[4] once said, talking about the Reactable (Jordá, 2005) that an instrument becomes a music instrument when someone other than his creator finds expressive features that his creator had not thought of – so the instrument is released from its context of creation and becomes something autonomous.

6. Acknowledgments

This article is part of the theoretical research from the PRICES project supported by CITAR – Research Centre for Science and Technology in Arts from the Portuguese Catholic University and the FCT – Foundation for Science and Technology, Portugal (POCI 2010).

República Portuguesa

References

Barbosa, A., Cardoso, G., Greiger, G. (2005); Network Latency Adaptative Tempo in the Public Sound Objects System; Proc. International Conference on new Interfaces for Musical Expression (NIME 2005); Vancouver, Canada.

Cadoz, C. (1999); Continuum énergétique du geste au son – simulation multisensorielle interactive d'objets physiques; Interfaces Homme – Machine et création musicale (ed. H. Vinet and F. Delalande); Hermes.

Chadabe, J. (1997); Electric sound – The past and present of electronic music; Prentice Hall; New Jersey.

Ferreira Lopes, P.(2008); Interaction typologies: traditional music instruments vs digital music instruments; Proc ICMC (International Computer Music Conference; Belfast.

Ferreira-Lopes, P. (2004); Étude de modèles interactifs et d'interfaces de contrôle en temps réel pour la composition musicale. Thèse de Doctorat ; Paris ; Université de Saint Denis - Paris VIII - Dép. de Sciences et Technologies des Arts.

Fölmer, G.(2006); *Audio Art* in http://www.medienkunstnetz.de/themes/overview_of_media_art/audio/print/; 23.04.2006

---

[3] João Pedro Oliveira in talk of PhD in Science and Technologies of Art- specialization in Computer Music, Computer Music II class at Portuguease Catholic University, Oporto, Portugal, 2010

[4] Jordi Janer in a talk of PhD in Science and Technologies of Art- specialization in Computer Music, Computer Music II class at Portuguease Catholic University, Oporto, Portugal, 2010

Jordá, S.(2001); New musical interfaces and new music-making paradigms; Proc. of New Interfaces for Musical Expression (NIME–01); Seattle.

Jordá, S.(2005); Digital Lutherie: Crafting musical computers for new musics performance and improvisation; PhD Thesis; Departement de Tecnoligia; Universitat Pompeu Fabra; Barcelona.

Kartomi, M.(1990); On concepts and classifications of musical instrument; The university of Chicago Press; Chicago.

Miranda, E.R., Wanderley, M.M.(2006); New digital musical instruments: Controls beyond the keyboard; Middleton; A-R Editions.

Schaeffer, P.(1966); Traité des objets musicaux; Editions du Seuil; Paris.

Sorensen, A., Brown, A. R.(2007); aa-cell in practice: an approach to music live coding; Proc. of ICMC (International Computer Music Conference); Copenhagen.

Stoichita, V., Lortat-Jacob, B.(2008); *La musiqueen action* in Pour la science n. 373; Novembre, (p. 42 -44).

Toeplitz, K.(2002); “L'ordinateur comme instrument de concert”; Actes des neuvièmes Journées d’Informatique Musicale, Marseille : ADERIM- GMEM, p. 199-207.

Vaggione, H.(2001a); Some Ontological Remarks about Music Composition Processes; Computer Music Journal, 25; p. 54 -61.

Vaggione, H.(2001b); Composing Musical Spaces by Means of Decorrelation of Audio Signals; Proc. of DAFX-01 (Conference on Digital Audio Effects); Limerick , Ireland; December 2001