The Bartlett School of Architecture

M.Arch Design for Performance and Interaction

Contextual Theory Paper

Tangible instruments for relatable performances,
or the issue of perception in electronic and digital musical performances

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1 Glossary

1.1 Tangible

The initial definition of "tangible" finds its origin in the late 16th century French or from late Latin tangibilis, from tangere "to touch" , but tangible is also commonly used today in a broader meaning : "clear and definite; real" (Oxford Dictionaries, 2017), or even "real and not imaginary; able to be shown, touched, or experienced" (Cambridge Dictionary, 2017). Both definitions are relevant to this essay. Later it will be discussed how those two definitions inform each other, in other words how the reality of a fact depends on the physical perception one has of it.

1.2 Instrument

The Cambridge Dictionary gives several definitions of an instrument : first, " an object that is played to produce musical sounds ", and second " a tool or other device, especially one without electrical power, used for performing a particular piece of work" (Cambridge Dictionary, 2017). Beyond the second definition, there is no reference to art or creation. However, I will keep both definitions for this essay as the second brings forth very relevant aspects that will be discussed : the idea that an instrument does not use electrical power, and the notion of performance. It is also necessary to point out is that in both definitions, the instrument is not "designed" to produce sound or to perform, it is "used" as such. The property of being an instrument (and not a tool or a machine) is not inherent to an object, it is defined by the relationship one engages with it.

1.3 Interaction

In this essay I am using the idea of interaction more in a sense of reaction, as can be defined by the third law of Newton : In a system of two objects A and B, if object A exerts a force on object B, object B will exert a force back on object A. As long as both entities of a system are exerting forces on each other, even if one of them is only reacting to the other and could not act on its own, I will consider that those entities are interacting. For instance, when an individual presses a key on a piano, the key exerts a physical force back on the player, which means that the player is interacting with the physical matter of the piano key. This essay will not discuss whether it is an interaction or not, but how that interaction can be characterised.

1.4 Performance

The definition of performance I am using in this essay implies the presence of two groups of human beings : one that performs (a performer) and one that assists to the performance (an audience), in other words one that presents an act, and one to which the presentation is intended. The second part of this essay

will focus on the relationship between those two entities, and more specifically on how the audience perceives the performer, in the specific case of a performer acting with an musical instrument.

2 Introduction

The development of digital tools such as Arduino (https://www.arduino.cc/) or Wekinator (http://www.wekinator.org/) allows us today to link physical inputs and outputs of complete different natures. A sound signal can trigger visual effects, movement can be transformed into light and even the number of bananas eaten every day in the US could possibly generate patterns of beautiful colours. While the possibilities for creation open up, the understanding, from a user point of view, of how those signals are being processed slowly disappears inside a imperceptible and incomprehensible box. With the approach of cybernetics, such systems would perfectly fall into the description of Stephen Gage : "a trivial machine to the designer and a black box to the user at the same time." (Gage S., 2006) In the case of music, after centuries of acoustic instruments where sound production was physically evident (Schloss, W.A., 2002), the implementation of complex sound machines started by Edison's phonograph in 1877, Cahill's electric Telharmonium in 1897 up to today's computer music have revolutionised musical creation, yet the production of sound is no longer trivial to the senses. (de Wilde L., 2016) (Cadoz C., 1999). Both for musicians and audiences, there is growing distance between the perception of instruments and their understanding. This essay studies the perception of the transformation from player's input to sound output in the specific case of musical performances, comparing how different types of instruments (electric or acoustic, analog or digital) impact the performer-instrument interaction and the perception of that interaction from an audience perspective.

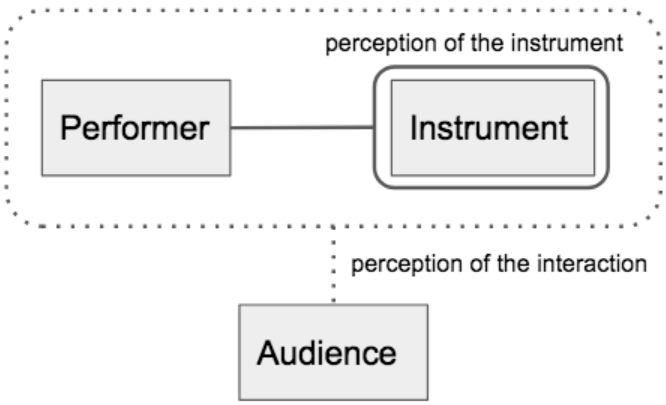

Figure 1: Performer, instrument and audience system

3 Performer-instrument interaction

The first system I will analyse is the performer-instrument system. To understand how the instrument is perceived by the performer, the notions of reality and perception must both be taken into account. That is why the concept of tangibility is so important : it brings together, in an inseparable concept, the reality of a fact and the perception one has of it.

3.1 Tangible interaction : energetic exchange

A tangible object is defined by its ability to be touched, which implies an action from the performed on the object (Georgaki A., Kouroupetrogiou G., 2014), but to be perceived and appear real, the object has to act back on the performer. It is not only the perception of the object answering to a performer's solicitation (by producing sound for instance) that creates the sensation of physical reality, there must be an "energetic exchange" between the performer and the object (Luciani A., 2014)(Luciani A. et al, 2007). When a cellist uses his bow on a string, it is not only the sound produced that creates the sentiment of physically, it is also the strings that vibrate in reaction to the pression of the bow. This vibration sends information back to the player in both hands through the bow and string, and in the chest and legs through the body of the instrument. The reaction of matter is what enables him to sense and transform the physical world. In the end, talking about "tangible interaction" is almost a pleonasm : an interaction must be tangible to be an interaction, as "interaction" implies that two entities (here the player and the instrument) are acting back on each other.

The energetic exchange is the first necessary setting to enable an instrumental interaction, on top of which is added the idea of energetic continuum between performer and sound defined by Cadoz (Cadoz C., 1999).

3.2 Instrumental interaction : energetic exchange and energetic continuum

Cadoz establishes how, in acoustical instruments (Figure 2), the energy of the sound produced and the energy of the performer's gesture are related. (Cadoz C., 1999)

"Toute l'énergie gestuelle n'est pas convertie, mais toute l'énergie acoustique a son origine dans l'énergie gestuelle" (Cadoz C., 1999)

"All the gestural energy is not converted, but all the acoustic energy finds its origin in the gestural energy" (translated from French by Marguerite Tricaud)

Conversely, if the instrument is electronic (Figure 3), such as in the case of an analog synthesiser, the energy is supplied by a exterior power source and the gesture's energy of the performer is only partially influencing the energy of the sound produced.

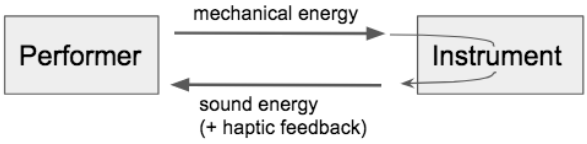

Figure 2: Interaction with an acoustic instrument

Figure 3: Interaction with an analog electronic instrument

If in addition to being electronic, the instrument is also digital (Figure 4), the distance between sound production and the performer's gesture grows larger: the mechanical energy of the gesture is converted into a set of data which is then processed by a computer algorithm, which later outputs another set of data into sound. There is no direct link between the mechanical energy of the performer and the sound.

Figure 4: Interaction with a digital electronic instrument

We can now differentiate the performer-instrument system into two categories : a coupled mechanical system and an input-output system (Fontana M., Luciani A., 2007). For Cadoz and Luciani, the interaction is instrumental only in the case of a coupled mechanical system, when the performer and the instrument merge into one: the instrument becomes a prolongation of the body of the performer.

That is why many designers are developing more tangible interfaces between musicians and instruments, in order to reconstruct the sensation of continuum and exchange (Luciani A., 2014)(Luciani A. et al., 2007). In other words, their

goal is to create a "cognitive tangibility" (Georgaki A., Kouroupetrogiou G., 2014) of the interaction to keep both the possibilities that are offered by digital tools and at the same time the richness of physical interaction. Research on that matter has been lead since 1997 at the MIT Tangible Media Group (Ishii H., Ullmer B., 1997) and started showing up in the industry of electronic music instruments in the last decade, with devices such as *Touché* by Expressive E (Figure 5).

Figure 5: *Touché* by Expressive E

But how does an exterior individual perceive that interaction? The Virtual Reality environment is one example of a cognitive tangible interaction for the user, but from an audience point of view, the interaction does not often offer any interest. Even if the instrument is tangible for the performer, it does not mean the interaction will be appreciable for the audience (Schloss, W.A., 2002).

4 Perception of instrumental interaction

When talking about the perception of instrumental interaction, I am aiming to understand what is a "good" musical performance: what makes it appreciable for the audience. It is of course impossible to objectively represent the diverse range of feelings each member of an audience is looking for when going to a live performance, but there are a few parameters that seem to be quite widely shared when describing an enjoyable musical event.

4.1 Live performances or the need to see the performer

First, it seems that the notion of "live performance" is a fundamental factor when talking about a pleasant musical experience. The reason why live music performances still exist, at the age of internet, records and mp3 players, is that it adds something to the auditive experience of music (Schloss, W.A., 2002). When going to a live concert, the richness of stimuli is enormous : the sound perceived by the ears, the haptic sensation of the body vibrating, social interactions as well as intellectual aspects of the event. Amongst all those stimuli, I will focus on the perception and understanding of the performance through the ears and the eyes.

The first question that appears is : does the audience need to see the performer ? This question has to be asked as it seems that in the great majority of electronic music performances, artists rely on complementary visuals. (Figure 6 and 7) However, I notice that even with such support, the performer always stays visible, even slightly. It is extremely rare to witness a live performance where the presence of the performer cannot be sensed. My hypothesis on this observation is the following: the audience must feel the artist's presence in order to know that the performance is truly live, meaning that the performer is creating, "here and now", a unique time-space that includes the audience. (Gurevich M. and Cavan Fyans A.C., 2011)

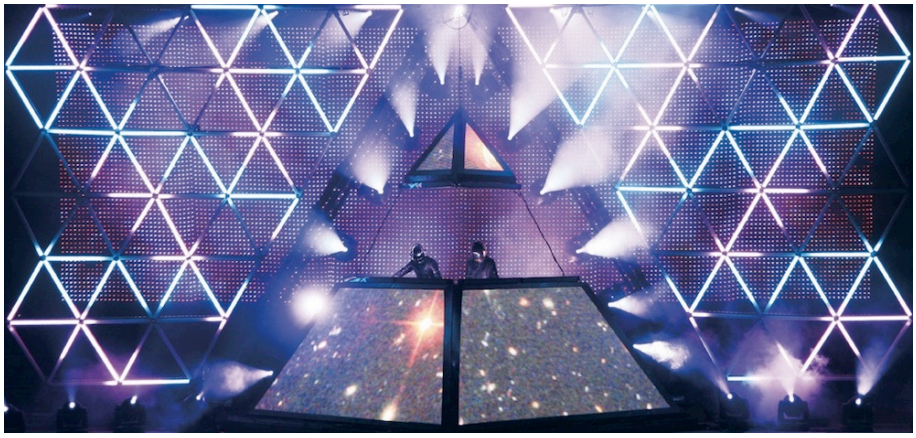

Figure 6: Daft Punk, Alive Tour 2006-2007

Figure 7: Etienne de Crécy, Pukkelpop 2008

I will from now on focus on live musical performances where the performer is fully perceptible by the audience and more specifically where his interaction with the instrument is the main visual aspect of the performance. Boiler Room (Figure 8), for instance, is an electronic music performance where the audience is extremely close to the performer and can see every single action of the instrumental interaction. But what do they see ?

Figure 8: Boiler Room

4.2 Transferable knowledge or the need to relate to the performer

I find it quite underwhelming to watch electronic musicians perform, as I cannot perceive how and where the sound is created, or how the performer is transforming the sound to express his own idea. Because I don't know what is happening inside the "black box", I cannot relate to what the performer is doing. What I mean by "to relate" is to put myself in the performer's position and sense how his actions are conveying his expression through sound.

At that point, anyone could object that the problem of perception by the audience does not only apply to digital or electronic instruments anymore, but to all of them, as for instance a piano could appear as a non-relatable instrument to anyone who is not familiar with its mechanical properties and therefore don't really understand how the sound is created.

Therefore, the perception of a performance does not only rely on the design of the instrument, it also depends on the ability of the audience to relate to the performance, or in other words to identify or represent the causes of its perceptions of the performance. I will introduce the concept of "causal perception", in which a user identifies the causes of his perceptions over the analysis of how those causes are being created (Cadoz C., 1999).

So two successful scenarios are possible :

- One: the cause of the sound produced by the instrument is fully perceptible by the eyes, meaning that the instrument is designed in a completely transparent way. In a cello for instance, all the components for the generation of sound are visible : the left hand pressing the strings, the right hand holding the bow, the string vibrating and the body of the cello resonating. The audience can identify

the causes of its perceptions.

- Two : parts of the causes are hidden, but the audience has a prior knowledge of what is happening in that hidden part. In a piano for instance, the mechanical system that transforms the gesture of the musician into sound is not perceptible, but we all have a representation of that system in our mind, either because we've seen the inside of a piano or because we have heard of it and created our own representation of it. The audience can represent the causes of its perceptions.

If I consider again the issue of the electronic musician playing on a synthesiser, the second scenario seems impossible to achieve : I can hardly imagine anyone having to teach an audience about sound synthesis before a performance. But what about the first one ? Would it be possible to design a transparent synthesiser, one in which any sound transformation is perceptible by the eyes?

Or is there a third scenario ? One that goes beyond the necessity of perceiving everything?

4.3 Magic

Let's consider again the concept of causal perception mentioned earlier. This hypothesis applies both to the performers perceiving their instrument and to an audience perceiving an interaction, and implies that intellectually understanding a physical fact is not as important as perceiving the causes of that fact. That is exactly what makes something appear "magical" : the interaction is perceptible and perceived, but it's not understandable. Because the relationship between the performer and the instrument is trivial to the senses, the mind is free to focus on the expression of the performer through the instrument instead of on its relationship with it (Gurevich M., Cavan Fyans A.C., 2011). Moreover, perceiving the "causes" does not mean perceiving the whole system producing the sound, but the fundamental parts where the sound and its characteristics find their origin.

In *The Dilemma of the Performer* and in *Intelligent Musical Instruments*, (Schloss, W.A., 2002)(Schloss W.A. Jaffe D., 1993), Andrew Schloss compares two juggling performances of the Flying Karamazov Brothers. In the first one, the jugglers simply wear gloves with sensors that detect when a ball is caught and trigger a sound at the exact moment of the catch. He explains how, even if the audience does not know the method by which signals are transferred and transformed, the causes of the sound production are evident for their senses: the magic happens. The audience perceives a continuum between the performer's gestures and the sound produced: it is an instrumental interaction. Later on, the group decides to add more and more complex technology to their performances (MIDI hardware and ultra-sonic sensors). Unfortunately, they did not realise they had crossed the "threshold of magic" : because the interaction was not trivial anymore, the audience was lost in trying to figure out the causes of their perceptions instead of enjoying the virtuosity of the performance.

In Myriam Bleau's performance of *Soft Revolvers* (Figure 9), the instrument is composed of four transparent disks that can be rotated by hand. The rotation speed triggers at the same time sound samples and lights. The system enabling

the performer-instrument interaction is not trivial, yet two factors allow the audience to identify the gesture as being the causes of what they perceive, without having to intellectually understand how the system is designed. Firstly, there is a direct and clear link between the gesture of the performer and the sound and light produced, and secondly that link is made visible at a large scale by a camera projecting the interaction behind the performer.

Figure 9: *Soft Revolvers* by Myriam Bleau, 2014, (http://www.myriambleau.com/)

5 Conclusion

After acoustic and electronic instruments, if the future of music is in the digital, there will be more of a need to create instruments and performances that are tangible for the performer and relatable for the audience. My claim is this: because complementary visuals will never truly replace the perception of the musician in musical performances, it is necessary to closely reconsider the design of musical instruments at both the scale of the performer and at the scale of the performance. To create such an object, the following parameters must be taken into account: there needs to be an energetic exchange between performer and instrument as well as an energetic continuum between performer's gesture and sound. This energetic continuum needs to be trivial to the senses of both the performer and the audience.

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