Audiovisual Dynamics: An approach to Sound and Image Relations in Digital Interactive Systems

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Abstract: This paper outlines an approach to the study of sound and image relations in digital interactive systems. It starts by addressing these relations and their different conceptions, and then centers its attention on aesthetic artifacts that use software as their medium and propose interactive experiences articulated through image and sound. It discusses the principles behind their creative shaping as possibilities inherent to the digital computational medium, and conceptually frames the nature of sound-image relations as procedurally enacted dynamic articulations of visual and auditory modes subjected to interaction. Finally, it focuses on these systems' surface analyzing distinctive features of their audiovisual dynamics.

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1. Introduction

While much has been written on the multiple histories of sound and image relations, this study responds to our belief that there is still room and need to resume the topic regarding its contemporary reinterpretations. In particular, concerning practices that explore the possibilities of software, inviting the audience to interact with dynamic audiovisual configurations. These practices do not necessarily claim the dominant or historical themes of audiovisuality. Rather, they creatively reshape it within the digital computational medium, demanding renewed concepts and forms of consideration. They place this study in the intersection of *audiovisuality* and *interactivity*, as themes of creative exploration, and as viewpoints from which to approach its subject matter.

This direction of inquiry was pursued in an exploratory manner, by examining and articulating complementary perspectives on audiovisuality, its digital computational nature, and its interactive forms. We traced the evolution of the topic of sound-image relations towards the contemporary context of digital interactive systems. We then approach these systems' *audiovisual surface* as a site for *interaction*. The specificity of software-based audiovisuality is addressed in light of its underlying *principles*, as creative possibilities of its medium. As the procedural nature of these systems is highlighted, we focus on characterizing their *dynamics*, or the variable, and often indeterminable, nature of their audiovisual behavior and responses to interaction.

These viewpoints structured the research on which this paper is based (Ribas 2012), from which we now underline the ideas that emerge as contributions to the understanding and description of sound-image relations in interactive systems.

2. Sound-Image Relations and Interactive Systems

We begin by establishing an open conception of sound and image relations, and what they may encompass, in light of a convergence between artistic forms of expression and media technologies, while also considering the perceptual and receptive implications of this evolution. Their foundations and models range from sensory, structural or conceptual analogies, to the coupling, transformation, or direct manipulation of sound and image through technological means, which points towards the process-based and interactive nature of contemporary forms of audiovisuality (Ribas 2012, 31-79).[1]

In the contemporary context, rather than confining our view to a specific typology or genre of interactive systems, we chose to encompass a diversity of aesthetic artifacts. They are defined as software-driven or computational systems, whose surface (outputs and interfaces) is audiovisual, and whose interactions specifically include the audience (as user). "*Surfaces are the faces that works turn to their audiences […] as a result of their implemented processes working with their data*" whose structures, as algorithms carried out by computers, are often unavailable to the user (Wardrip-Fruin 2006, 216).

We consider the works' processes, or the procedures that structure their behavior, from the point of view of the users' phenomenology, while taking into account this conceptual reality of the work and the principles that drive its creation. We then focus on the audiovisual surface they make available for interpretation and interaction.

1. We trace this history back to Edison's machines and Wagner's aesthetic ideal of synthesis that inspired both an operatic simultaneity and a parallelism between the musical and the visual arts. While these analogies moved towards a transfer of structural methods of creative production, the simultaneous inscription of sound and image in the film medium yields their coupling (synchronization and montage) as well as new possibilities for synthesis and transformation. Two tendencies then emerge on a conceptual and technical basis: exploring film as a perception device, and the analog electronic unicity of sound and image, paving the way for interaction. We then focus on two intersecting topics: software-driven audiovisuality and interactivity (Ribas 2012, 31-79). In its contemporary manifestations, audiovisuality becomes ubiquitous and multifarious as the ideal of synthesis finds a counterpart in media technologies as a 'digital fusion' of sound and image (Daniels and Naumann 2010, 8; Zénouda 2006, 174).

3. Audiovisual Surface and Interaction

In order to study the ways in which interaction reshapes 'audio-vision' (Chion 1994), we address this perceptual mode of reception and the cross-modal mechanisms that constitute its foundations. We can then distinguish perceptual phenomena from audio-visual objects of perception that eventually promote the binding and synchresis (perceptual synthesis) of associated stimuli.[2]

Devised with the aid of technological means, these artificially constructed relations correspond to different methods and concepts, for linking the visual and auditory, or for correlating them to other (often intangible) realms. Sound and image become abstract manifestations of their synchronic and diachronic relation or correlation.

3.1. Interaction: New Roles of Sound and Image

Interaction reshapes audio-vision, through an active (sensorimotor) implication of the user, involving the haptic capture of the visual and auditory modalities, as a form of perception that arises from action (Mangen 2006, 410). Interaction implies that both entities are able to act and influence each other. The system may incorporate human activity into the way images and sounds are presented, and thus perform differently (Candy and Edmonds 2002, 2002). The user is no longer dealing with a self-contained audiovisual object, but rather with 'processes and events' that are 'brought into existence', as dynamic outputs of real-time computations (Hayles 2006, 181).

Consequently, and beyond the intrinsic value of audio and visual elements or the added value effects of their combination as cinematic manifestations, the audiovisual analysis turns towards the new roles that sound and image as *means* and as *products* of interaction.

3.2. Strategies of Articulation

In this context, their relations can also be considered at different levels, as they are specified within the system (as mappings between data), or as surface configurations of visual and auditory modes that the user actually accesses and interacts with. We can therefore approach sound-image relations by distinguishing interfaces, the user actions they promote, and their possible outcomes, as suggested by Levin (2010) or Kwastek (2010). By doing so, rather than defining relations, we are describing different strategies of sound-image articulation, according to the operative and productive possibilities of each system.

3.3. Interactivity and Performativity

In order to circumscribe the scope of interactive systems we can use the notion of performativity to address works that explore how a "*feedback loop can be established between the system and its user(s)*" allowing them to explore "*the possibility-space of an open work, and thereby to discover their own potential as actors*" (Levin 2010, 271).[3] We can also view these artifacts as apparatuses (comparable but different from instruments) whose 'functionality' as 'production devices' is potentially 'unique and novel' to the user, thus inciting creative exploration (Kwastek 2011, 157).

2. Audio-visual forms often follow design strategies that try to 'emulate', or 'play' with, our basic mechanisms of cross-modal processing and integration of different sensory modalities (Whitelaw 2008b). These relate to cross-modal interactions as well as to analogies we form upon amodal dimensions or qualities, which, in contrast to the interpersonal variance of synesthesia, are common phenomena of human perception (Shimojo and Shams 2001; Daurer 2010).

3. This notion highlights the performative dimension of the experience of a work, as jouable (playable), as performed by its spectators (Boissier 2004).

However, this view emphasizes an instrumental nature, to which the interactive systems considered do not necessarily correspond. This entails examining alternative strategies of sound-image articulation, as well as other possibilities or principles that govern their creation.

4. Principles and Medium

In order to further scrutinize the audiovisual surface, we provide an alternative perspective by resorting to the 'principles' that, according to Levin (2010), motivate the development of software artworks that are "*concerned with (or articulated through) relationships between sound and image*". They comprise sound and music visualization, the transmutability of digital data, generative autonomy and interactive performativity.

4.1. Visualization, Sonification and Transmutability

While the common traits to sound or music visualization or notations practices are the development of "*expressive visual languages*" in relation to sound[4], or the aim to provide insight into the structure of a signal or composition (Levin 2010, 272), the concept of visualization encompasses a multiplicity of methods and aesthetic strategies.[5] In this sense, sonification is its parallel, as the use of acoustic means to convey information or concepts, often used as an alternative or supplement to visualization. It is "*used artistically, as an aesthetic concept and method*", namely as a means to make the environment audible (Grond and Schubert-Minski 2010, 284).

The principle of transmutability relies on the premise that any kid of input data can be algorithmically visualized or sonified. While mostly used as a means to an end, in enabling some "*real-world data signal*" or "*data stream of interest to be understood, experienced, or made perceptible in a new way*", it can also be an end in itself, as the "*starting point for a conceptual transformation and/or aesthetic experience*" (Levin 2010, 274). This highlights the inherent 'translatability' of data as raw material that transmutes into any chosen visual or auditory form (Whitelaw 2008a, 45–54).

4.2. Performativity and Generativity

The notion of performativity concerns systems that entail the "*mapping of human data*" or "*human performances*" to images and sounds, as "'*open works*' *or* '*meta-artworks*' *… which are only experienced properly when used interactively to produce sound and/or imagery*" (Levin 2010, 275). They emphasize an interactive performativity as subject matter, rather than interaction as a mere possibility or attribute of a system.

In turn, the principle of generativity refers to the potential autonomy of a system to "*produce animations and/or sound from its own intrinsic rule-sets*" (Levin 2010, 277). It draws attention to the "*rules of creation*" of the work, as "*artistic constraints*" (Bootz 2005); as "*recipes for autonomous processes*" (Galanter 2006) that develop in time, in a self-organizing manner, potentially leading to unforeseeable results, which are not completely predictable neither by artists nor user (Boden and Edmonds 2009, 24).[6] What becomes relevant then, is how this generative autonomy is manifested and may be perceived by the audience.

4. Which display either "time-based representations of perceptual phenomena", like pitch, loudness, and other "relatively instantaneous auditory features" (Levin 2010)

5. Moreover, it can be extended to visualizations of the human voice or other user produced sounds, as well as an algorithmically defined connection between sound and image, entailing their simultaneous generation or submission to similar parameters.

6. The work occurs while running as a unique performance whose rules of creation, or procedural logic, can only be grasped through careful observation and interaction.

These principles draw attention to the specificity of software-driven systems and to their heterogeneity as aesthetic artifacts that explore distinct possibilities of their medium. They correspond to different ways of exploring the mapping of a given input data or source information into visual and auditory form, and to the possibility of devising dynamic audiovisual behaviors and responses to interaction. As such, we can extend their discussion to other notions that are used to address these creative possibilities, and to define themes or aesthetic qualities of these systems.

5. Possibilities and Qualities

The artifacts considered in this study use computers not only as storage and transmission media but require computation in order to be themselves, during the time of their experience. They are computationally variable works in which "*processes are defined in a manner that varies the work's behavior (randomly or otherwise)*", either without input from "*outside the work's material*", with input from "*external data or processes*", or with human input; the latter meaning audience interactive (Wardrip-Fruin 2006, 389–99).

These factors of variation again highlight the creative possibilities of a medium, where "*data and process are the major site of authoring*" (Wardrip-Fruin 2006, 381). In fact, the principles mentioned correspond to a rephrasing of "*aesthetic possibilities*" that, according to Levin, stress the self-referential nature of computational works that "*address as their subject matter*" the "*structures, materials and processes by which they are created*", namely: interactivity; processuality; generativity; transmediality (Levin 2003; 2007).[7]

According to this, transmediality is linked to audiovisuality, multimodality and thus to transmutability, which stresses the inherent 'polymorphism' of digital data. While these terms accent the translation processes performed on non-process elements of the work (data and its audiovisual forms), the principles of generativity and interactivity bring to the fore the processes, as operations carried out by the work (defining the surface and supporting interaction).

5.1. Processuality and Performativity

Processuality concerns the algorithmically structured operations carried out by a procedural system (that computationally executes rules), potentially leading to variable outcomes. As Jaschko (2010, 130) asserts, process is a "*central aesthetic paradigm*" of generative and interactive artworks, since "*live processes… generate unique configurations and dynamics*", performed either by the system, or by system and user. Process then refers to the "*time-based evolution of… sequences of events*" as results of ongoing computations, that conflates with performativity as a term designating both the "*quality of a technological artifact in operation*" (an execution) and the 'live' dimension of a presentation (Broeckmann 2005).[8] Hence, the expression and experience of these works is shaped by their modes of liveness (temporal simultaneity) and presence (spatial co-attendance), together with their visual and auditory realization (Kwastek 2009, 93).

5.2. Surface vs. Procedural Expression

Implied in these notions is the idea that beyond the "*retinal beauty*" of audiovisual sensory perceivable results (Jaschko 2005), the "*iconographic level*" (Broeckmann 2005) or

7. The author also mentions "connectivity" and "dynamism", adding that "naturally, these are not the only principles", but they outline aspects that "really have much more to do with features of the medium and how it operates in relation to people" (Levin 2003; 2007).

8. As Broeckmann (2005) argues, processuality is one of the essential "aesthetic qualities" of electronic and digital artworks, whose aesthetic experience "hinges, to a large extent, on non-visual aspects" or "machinic qualities" manifested at the level of "movements, of processes, of dynamics, of change".

beyond the "*rhetoric of the surface*" (Bootz 2005), digital computational works entail a 'conceptual level' tied to the 'cognitive recognition' of the formal processes they carry out (cf. Jaschko 2005; Whitelaw 2010, 158). This emphasizes the procedurality that Murray or Bogost characterize as the "*principal value*" of the computer in relation to other media, or its "*defining ability*" to execute rules that model the way things behave (Murray 1997, 71). We then move towards an aesthetic level that is tied to their "*procedural rhetoric*" or "*the practice of using processes expressively*" (Bogost 2008, 122–24).

Therefore, an analysis of the audiovisual surface cannot be limited to its sensorial qualities of expression, but include the expressive qualities of the procedures that govern its behavior. In other words, these works' content "*is their behavior and not merely the output that streams out*" (Hunicke, LeBlanc and Zubek 2004, 1).

5.3. Dynamics of the Work-as-System

These notions highlight the subordination of audiovisuality to procedurality, and ultimately, how sound and image as aesthetic materials, subsume to the processual and performative aesthetic qualities of works that occur while running, as processes performed in real-time, with the participation of the audience. This provides the conceptual ground for our approach.

On one level, what is emphasized is the possibility to *create behavior* — whether autonomous, reactive or interactive. In this sense, we address artifacts whose subject matter is not necessarily tied to relations between the visual and auditory. However, by exploring the possibilities of the medium, they propose potentially unique, dynamic configurations of images and sounds. Our attention indirectly diverges from practices concerned with the mapping or translation of any kind of information or content into visual and/or auditory form, as we shift the focus towards systems where sound and image are the tangible expression and consequence of a dynamic process (emphasizing processuality and interactivity).

On another level, what becomes defined as the distinctive quality of these systems is the dynamics of their behavior.[9] In contrast to other time-based forms of audiovisuality, they not only have a *transient*, but also a *variable* nature, that entails the temporal simultaneity and spatial co-attendance of the user. 'Liveness, immediacy and presence', become characteristic aspects of the experience of these process-based and participatory forms of audiovisuality (Jaschko 2010).

Consequently, our study is then dedicated to characterizing the *observable dynamics* of the work-as-process (as an activity performed in time), and of the work-as-system (that includes the user).

9. The notion of dynamics refers to the observable 'run-time behavior of the work-as-system' as part of a framework proposed by LeBlanc to understanding computational systems "where the interaction between coded subsystems creates complex, dynamic (and often unpredictable) behavior". Mechanics, Dynamics and Aesthetics are causally linked levels of the work, as "aesthetics is born out in observable dynamics and eventually, operable mechanics" or the underlying rules that formally specify the work "at the level of data representation and algorithms" (Hunicke, LeBlanc and Zubek 2004).

6. Perspectives on Audiovisual Interactive Systems

Drawing on the previous views on the audiovisual surface, the principles behind its creative shaping, and the qualities of these systems' behavior, we propose an approach to audiovisual interactive systems that articulates different viewpoints: it considers their heterogeneity as aesthetic artifacts, and addresses both their audiovisual and interactive dimensions under the perspective of the dynamics that defines their experience. Having applied these perspectives to four case-studies, while also relating their characteristics

to those of other systems (Ribas 2012, 271–319), we now summarize its main points. In order to contrast different audiovisual configurations as well as contexts and possibilities for interaction we chose two online works and two installations: Antoine Schmitt's *Worldensemble* (2002), Peter Luining's *360° rotatable* (2003), *Manual Input Workstation* (2004) by Levin & Lieberman (Tmema) and *Se Mi Sei Vicino* (2006) by Sonia Cillari.

6.1. Systems as Aesthetic Artifacts

We begin by contextualizing their themes and principles according to their self-referential nature as works that are prospective in exploring the possibilities of software, with different aesthetic intents. These artifacts are considered abstract, or non-representational, since the audiovisual surface is a product of the work's operations and interactions. Sound and image, in their dynamic articulations, express the subject matter of these works, be it their potential autonomy (as endless audiovisual rhythms), reactivity to human actions (as audiovisual abstractions of interaction) or even as translations or expressions of specific aspects (e.g. gestural expression or proxemic relations) of human participation.

6.2. Audiovisual Dynamics and Interaction

We then describe their audiovisual surface behavior addressing the nature of its elements (predefined or generated), the ways they appear associated (correlated or responding to different factors), and related to user actions or input. We therefore approach increasingly complex articulations between human input and audiovisual outputs, as well as custom interfaces and physical forms of interaction. As the behavior of these systems may be tied to different factors, a perspective on interaction is not solely focused on action-reaction patterns, but on the overall variable behavior of the work, in each occurrence and in response to interaction.

6.2.1. Interaction and Agency

In order to develop this analysis, we revisit the notion of interaction according to the roles of user and system as agents determining the audiovisual outcomes. Rather than focusing on instrumental distinctions such as types, degrees or levels of interaction, we aim at characterizing the "*aesthetic processes encouraged*" by interactive works (Kwastek 2008, 22). To this end, it becomes useful to consider the "*aesthetic pleasure of agency*", as proposed by Murray (1997), which depends on the ways our actions are aligned with tangible effects. Agency is linked to the possibility to access different spaces, as a pattern of "*exploration and discovery*", and to the "*constructive role*" the users may assume when they can "*build in some way*" the very content of the work.

We discuss the ways in which the user may *explore or configure* the audiovisual surface, resorting to derivations of Aarseth's (1997) user functions. Nonetheless, they do not necessarily correspond to an alignment between action and effect. The users "*may not realize that they are affecting the artwork, nor (if they do) just what behavior leads to just which changes*" (Boden and Edmonds 2009, 35),[10] since there may be additional factors of influence, other than those explicitly related to user input or actions.

An alternative way of putting this is considering that agency, rather than pertaining to the user, is attributed to the system, in the very sense that Murray ascribes to it — taking 'meaningful action' leading to 'observable results'. Just as a human being has the capacity to sense its environment, operate on it, and make decisions, a system can be imbued with

10. These effects may be partial or divided between sound and image, ephemeral, not clearly perceptible or even not perceptible at all.

these properties. Agency can be understood as the "*property of an autonomous entity that is its capacity to act in or upon the world*" (Jones 2011). Interaction becomes a means of testing the behavior of systems that potentially run autonomously, in a self-organizing, and often unpredictable, manner.

6.2.2. Surface Dynamics and Determinability

Having examined the variable behavior of these systems as governed by different factors we describe their *surface dynamics* in terms of changes in the number, arrangement or creation of surface instances over time. The work's behavior is also characterized by its *determinability*, or the degree to which it operates predictably in the production of surface elements or configurations, in each occurrence, and in response to interaction. However, the audio and visual dimensions may not necessarily assume a correlated behavior, and the same applies to its determinability. The latter also leaves open what can be considered an exact repetition of the same experience, thus questioning the degree to which one can grasp, or control, the factors that define the precise configuration of the audiovisual outputs (Ribas 2012, 247–65).

6.3. Discussion

This description goes beyond the previous view on sound and image as means and products of interaction, and on their relations as mapping to user input, in revealing how each of the artifacts considered devises a specific way of governing the behavior or of generating visual and auditory elements, and in this process, include (or even depend) on the user. So rather than aiming at generalizations of their sound-image relations (as data mappings), we seek to underline distinctive features of their dynamics. We emphasize how sound and image acquire meaning through action, as the products of processes (performed by the system, with the participation of the user).

This approach also reveals how interaction entails different forms of engagement with the work as a means of exploring its (variable) behavior or its productive possibilities, or as a form of influencing, or of defining, its audiovisual outcomes.

7. Conclusion

This study addressed a topic of audiovisuality that is reshaped in reference to its medium. But rather than resolving this topic, it provides a point of departure for further investigating dynamic interactive audiovisuality. Namely, we envisage the study of a wider set of artifacts in order to refine an analysis of the characteristics of their behavior. While we have focused on describing the works' dynamics, future research also contemplates how the audience experiences its features, namely through structured observations of the interaction process. In particular, we can further examine its determinability (in relation to each modality), and the degree to which it is perceived by the user as a significant aspect of the experience of the work.

We approached a segment of contemporary practices that, in their diversity, often move ahead of theory. They reshape the very conception of sound-image relations beyond its dominant themes or approaches. Acknowledging this variance, this work responds to its demands, by conceptually framing the nature of these sound-image relations, as procedurally enacted dynamic articulations of visual and auditory modes, subjected to

interaction. In this manner, it provides a direction for researching the constant creative reformulations of this topic. One that embraces the diversified nature of audiovisual systems as aesthetic artifacts, their principles, and themes, and what they propose as interactive experiences. It respects this diversity by describing sound and image, and their relations, according to the distinctive dynamics of these systems, or the variable (and often indeterminable) behavior, that defines their meaning and experience.

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