

Sound-Image Relations and Dynamics in Digital Interactive Systems

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Abstract — This paper summarizes our research on sound-image relations in digital interactive systems, proposing a contribution for their understanding and description. It starts by addressing the multiplicity of sound-image 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. The study is oriented towards their analysis from the perspective of the surface that is experienced by the audience as user. It discusses the principles behind its 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 four aesthetic artifacts, analyzing distinctive features of their audiovisual dynamics.

Index terms — sound-image relations, audiovisuality, digital, art, design, interaction.

I. INTRODUCTION

The topic of sound-image relations is characterized by its plurality as a theme of creative exploration. While much has been written on its multiple histories, we believe that there is still room 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 configurations of images and sounds. 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.

Consequently, rather than assuming a pre-defined idea of sound-image relations, we opted to confront the different ways in which they are conceived and described. And rather than confining our view to a specific typology or genre of interactive systems, we chose to encompass a diversity of aesthetic artifacts. Their analysis is focused on the audiovisual surface they make available for interpretation and interaction.

This direction of inquiry was pursued in an open-ended and exploratory manner, circling from deductive objectives to inductive readings and interpretations of

data, while examining and articulating complementary perspectives on audiovisuality, its digital computational nature, and its interactive forms. These different viewpoints structure the study, forming an open framework of key topics and instrumental concepts that shaped our understanding and approach to the subject.

We traced an *overview* of the topic of sound-image relations, by mapping the paradigms and models that shape its evolution 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*. We then contextualize these *systems as aesthetic artifacts*, analyzing the transient, variable, and often indeterminable, nature of their audiovisual behavior and responses to interaction.

Following this thematic structure, this paper underlines the ideas that emerge as specific contributions to the understanding and description of sound-image relations in digital interactive systems.

II. SOUND-IMAGE RELATIONS AND INTERACTIVE SYSTEMS

This study draws an open conception of sound-image relations and what they may encompass. From a diachronic viewpoint, its multiple themes comprise debates on the merging of the arts, technological innovation and the search for new artistic forms of expression, as well as the perceptual and receptive implications of this evolution.¹ Their foundations and models may range from sensory, structural or conceptual analogies, to the

¹ We trace this history back to Edison's machines and Wagner's aesthetic ideal of synthesis that inspired an operatic simultaneity and a parallelism between the musical and the pictorial 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) and new possibilities for synthesis and transformation. Two tendencies emerge on a conceptual and technical basis: an exploration of film as a perception device and of the analog electronic unicity of sound and image, paving the way for interaction. As digital technologies entail diversified developments, we focus on two intersecting topics: software-driven audiovisuality and interactivity [1: 31-79].

coupling, transformation, or direct manipulation of sound and image through technological means, which point towards the process-based and interactive nature of contemporary forms of audiovisuality [1: 31-79].

In its contemporary manifestations, audiovisuality becomes ubiquitous and multifarious. The yearning for a synthesis finds a counterpart in media technologies as a ‘digital fusion’ of sound and image [2: 8, 3: 174].² With the digital computational medium all previously conceived relations can coexist and be reformulated, as the “so-called universal machine” can integrate all formats, and emulate all functional principles of previous media technologies, while also entailing new ones [4: 121]. Every physical and sensory realm becomes transcoded into a numerical representation and governed by algorithmic procedures, rendering the possibilities for linking, generating and manipulating the visual and auditory virtually infinite. Due to this creative potential, new forms of audiovisuality arise, demanding action and participation in interactive experiences.

In order to encompass the potential diversity of these aesthetic artifacts, we define the systems considered in this study according to their unifying traits. They are software-driven or computational systems, whose surface (outputs and interfaces) is audiovisual, and whose interactions specifically include the audience as user. In Wardrip-Fruin’s words, “Surfaces are the faces that works turn to their audiences [...] as a result of their implemented processes working with their data”, while the algorithms, as “structures of ‘processes’ carried out by computers”, are often unavailable to the user [5: 216]. We therefore address the work’s processes, or the procedures that structure their behavior, from the point of view of the users’ phenomenology, by focusing on the surface. Since the surface is creatively shaped as software, we take into account this conceptual reality of the work and the principles that drive its creation.

III. AUDIOVISUAL SURFACE AND INTERACTION

By addressing *audio-vision* as a perceptual mode of reception, and the cross-modal mechanisms that constitute its foundations, we can distinguish perceptual phenomena from *audio-visual* objects of perception that eventually promote the binding and the synchresis (or perceptual synthesis) of associated and concomitant audio and visual stimuli. These 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 [6].³

² When ‘numerically represented, defined by a program, and subjected to interactive manipulation’ [3: 174].

³ Their creation is based on ‘techniques of associative construction’ that provide a particular “tuning of acoustic and visual elements”, which tends to ‘activate’ (pre-conscious and conscious) links or connections between stimuli [7].

These relate to cross-modal interactions as well as to analogies we form upon amodal dimensions or qualities, which, in contrast to the subjective interpersonal variance of synesthesia, are common phenomena of human perception [8, 9]. As they are 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. As such, sound and image become abstract manifestations of their synchronic and diachronic relation or correlation.

A. Interaction and the new roles of sound and image

Digital interactive systems place the users in a mode that is not merely receptive but active and participatory in shaping the audiovisual outcomes. Accordingly, 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 [10: 181]; they give us “not objects, but instances—occasions for experience” [11: 311].

Interaction reshapes the rules of audio-vision as an active (sensorimotor) implication of the user. It involves the haptic capture of the visual and auditory modalities, as a form of perception that arises from action [12: 410]. It implies that both entities are able to act and influence each other. The system may “incorporate human activity into the way visual images and sounds are presented”, and thus ‘perform’ differently, according to what the user does [13: 2002]. This entails new ways of entering time unmatched by other experiences, as the user defines a ‘temporal pace’ and ‘spatial path’ within the possibilities presented by the system [3: 133, 14].⁴

Accordingly, 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 assume as *variables* of a dynamic system, defined by a program and reacting to user input. They become the aggregated means through which the user interacts and the products of interaction (as manipulation tools and manipulated objects), defined according to the system’s operative possibilities.

B. Strategies of sound-image articulation as means and products of interaction

We can therefore approach sound-image relations in interactive systems by distinguishing interfaces, the user actions they promote, and their possible outcomes, as suggested by Levin [15] or Kwastek [16]. These can range from the common computer screen and cursor-based interactions, towards camera-based and other custom, or even tangible interfaces, emphasizing the

⁴ The users do not just actively construct a cognitive interpretation, but also actively define what and how they receive.

human actions or ‘performances’ demanded to the user. They may allow free gestural actions (such as drawing) or cursor-based actions, for manipulating graphic elements or simulated objects whose visual properties (colors, shapes), physical properties (height or weight) or contextual properties (proximity, distance) are associated to sound properties. This can also extend to the physicality of bodily actions (including presence or movement) as well as the manipulation of tangible objects. Similarly, the operative and productive possibilities may range from the visual manipulation of sound to the simultaneously manipulation, or creation, of audio and visual compositions. In summary, the user may be given the possibility of manipulating or generating images and sounds through any kind of input that the system is able to detect, be it motor, physical actions, or even voice input.

In this context, sound-image relations are also 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 accesses and interacts with. Thus, rather than referring to *relations* we may refer to strategies of sound-image articulation devised within each system.

C. Interactivity and performativity

This kind of description of sound-image articulations emerges from the specificity of the aesthetic artifacts considered, whose analysis may be tied to, but does not necessarily depend on, the typology of a system or its presentation format. This raises the question of the scope of systems addressed; how they can be circumscribed. Levin proposes the notion of performativity to encompass audiovisual interactive systems that can range from ‘games’ to “expressive audiovisual ‘instruments’ or ... ‘toys’” being that, in many cases, these boundaries blur, while they also move between different ‘forms and contexts’ as commercial products, installations or browser-based Internet experiences.

The notion is used to underline what these systems share as works that explore how a “feedback loop can be established between the system and its user(s) — allowing a user or visitor to collaborate with the system’s author in exploring the possibility-space of an open work, and thereby to discover their own potential as actors” [15: 271]. Performativity can then be associated to the notion of the ‘playable’ (*jouable*), as a common characteristic of interactive systems that place themselves between art, games, instruments, without claiming any of these forms. What it asserts is “the notion of exercise, the performative dimension of experience” of a work that is ‘performed by its spectators’ [17].

An alternative way of characterizing audiovisual interactive systems is proposed by Kwastek, defining them as apparatuses (comparable but different from instruments) whose ‘operative possibilities’ and ‘func-

tionality’ as ‘production devices’ are potentially ‘unique and novel’ to the user. As such, they incite the user to engage in their ‘creative exploration’ [18: 7, 19: 157].⁵ However, this view emphasizes productive or even instrumental possibilities to which the systems considered in this study do not necessarily correspond. Their audiovisual outcomes may not merely result from, nor be mere products, of audience interaction, but may instead be driven by factors complementary to interaction. This entails considering alternative strategies of sound-image articulation, as well as other possibilities or principles that may govern their creation.

IV. PRINCIPLES AND MEDIUM

In order to further scrutinize the audiovisual surface, we provide an alternative perspective on the subject, by considering its creative shaping according to different possibilities of its medium. We resort to the different principles, which, according to Levin, motivate the development of software systems that are “concerned with (or articulated through) relationships between sound and image”. Their diversity is approached through the notions of “sound visualization and notation, transmutability of data, performativity, and generativity”, which are illustrated with software-driven artworks that “use music to generate aesthetic or analytic visualizations, ... map ‘real-world’ data signals to graphics and sound, ... use human performances to govern the synthesis of animation and music”, and “generative artworks [that] produce animations and/or sound autonomously — from their own intrinsic rule-sets” [15: 270-277]. However, within each principle the methods and strategies of sound-image articulation greatly differ, both in technical and aesthetic terms.

A. Visualization, sonification and transmutability

The common traits to sound or music visualization or notations practices are the development of visual languages that display either “time-based representations of perceptual phenomena”, like pitch, loudness, and other “relatively instantaneous auditory features”, or provide insight into the structure of a sound signal or musical composition [15: 270-277]. Yet, an algorithmically defined connection between sound and image may also entail their simultaneous generation or their submission to similar parameters, and can also expand the principle towards visualizations of the human voice or other user produced sounds.

As a theme of creative exploration, visualization is a concept that encompasses a multiplicity of methods and aesthetic strategies. As such, its parallel is sonification,

⁵ Rather than mere instruments, they offer an open field of possibilities for the user to explore, whose inherent rules are only decoded through testing, as ‘forms of expression that make possible the articulation of yet other forms of expression’ [20: 117].

or the use of acoustic means to convey information or concepts, which is often used as an ‘alternative or supplement’ to visualization. Sonification is used “artistically, as an aesthetic concept and method”, namely as a means to make the environment audible [21: 284].

This is treated by Levin under the principle of ‘transmutability’, which encompasses both the visualization and sonification of ‘any kind of input data’. Mostly “used as a means to an end”, the transmutability of digital data enables some ‘real-world data signal’ or “data stream of interest to be understood, experienced, or made perceptible in a new way”. However, it can also be an end in itself, since the premise that “any information can be algorithmically sonified or visualized is the starting point for a conceptual transformation and/or aesthetic experience” [15: 274]. This highlights the inherent ‘translatability’ or ‘mutability’ of data as ‘raw material’, as an abstraction of information or content; as numerical quantities and properties that ‘transmute’ into any chosen visual or auditory form [22: 45-54].

B. Performativity and generativity

Behind the notion of performativity are systems that entail the “mapping of human data” or “human performances” to images and sounds; they depend on the user to perform and allow the user to perform their outcomes. Most of these systems are “‘open works’ or ‘meta-artworks’ ... which are only experienced properly when used interactively to produce sound and/or imagery” [15: 275]. They emphasize an *interactive performativity* of user and system, as a process of actualization of the work. Interactivity itself is the subject matter, rather than a mere possibility or an attribute of a system.

In contrast, the principle of generativity refers to the potential autonomy of a system to “produce animations and/or sound from its own intrinsic rule-sets” [15: 277]. It draws attention to the ‘rules of creation’ of the work as ‘artistic constraints [23]. The artist specifies rules as “recipes for autonomous processes” [24] that develop in time, in a self-organizing manner, and potentially leading to unforeseeable results, which are not completely predictable neither by artists or user [25: 24]. 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. Thus what becomes relevant is how the potential *generative autonomy* of the system is manifested and may be perceived by the audience.

These principles define themes of creative exploration rather than attributes of systems; however, they also interrelate as we expand the scope of systems. Their discussion points to the specificity and self-referential nature of these works (as digital computational systems), and to the subjective discourses they entail 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 this discussion to the different notions that are used to address these possibilities, and to define themes or qualities of audiovisual software systems.

V. PRINCIPLES, POSSIBILITIES AND QUALITIES

The audiovisual systems considered in this study use computers for computation and not only as storage and transmission media; they require computation during the time of their experience, and in order to be themselves. These 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 being specifically “from humans aware of the work”, that is to say, audience interactive [5: 389-399].

These factors of variation relate to the themes or principles discussed, which correspond to a rephrasing of the main “aesthetic possibilities” inherent to the digital computational medium, adapted by Levin to sound-image relations. In his words, they 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 (the character of the feedback loop established with a user; creative flow, play, cybernetic feedback); processuality (the character of algorithmic processes; generativity); transmediality (the way the senses are addressed in simultaneity; tangibility, audiovisuality, environment) [26, 27].⁶

They emphasize creative possibilities of a medium, where “data and process are the major site of authoring” [5: 381]. Transmediality is linked to audiovisuality, multimodality and to transmutability, which stresses the inherent ‘polymorphism’ of digital data or “its susceptibility to transformation” [22]. While these terms accent the translation processes performed on non-process elements of the work (data and its audiovisual rendering), 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).

A. Processuality and performativity

Processuality emphasizes the algorithmic structuring of processes, as operations carried out by a procedural system (that computationally executes rules), potentially leading to variable outcomes. As Jaschko asserts, proc-

⁶ 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” [26, 27].

ess is a ‘central aesthetic paradigm’ of both generative and interactive artworks, since “live processes take place that generate unique configurations and dynamics”, performed either by the system itself, or by system and user [28: 130]. This understanding of ‘process’ refers to the “time-based evolution and transformation of ...sequences of events” as results of ongoing computations. It conflates with the notion of performativity, as a term used to designate both the “quality of a technological artifact in operation” (an execution) and the ‘live’ dimension of a presentation [29].⁷ Thus 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 [30: 93].

Implied in these notions is the idea that beyond the “retinal beauty” of audiovisual sensory perceivable results [31], the “iconographic level” [29] or beyond the “rhetoric of the surface” [23], digital computational works entail a ‘conceptual’ level tied to the ‘cognitive recognition’ of the formal processes carried out by a system [cf. 31, 32: 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 [33: 71]. We then move towards an aesthetic level that is tied to their “procedural rhetoric”, or “the practice of using processes expressively” [34: 122-124]. Therefore, an analysis of the audiovisual surface cannot be limited to its sensorial qualities of expression, but includes 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 [35: 1].

VI. 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 procedural 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 to the nature of sound-image relations in digital interactive systems.

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

⁷ As Andreas Broeckmann [29] 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”.

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 (relating to visualization, sonification or transmutability). While not excluding these practices, we shift the focus towards systems where sound and image are the tangible expression and consequence of a dynamic process (thus, emphasizing processuality and interactivity).

On another level, what becomes defined as the distinctive *quality* of these systems is the *dynamics* of their behavior.⁸ 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. In other words, ‘liveness, immediacy and presence’, become characteristic aspects of the experience of these process-based and participatory forms of audiovisuality [28]. 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 (including the user).

A. Dynamics and interaction

We now revisit the notion of interaction according to the roles of user and system as *agents* determining the audiovisual outcomes. Interaction entails that both entities act and influence each other, being that different categories, types, degrees, levels and intents of interactivity can be discussed. However, this kind of instrumental distinctions may not suffice to characterize the ‘aesthetic processes encouraged’ by different interactive works [36: 22]. In this sense, Janet Murray [33] distinguishes mere interactivity from the ‘aesthetic pleasure of agency’ that depends on the ways our actions are aligned with tangible effects, as ‘an experience to be savoured for its own sake’. 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.

B. User functions

We can tentatively align these actions with different interpretations of the ‘user functions’ defined by Espen

⁸ 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” [35]. The dynamics, or the observable behavior of the systems considered in this study is variable; they vary their behavior according to different factors.

Aarseth [37] that relate to the processes for ‘revealing’ and ‘generating’ surface elements from data. One pertains to the ways the user can *explore* or *access* specific spaces or configurations, which are not created with their intervention. The other concerns the ways in which the users can ‘configure’ the audiovisual surface, by *explicitly modifying*, *rearranging* or *creating* surface instances, or by altering variables, hence reconfiguring the surface. Nonetheless, these functions do not necessarily correspond to an alignment between user actions and their intended effect. The users “may not realize that they are affecting the artwork, nor (if they do) just what behavior leads to just which changes” [25: 35],⁹ since there may be additional factors governing the variable configurations of the surface, other than those explicitly related to user input or actions.

C. Agency

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’, and “exerting power over enticing and plastic materials” [33: 153]. Just as a human being has the capacity to sense its environment, operate on it, and make decisions, a system can be imbued with these properties. Agency can be understood as the “property of an autonomous entity that is its capacity to act in or upon the world” [38]. This can be a form of promoting an alternative aesthetic pleasure beyond interactivity, a ‘procedural pleasure’ [39: 422] tied to the ways in which these systems may promote imagination and speculation on their operations. Interaction becomes a means of testing the behavior of systems that run autonomously, in a self-organizing, and often unpredictable, manner.

D. Surface dynamics and determinability

Taking into account that the variable behavior of these systems may be governed by different factors, we can 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 [1: 247-265]. 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 being tied to the degree to which one can grasp, or control, the factors that define the precise configuration of the audiovisual outputs.

⁹ These effects may be partial or divided between sound and image, ephemeral, not clearly perceptible or even not perceptible at all.

VII. AESTHETIC ARTIFACTS: THEMES, AUDIOVISUAL DYNAMICS AND INTERACTION

Drawing on these views on the audiovisual surface, the principles behind its creative shaping, and the distinctive qualities of its behavior, we propose an approach to audiovisual systems that articulates different viewpoints: it contextualizes their heterogeneity as aesthetic artifacts, and considers both their audiovisual and interactive dimensions under the perspective of the dynamics that defines their experience.

We first approach the different ways in which these artifacts explore the possibilities of its medium as their subject matter (their themes and concepts). This is the starting point for considering sound-image relations as dynamic surface configurations of visual and auditory modes (the ways they appear associated and related to user actions). As their behavior 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.

A. Perspectives and case studies

These interdependent viewpoints are applied to four case studies, whose selection is guided by the diversity of their audiovisual and interactive configurations, reflecting their self-referential and, ultimately, abstract nature. In this sense, sound and image mediate the specific reality of the work as system, as an expression or consequence of processes that are newly defined for the work, thus unique and novel to the user. In order to contrast different 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.

Worldensemble is described as an ‘instantaneous endless interactive autonomous piece’ composed of ‘sound, image and algorithms’ [40]. Reduced to a minimal expression, sound and image draw attention to their underlying cause; they enable us to apprehend the mode of being of programmed entities. Interaction is reduced to navigating the ensemble, mostly as a means to test its behavior. In contrast, the other systems more evidently promote interaction, while closely linking sound, image and human input, although in distinct ways.

360° rotatable is a user-driven sound engine where sound loops are attached to graphic shapes that respond to mouse actions, while also subverting control with their animated behavior. This minimalism provides a way of bringing “interactivity back to its basic” [41], to a pure pattern of audiovisual events that mediate nothing other than their activity and reactivity.



Fig. 1. Antoine Schmitt, *Worldensemble* (2002).

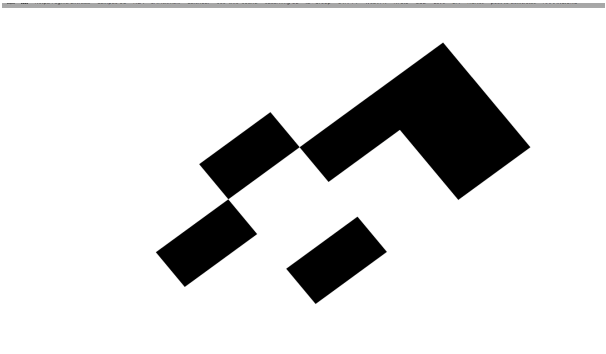


Fig. 2. Peter Luining, *360° rotatable* (2003).

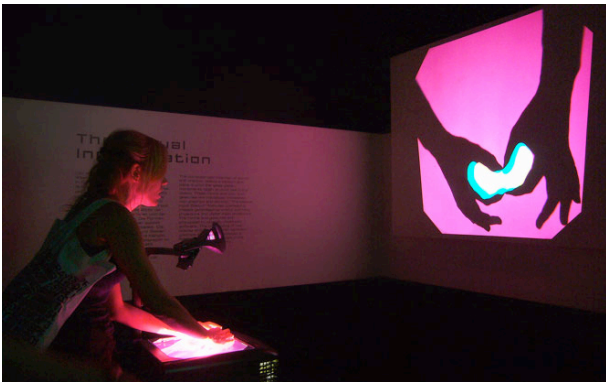


Fig. 3. Levin & Lieberman (Tmema), *Manual Input Workstation* (2004).



Fig. 4. Sonia Cillari, *Se Mi Sei Vicino* (2006).

In turn, both the *Manual Input Workstation* and *Se Mi Sei Vicino*, devise unconventional interfaces where the physical dimension of interaction is brought to the fore, as well as the interdependency between user input and audiovisual outcomes. These systems not only react to specific actions but also incorporate input data that is used to determine the ways in which the visual and auditory elements are defined and behave.

Levin & Lieberman devise the *Manual Input Workstation* as a suite of three “audiovisual vignettes which probe the expressive possibilities of hand gestures and finger movements” [42: 115]. The users’ hand gestures are interpreted by a computer vision system and used to generate synthetic graphics and sounds, which become tightly coupled to the visitors’ actions.

The installation and performance *Se Mi Sei Vicino* takes this discussion to another level of complexity while ‘exploring the body as interface’, with the aim of “measuring human encounters” [43] or ‘proxemic’ relations (distances, physical and social) between humans interacting. It is the relative distance between the bodies of human participants that is detected by the interface and drives the behavior of a dynamic visual structure, therefore, determining what is to be seen and heard.

B. Discussion

These works can be considered prospective in exploring the possibilities of software, while respectively questioning the cause of their behavior, abstracting interactivity to a basic pattern, or incorporating human expression in audiovisual performances, as well as audiovisual translations of human interactions. Consequently, sound and image (and their dynamic articulations) express the subject matter of these works, as autonomous entities, as reactive events, or even as translations of the information that is detected and incorporated by the system, be it the individual’s gestural expression or the proxemic relations between human participants.

By further characterizing their audiovisual surface behavior we address the nature of the visual and auditory elements, the ways they appear associated, and related to user actions, and approach increasingly complex articulations between human input and audiovisual outputs, as well as custom interfaces and physical forms of interaction. This description also complements and binds the previously defined views on sound and image, as means and products of interaction, and their mapping to user input. It shows that 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.

Rather than aiming at generalizations of their sound-image relations (as data or output modes), this logic of description provides a means to underline the distinctive features of the dynamics that defines and distinguishes

these aesthetic artifacts. We emphasize the ways in which 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 behavior or its productive possibilities, or as a form of influencing, or defining, its audiovisual outcomes.

VIII. CONCLUSION AND FUTURE WORK

In this study we addressed a topic of audiovisuality that is reshaped in reference to the creative possibilities of its medium. But rather than resolving this topic, we provide 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 this study described their dynamics, future research also contemplates how the audience experiences its features, through methods such as structured observations of the interaction process. In particular, we can further examine the determinability of the work's behavior, and the degree to which it is perceived by the user as a significant aspect of the experience of the work.

This study approached a segment of contemporary practices that use software as their medium, and propose interactive experiences articulated through images and sounds. In their diversity, they often move ahead of theory, reshaping the very conception of the topic 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 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, while embracing 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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