

Perspectives on digital computational systems as aesthetic artifacts

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ABSTRACT

This paper addresses the study of digital computational systems as aesthetic artifacts seeking to provide instruments for their analysis and critical understanding. What this aim implies is the need to articulate complementary perspectives for considering not only their specificity as digital computational (software-driven) systems, but also the different aesthetic intents that drive the creation of these artifacts, as well as the kinds of experience they propose. This approach entails articulating the viewpoint of their creation or poetics with the viewpoint of their experience or aesthetics, while tackling into their enacted processes. Accordingly, this paper discusses concepts, models and frameworks that not only argue on the distinctive processual nature of these systems, but also stress the interdependency of views on their principles, mechanics and experience.

KEYWORDS

Digital; Computational; Art; Design; Aesthetics; Models; Frameworks.

1 | INTRODUCTION

This paper was motivated by a previous study of audiovisual interactive systems and is also informed, or can be seen as the result, of a pedagogical approach to their study [1]. When considering artifacts that explore the possibilities of software as a creative medium and that propose interactive experiences that are articulated through images and sounds, a question that emerges is that before addressing their audiovisual and interactivity specificity, we need to provide a deeper understanding of these systems as aesthetic artifacts (Ribas, 2013). This lead us to acknowledge that, rather than just focusing on their surface audiovisual modes of expression we need to understand the dynamics of these systems, and before addressing the specifics of audience interaction, we need to frame interaction as one of the dimensions of the dynamic and variable behavior of these systems.

To this end, we discuss different concepts and frameworks for understanding these systems. We begin by framing practices, while addressing the principles that motivate and drive the creation of these

artifacts. We then consider their digital computational specificity, by framing systems, and address their dynamic nature as systems that are driven by processes, by framing processes. These views emphasize processuality as a distinctive feature of these systems that is tied to their procedural creation and to the performative dimension of their experience. In this manner, they shift the focus from their (audiovisual) surface to their procedural modes of expression and dynamics. According to this, we discuss complementary but interdependent views on these systems, by framing perspectives, concerning their creation, enactment and experience.

2 | PRACTICES AND PRINCIPLES

In order to frame the diversity of practices that use software as their medium, and are “concerned with (or articulated through) relationships between sound and image”, we resort to the principles (or motivations) that drive the creation of audiovisual software, as proposed by Golan Levin (2010). They comprise sound visualization and notation, the transmutability of digital data, performativity and generativity. They correspond to the use of sound or music “to generate aesthetic or analytic visualizations”, to works that “map ‘real-world’ data signals to graphics and sound”, or works that “use human performances to govern the synthesis of animation and sound or music”, and also to “generative artworks [that] produce animations and/or sound autonomously — from their own intrinsic rule-sets” (Levin, 2010, pp. 271-7).

Beyond their audiovisual specificity, these principles are also suited to frame a wider diversity of practices. They are in fact Levin’s rephrasing of the main “aesthetic possibilities” inherent to the digital computational medium, namely: interactivity, processuality (tied to generativity) and transmediality (tied to transmutability) [2]. Naturally, these are ‘not the only’ aesthetic possibilities tied to digital computational technology, although they sum up aspects that “really have much more to do with features of the medium and how it operates in relation to people” (Levin, 2003; 2007).

These terms again highlight the mutability of digital data or its “susceptibility to transformation” or to be mapped into any tangible (visual or auditory) form

(Whitelaw 2008). Interactivity and processuality again bring to the fore dynamic processes that define the surface and support interaction. As such, they express creative possibilities of a medium where “data and processes are the major site of authoring” (Wardrip-Fruin, 2006, p. 381)[3].

When considering these principles in light of the data and processes they entail and emphasize as subject matter, we can assume that the premise that any information (once digitized) can be algorithmically sonified or visualized, as expressed by the transmutability of digital data, can ultimately encompass all visualization and sonification practices. This notion corresponds to different ways of exploring the mapping of a given input data into visual and auditory form. It puts an emphasis on data as information or content, its mode of representation and perception, and on the mediating transformational process.

Performativity invokes how user and system are involved in an interactive feedback-loop, as an audience interactive performativity. In turn, generativity relates to the potential autonomy of systems that imply rules as “recipes for autonomous processes” (Galanter, 2006) potentially leading to unforeseeable results, which are not completely predictable neither by their creator nor by the audience or user (Boden & Edmonds 2009, p. 24). Both *generative autonomy* and *interactive performativity* emphasize the possibility of devising dynamic audiovisual behaviors and responses to interaction. They accent processes as observable activities performed by the work, defining its surface and supporting interaction. In this sense, what they stress is not only a “unique aspect of software as a medium”, the fact that “it enables response”, but also other “fundamental expressions of software” that may include “dynamic form, gesture, behavior, simulation, self-organization, and adaptation” (Reas, 2003, p. 175).

As Wardrip-Fruin states, “authoring new processes” is a significant means of expression for authors, as the creative opportunity of “defining new computational behaviors”:

Seizing this opportunity requires a bit of a shift. It is common to think of the work of authoring, the work of creating media, as the

work of writing text, composing images, arranging sound, and so on. But now one must think of authoring new processes as an important element of media creation. (Wardrip-Fruin, 2012, p. 7)

This view highlights the procedures or operations performed by the work, suggesting that sound and image acquire meaning only as the products of processes, performed with or without the participation of the user. Therefore, the subject matter of these works is not merely tied to surface (audio, visual) representations, but by exploring the possibilities of software they can present dynamic, and potentially unique, audiovisual configurations. These can be considered, however, not as an end in itself, but as a *consequence* and *expression* of processes.

The relevance of these principles — understood and used artistically as aesthetic concepts and methods — is that they draw attention to both the digital computational specificity of these systems and to their diversified nature as aesthetic artifacts. They express what they share, as self-referential works that are speculative and prospective in exploring the possibilities of software as their medium, and also, how they diverge in the subjective discourses and intents they entail as aesthetic artifacts.

3 | SYSTEMS AND DIGITAL COMPUTATION

Framing creative practices and aesthetic artifacts while emphasizing data and processes as their significant themes calls for a deeper understanding of the role of digital computation in these works. In other words, we need to frame these aesthetic artifacts as digital computational systems that use computers for computation and not only as storage and transmission media. They require computation, not only for their authoring, but also during their experience and “in a manner that defines the work”. Rather than “fixed” (or containing nothing within their process definitions that leads to variation), this is “reconfigurable and process-oriented work” that “explicitly includes processes of digital computation in its definition” in order to be itself (Wardrip-Fruin, 2006, p. 19)[4].

Following this idea, it becomes useful to consider the “forms and roles” of computation that distinguish the ways in which these works operate, according to their

computational variability, interaction and source of interaction. These are computationally variable works in which “processes are defined in a manner that varies the work’s behavior (randomly or otherwise)”, that is, 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”, as audience interactive work (Wardrip-Fruin, 2006, pp. 397-400).

Naturally, these factors of variation (intrinsic rules, or external data or process) may either be exclusive or combined within the work. However, seen according to principles mentioned earlier, they become a significant feature or theme of the work — be it its potential autonomy, its exploration of external data or even human input or performances.

Accordingly, as Manovich asserts, what better characterizes these works are the “operations” that shape them and structure their experience, given that,

Encoded in algorithms and implemented as software commands, operations exist independently from the media data to which they can be applied. The separation between algorithms and data in programming becomes the separation between operations and media data. (Manovich 2001, p. 121) [5]

What we are experiencing, even as static displays, is constructed by software in real time as the dynamic output of a real-time computation, which gives us not objects but instances or occasions for experience, since the final ‘media experience’ is usually a dynamic one.

Instead of fixed documents that could be analyzed by examining their structure and content ... we now interact with dynamic “software performances.” I use the word “performance” because what we are experiencing is constructed by software in real time. (Manovich, 2013, p. 33)

So these artifacts may produce (audio, visual) artifacts, but are also aesthetic artifacts in themselves, as process creations or works that occur while running [6]. As programmed works they are designed to run — running is their “raison d’être”— and one can think of each occurrence of the work as a *unique*

performance (Bootz, 2005). This performance may vary in each occurrence according to “internally-defined procedures” that allow the work to respond, recombine its elements and reconfigure (Wardrip-Fruin, 2006, p. 2). This point of view is then conforming to the nature of works that are *driven by processes as dynamic systems*.

4 | PROCESSES AND MODES OF EXPRESSION

The terms processes and processuality are not used without ambiguity, as seen from the perspective of their creation, enactment or execution and experience. They invoke the algorithmic structuring of processes, as defined within the work and carried out automatically by digital computation, as well as the idea of the work as a process or an activity performed in time, as a unique performance.

The concept of processuality is often used to address an artistic application to processes that involves their design (as a conceptual notation) and execution (by machines that carry out processes). According to Levin (2007), processuality is a concept that connects concerns with “building machines that develop processes” and “conceptual descriptions of processes”. In other words, it involves the design of processes (as a logical score, a conceptual notation) and their execution by machines (Cramer, 2002), thus relating to code “as something ‘generative’; that is always in progress, and on execution produces unpredictable and contradictory outcomes ... in a continuous state of ‘becoming’” (Cox et al., 2001, p. 167).

The notion of processuality highlights what rule-based processes may generate as forms and behaviors, as processes in “development, flux and change”. In Jaschko’s (2010) view, however, as both generative and interactive artworks, since “live processes take place that generate unique configurations and dynamics”, performed either by system or by system and user, resulting for the latter in a strong “sensation of immediacy and presence”.

This view of processes refers to a time-based evolution of sequences of events as results of ongoing computations, which according to Broeckmann (2005), conflates with the notion of performance as the “quality of a technological artifact in operation” (an execution) and the “live dimension” of its presentation.

As the author argues, processuality and performativity are 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”. This is another way of emphasizing processes (and performance), as a distinctive expression of these systems.

4.1 EXPRESSIVE PROCESSES

A more strict view of processes defines them as “the mechanisms of change” that occur within a system, as Dorin et al. (2012) establish when considering generative systems. As the authors assert, processes may or may not be directly apparent to the viewer of a work, since they involve “hierarchical relationships where a global or macroscopic process is composed of many micro processes” (Dorin et al., 2012, p. 245). Therefore, not all processes are immediately perceptible as observable activities. More importantly, “not all processes contribute equally to the experience and meaning of digital works”, as Wardrip-Fruin (2006, p. 81) asserts. For this reason, he uses the concept of “expressive processing to talk about what processes express in their design—which may not be visible to audiences”, but is central to understanding computational media processes, in their “potential numerousness, repetition and complexity” (Wardrip-Fruin, 2012, pp. 4-9).

The concept of “expressive processes” also critically questions what processes operate more significantly “as part of the work’s expression”, while debating the value of considering their “intensity” [7], for relevance is not in process intensity as such, but rather in the intensity of expressive processes — those that clearly contribute for the work to be itself and more evidently define its meaning and experience (Wardrip-Fruin, 2006, pp. 80-1) [8].

However, a deeper understanding of processes entails distinguishing “implemented processes”, as concrete realizations of “abstract processes”, which support an “operational logics”, i.e. embody an appropriate behavior of that system towards a particular end (Wardrip-Fruin, 2006, p. 214). It also entails considering the interplay between the activities carried out by process defined within the work itself,

from those performed by its audience as interactions. Moreover,

[Processes] generally don't operate on their own. ..., the operations of digital media are, in crucial ways only truly realized in contact with audiences. (Wardrip-Fruin, 2012, p. 11)

From this point of view we can consider both user and system as agents determining the work's outcomes. We can assume that agency, as an ability to take action leading to meaningful results — much in the sense described by Murray (1997, p. 153), as “exerting power over enticing and plastic materials” — can be attributed to both system and user (through the system's reactive agency).

From the perspective of audience interaction, the notion of expressive processes also supports the idea that actions and processes leading to observable results, rather than the products of processes — or “actions and processes, as opposed to (re)presentations” (Kwastek, 2013), are the core of the aesthetic experience of interactive artworks.

4.2 PROCEDURAL EXPRESSION

In sum, the focus shifts from the outcomes of processes towards the processes or operations performed by the work, and from creative possibilities (as the authoring of processes) to the aesthetic qualities of their experience. These views emphasize processuality and performativity as fundamental qualities of the experience — and as useful concepts for an understanding — of digital computational systems as aesthetic artifacts.

As Jaschko underlines, beyond the “regime of the ‘display’” or “visual appearance of a work” the essential aesthetic dimension of processual artworks is that of performativity, which is relative to the ‘acts’ from which form and meaning arise (Jaschko, 2010, p. 134). These aesthetic qualities are tied to both their generative and interactive potential. At the same time, they highlight the double status of these works as artifacts and as ephemeral moments for experience.

Understanding digital computational systems as aesthetic artifacts then entails moving beyond a “rhetoric of the surface” (Bootz, 2005) towards an aesthetic level that is tied to their “procedural rhetoric” or “the practice of using processes expressively”

(Bogost, 2008, pp. 122–24) [9]. Accordingly, as suggested by Carvalhais (2010), procedurality becomes relevant as a “conceptual grounding and aesthetic focus in artistic creation and appreciation, as an aesthetic pleasure in itself”.

Beyond surface modes of expression, we must consider the procedural ones, shifting our view towards the *dynamics* of these systems, or their variable behavior in each occurrence and in response to interaction.

5 | PERSPECTIVES

Any practices that exhibit dynamic real time behavior, or responsiveness to their environment and require real time computation and/or networking fall into the class of practices for which, I believe, a wholly new branch of aesthetics is demanded: the aesthetics of behavior. (Penny, 2008)

In other words, these works' content “is their behavior” and not merely the media output that streams out, as argued by Hunicke, LeBlanc and Zubek (2004). Supporting this view, is the framework proposed by the authors as a formal approach to understanding computational systems “where the interaction between coded subsystems creates complex, dynamic (and often unpredictable) behavior”. These are “designed artifacts that build behavior” via interactions, and that can be seen in terms of the “separate, but causally linked” perspectives of Mechanics, Dynamics, Aesthetics [10]. From a bottom-up (MDA) perspective, “the mechanics give rise to dynamic system behavior, which in turn leads to particular aesthetic experiences”, while from the top-down (ADM) user's perspective, “aesthetics set the tone, which is born out in observable dynamics and eventually, operable mechanics” (Hunicke et al., 2004, p. 2).

The relevance of this framework is that it makes evident the interdependency between these — separate but inseparable — “views, or lens” over systems and at the same time supports an ADM top-down approach. In accordance with this idea, Bogost defends, rather than a “bottom-up, code literacy” approach, we can assume a top-down approach that involves “learning to read processes”, namely by interacting with a procedural system “with an eye

toward identifying and interpreting the rules that drive that system”, its *operational logic*, its modes of operation and action (quoted in Wardrip-Fruin, 2006, p. 48).

Code is attractive to traditional critics in part because it is, like traditional media, fixed. But our fundamental challenge is to begin to understand dynamic media systems. In other words, I believe we need to focus on what code is used to express and construct: the operations of systems. (Wardrip-Fruin, 2006, p. 6)

The concept of operational logics addresses this idea, by inference and deduction of the modes of operation of works that embody digital processes, as dynamic systems; by focusing on what it does and can do instead of just what it shows or says [11]. The author adds that this approach, rather than replace, can “complement and expand audience-focused understandings” as a starting point for a critical interpretation of these systems, while “moving beyond frameworks developed for fixed media” (Wardrip-Fruin, 2006, p. 7).

Complementing this view, Dorin et al. discuss existing frameworks focused on processes, asserting that they are often more focused on the “medium through which processes are enacted” or “on the means by which the form is achieved” than on the processes that create them. The authors argue on the need for a “broadly applicable framework” suited to the description and analysis of “dynamic processes” that can also be “intuitive and flexible” and does not depend on technology (Dorin et al., 2012, p. 239)[12].

[Our framework] does not require or privilege technology, but equally it is silent on the critical implications and origins of processes and their implementation. This reflects our desire for an analytical descriptive rather than critical framework. ... In focusing on process per se, our framework addresses the most significant limitation in current analysis of this practice.... (Dorin et al., 2012, p. 256)

The authors favor a descriptive approach suited to a “wide variety of works, irrespective of medium, message or form”, but one “that supports critical analysis by offering a conceptual model” for engaging

with processes (2012, p. 256). Importantly, they also acknowledge the need to complement this view not leaving silent the artistic motivations behind these works.

In conclusion, these approaches stress the need for complementary views over systems, oscillating between their creation, performance and experience. They support the strategy outlined in this text in its aim to articulate distinct, but interdependent, perspectives on these systems; perspectives suited to consider both their “poiesis (construction)” and “aisthesis (perception)” (Cramer, 2002), while probing into their enacted processes.

In their complementarity, the principles, models and frameworks discussed suggest a way to actually understand and describe digital computational systems, not only as systems but also as aesthetic artifacts. In order to do so, we can consider their interdependent dimensions: their *conceptual dimension* (regarding their motivations, principles or themes, or what they address as subject matter); consider these aspects as they are computationally implemented (as formally specified at the level of their *mechanics*, data and processes); and finally, address the elements of their experience, concerning not only their surface (audio, visual) modes of expression, but also their *dynamics*, or their variable (and often indeterminable) behavior according to its processual and performative qualities. By articulating such views, we can develop instruments for an analysis and critical understanding of these systems, while tackling deeper on the questions that their conceptualization, enactment and experience raise.

ENDNOTES

[1] The views explored in this text corresponds to further developments of a study summarized in Ribas (2013) and its adaptation to a pedagogical approach as conducted with master students, and as reflected in the work of Lee et al. (2014).

[2] In Levin’s 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); processuality (the character of algorithmic processes; generativity); transmediality

(the way the senses are addressed in simultaneity) and connectivity (Levin, 2003; 2007).

[3] They contrast data as the “non-process” element of a work, with processes as the “procedures or operation carried out by the work”, such as those that “respond to interaction, arrange data”, and can be “selected from a set of available options in an authoring system” or “newly-created for the work” (Wardrip-Fruin, 2006, p. 10).

[4] This is work that is “explicitly designed for its surfaces to be experienced in a context employing digital computation” performed by any computational device (Wardrip-Fruin, 2006, p. 19).

[5] According to this idea, Manovich questions the limits of the terms ‘digital’ and ‘media’ to define what is specific about computational works. The author emphasizes computation as the ‘new’ logic behind media, and questions the limitations of the term medium to encompass this logic (Manovich, 2001; 2013). Cramer similarly proposes to focus on ‘software’ rather than ‘media’, since computers are not just media but “are capable of writing and reading, interpreting and composing messages within the limitations of the rule sets inscribed into them” (Cramer, 2002). In accordance with this, rather than using the term media, we consider the artifact, work or system, whose nature is digital but whose specificity is computational, as suggested by Wardrip-Fruin (2006, p. 9).

[6] Their “outcomes may be artefacts (visual, sonic, musical, literary, sculptural, etc.), including static or time-based forms”, however these systems, as process creations, are also aesthetic artifacts in themselves (Dorin et al., 2012, pp. 244-7).

[7] Process intensity is the degree to which a program emphasizes processes instead of data. When a work of digital literature emphasizes the presentation of pre-created words, images, and sounds, those are all data. When it emphasizes algorithms and calculations, those are processes (Crawford, 1987, quoted in Wardrip-Fruin 2006, p. 65).

[8] In addition to this, the author suggests that processes that are newly designed for the work are easier to identify as contributing to the work’s expression (whether by algorithmically generating

images or sounds, governing the behavior of the surface, or supporting interaction).

[9] This view underlines procedurality as the “principal value” of the computer in relation to other media, as its “defining ability” to execute rules that model the way things behave (Murray, 1997, p. 71).

[10] Mechanics refers to “the rules and concepts that formally specify the [work]-as-system”, i.e., its components “at the level of data representation and algorithms”. Dynamics describes the “run-time behavior of the [work]-as-system”. When considering interaction, it pertains to the “run-time behavior of the mechanics acting on player inputs and each others’ outputs over time”. Aesthetics designates the “desirable emotional responses evoked by the game dynamics”, when confronting or interacting with the work (Hunicke et al., 2004, 2).

[11] An operational logic is a pattern that emerges in the interplay between the elements of digital media when they operate: data, process, surface, interaction, author and audience (Wardrip-Fruin, 2012, p. 14).

[12] The authors propose a descriptive framework for generative art composed of four primary elements: entities; processes; environmental interactions; and sensory outcomes (Dorin et al., 2012, p. 239).

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