Creation of Meaning in Processor-based Artefacts

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Abstract

Processor-based artefacts are often created following conventions inherited from analogue media forms, allowing the development of experiences that, in spite of the new platforms, are not fundamentally different from those that were already possible in the previous contexts. But contemporary media and arts often use processor-based artefacts focusing on conceptual and mechanical principles that do not attempt to simulate earlier forms but rather explore their computational nature. These systems bring about new modes of reading and new challenges, to both readers and artists or designers. In order to optimize the usage of processor-based media, creators need to understand how these artefacts are interpreted and how readers develop processes of creation of meaning in procedural contexts. This will allow authors to ground their practices on procedurality rather than only on surface con-tents, and to make a constructive use of contingent behaviour, learning, adaptation, selection, and other traits of these systems, not being limited to the emulation of well-established media forms. This paper outlines some of these challenges and proposes designing for the meaningful interpretation of computational artefacts.

Keywords

Processor-Based Media, Computational Art and Design, Artificial Aesthetics, Interaction, Creation of Meaning, Ergodic Experience, Virtuosic Interpretation.

Introduction

Our media landscape is dominated by processor-based systems. We often call these systems *digital*, a misnomer focused on their data encoding properties and that ultimately disregards their chief characteristics, a set of features that are synthesized by the four affordances identified by Janet Murray (1997, 2012): they are procedural, participatory, spatial, and encyclopaedic.

These media forms have become increasingly relevant in contemporary mass and personal communication, as well as in the arts, where we can find long-running events (such as Ars Electronica, ISEA, or Transmediale) that testify to their relevance for artists and academics, and commercial enterprises (as e.g. Bitforms[1] or s[edition][2]) demonstrating their market potential.

Procedural media are semiotically unique because they are built by software (Manovich, 2013) and have a very high potential for interaction, two characteristics that turn them into metacommunicational apparatuses (Engle, 2008, p. 15; Whitelaw, 2004). Computers are universal machines, able to simulate any process that can be precisely described. Processor-based media inherit this universality and are excellent at simulating and remediating other media. They are able to take over the roles of other media forms easily and cheaply, acting as a universal solvent (Hayles, 2005, p. 31), and being protean to the point of being better described by the collective noun *digital medium*, as Murray suggests (2012).

Being universal, processor-based media become more than mere extensions of the human, as they gain the capacity for autonomy, they acquire an increased agency, and therefore demonstrate a set of emergent properties.

Their high capability for simulation means that, despite replacing previous media forms, they do not necessarily transform their contents while doing so. Film created with digital tools and mediated by processor-based media can be (almost) indistinguishable from analogue film. Books written, edited, and published using computational platforms can retain a classical structure in spite of the drastic transformation in tools, infrastructure, and interfaces. We identify this phenomenon in many other media forms, with patterns in their contents, as e.g. narrative structures, not being necessarily altered too, not being affected by the transition of media between different distribution technologies (Jenkins, 2006, p. 13).

An example of this can be found with linear narrative structures, that originated in orality and somatic

1 www.bitforms.com

2 www.seditionart.com

technologies, were further developed in molar media, and inherited by processor-based systems, that still allow them to be experienced by audiences. Nothing in processor-based media primes narrative towards linearity, if anything, much on the contrary. But the same already happened with molar media forms, where the prevalence and dominance of linear narrative structures was not so much due to their structural characteristics but rather, as Aarseth proposes, either to ideological reasons or to a remote influence of the papyrus scroll (1997, p. 47), which was in fact a strictly linear-access device (Bolter, 1984, p. 137).

Molar media forms weren't always used to develop linear contents. If technologies as the codex are suitable for linearity, in reality, they are random access technologies, and therefore facilitate nonlinearity. Some of the media forms developed with the codex already explored those characteristics to breed nonlinear textuality, or proto-hypertextual structures as e.g. dictionaries, encyclopaedias, or *Choose Your Own Adventure*-type books (Aarseth, 1997, p. 48; Darnton, 2009). Beyond these, some authors have occasionally attempted to question linearity by exploring other forms of access, as Julio Cortázar did with *Hopscotch*, or authors of the Oulipo did in various works.

We can also speculate whether the prevalence of linearity across media may be related to the linear way how we humans experience and recall life, and how therefore we may prefer to codify our experiences, speaking of life in terms of physical motions or of a spatial travels (Hofstadter & Sander, 2013), and consequently thus translating experience into messages and media forms. Regardless of how non- linear, discontinuous, or sinuous our thought processes may be, the *narrative theory of the self* (Floridi, 2014, p. 68) points to the construction of a linear story as the basis for one's identity. Or perhaps this happens *in spite of how* non-linear, discontinuous, and sinuous our thought processes are, in an attempt to counter those characteristics.

The Oulipo's works, and other experiments in nonlinear textuality, have by and large remained curiosities and were often regarded as oddities. But they became increasingly relevant as case studies and inspiration when native processor-based media forms began to emerge. This was perhaps due to the fact that many of these works, although developed at a time when computational technologies were either non-existent or not easily accessible, were already deeply procedural. They relied on algorithms or effective procedures as part of their mechanics (Carvalhais, 2016, p. 43), and were effectively developing artefacts comprised of both a surface and a *subface* (Nake, 2016). They were thus, as Aarseth also recognised, already *cybertexts*, and pointed to the increasing complexity that the media experience of native procedural forms would soon make possible.

Processor-based media have drawn from these early cybertexts and from the familiar experiences and conventions of classical forms, with an increasing number of native computational forms grounding their aesthetic experience in conceptual and mechanical principles that explored procedurality. Amongst these we can find games as *Façade*, that builds complex narrative experiences by using artificial intelligence to "move beyond traditional branching or hyper-linked narrative"[3] in the creation of interactive drama. Games as *Spelunky* (2008) or *No Man's Sky* (2016) resort to procedurality to generate a potentially infinite number of game worlds or maps, while *Rogue Legacy* (2013) uses evolutionary processes to develop an assortment of playable characters. Interactive documentaries such as *Do Not Track* (2015) rely on resources drawn from big data, from the Web, and from social platforms to build the narrative experience. Artworks bring procedurality to the fore, centring the aesthetic experience in its (total or partial) understanding, as e.g. Karl Sim's *Galápagos* (1997), John F. Simon Jr.'s *Every Icon* (1997), Casey Reas's *Process* series (2004-), Pall Thayer's *Microcodes* (2009-2014), or Lia's *Monochromes* (2016).

Virtuosic Interpretation

As technology and media change, they transform human perception (McLuhan, 1964). If we regard perception as a system through which we build hypothesis about the world (Gregory, 1980) — or about the information being acquired from the world — it then follows that our contacts with any media form are informed by our previous knowledge of other media forms. Therefore, any new technologies, and any new media, breed new modes of reading. Some of these new modes of reading have been studied by e.g. Michael Joyce (1995), Espen Aarseth (1997), Jay David Bolter (2001), Florian Cramer (2001), Katja Kwastek (2013), or ourselves (2016), and they are not only related to the interpretation of signs, but also to other user functions, including what

[3] www.interactivestory.net/#facade

we vaguely describe as *interaction,* which adds a new layer of complexity to the artefacts.

Another layer of complexity is brought by the increasing multimodality of processor-based media, which is again facilitated by the common coding of all digital media forms, and by their computational capability for simulation and remediation. Besides the most frequent modalities — visual, auditory, haptic, etc. — processor -based media often resort to what we may describe as a *mathematical* (Strickland, 2007) or *procedural* modality (Carvalhais, 2016, p. 257), whose workings we need to keep in close attention. The new experiences that are made possible by these multimodal *new media* — in the sense proposed by Manovich (2001, 2013) — may therefore lead audiences to experience a strong feeling of defamiliarization that may lead to a large number of divergent interpretations of their contents (Melo & Carvalhais, 2016). This is particularly important to keep in mind when we conclude that the creation of meaning in these media forms is not only dependent on the interpretation of signs but also on the procedural modality and, therefore, is not only dependent on logical and lexical semantics but also on *procedural semantics* and consequently on *procedural rhetorics* (Bogost, 2007).

By attempting to decode and understand the subface of these media forms, the reader makes an effort to develop mental simulations of them. For this, the reader creates hypotheses that are confronted with the surface of the artefact and confirmed, falsified, or refined during that experience (Carvalhais, 2011, 2012, 2013; 2015b). This effort is naturally dependent on the reader's capability to deduce the processes — or to remember previously known analogous processes that may accelerate this undertaking — but also on having the possibility to establish multiple contacts with the system, to evaluate the simulations.

If a system does not allow this contact with multiple instantiations — e.g. if the system's outputs are molar, such as prints, and the reader only has access to a single print — then this effort cannot be successfully developed unless the reader discovers recognizable patterns in the surface that may allow her to deduce a particular morphogenetic process. Even so, without the possibility to compare and contrast such process with alternative outputs of the processor-based form, the reader will never be able to attest the validity of the analogue process.

Depending on the complexity of the system, and on the reader's previous knowledge and capabilities, she may not attempt to develop a full simulation of the system but rather opt for developing several smaller partial simulations, focused on sub-systems or behaviours. In either case, simulations attempt to predict future behaviours and outputs of the system, thus informing the reader about it and about its horizons of action.

When a nonlinear, open, or generative (Galanter, 2006) artefact is impossible to access in its entirety — either because it is infinite, or because it may be too vast to become infinite -like at a human scale — a human simulation that is able to generate accurate predictions of the system's behaviours and outputs, can be seen as the culmination of its experience by the human reader (Carvalhais & Cardoso, 2015a) and one of the possible forms to achieve closure in the aesthetic experience.

This witnessing of multiple instantiations of a system, the comparing different samples of its outputs, the confronting of these with one's previous knowledge and the experience of comparable systems, is what we have termed the *virtuosic interpretation* of a system, a process of ergodic contemplation that allows the reader to develop a *theory of the system*. This is a process of reducing uncertainty about the system and of acquiring information about it, either through direct contact with its effusions or via indirect contact with the simulations that are developed.

An aesthetic system therefore becomes not only the coded process (or its *mechanics*, according to Hunicke, Le-Blanc and Zubek (2004)), its runtime (or *dynamics*), and interpretation (the *aesthetics*), but also the dynamics and mechanics of the simulated systems, that are developed in parallel with the witnessed system and continuously compared with it.

Reader Challenges

The process of developing a theory of the system involves some risks for the reader. First and foremost, the risk identified by Aarseth as the *aporia,* the inaccessibility that is not "ambiguity but, rather, an absence of possibility" (1997, p. 3). This is also not, Aarseth notes, the same aporia that is experienced in classical media forms, where one may not be able to make sense of a part in spite of having access to the whole. This is an aporia that prevents making sense of the whole because a particular part may not be accessible (1997, p. 91).

We may identify another form of aporia in the risk of rejection created by an interpretation that is raised to intervention. As the reader becomes a player and a gambler within the system, she now faces the risk of arriving to inaccurate interpretations, and of deducing incomplete or inaccurate information about the system, and thus developing inaccurate (or dysfunctional) simulations that may ultimately lead to incorrect action. Although failure may of course lead the reader to reconsider the processes and to learn (Juul, 2013), this only happens when one is, by any means, made aware of the failure and of the discrepancies between the simulations being developed and the actual system the reader is interacting with. Therefore, if, in spite of the reader's efforts, failures persist, we may assume that they may be due to an inadequate understanding of the system one is communicating with (Wilden, 1987), but this doesn't necessarily mean that the responsibility should be placed on the reader's side.

Besides the aporia, we also have the risk of becoming *lost in the finite*, to resort to Søren Kierkegaard's terminology, that describes as such instances when one is bound by necessity, fate, and triviality. When this happens with a processor-based media form, the reader may end having a reduced agency and autonomy within the system, and being led to accept paradigms without questioning them, thus losing their individuality in the exchange.

Conversely, when confronted with a large number of possibilities, the reader may become *lost in the infinite*, with this corresponding to continuously sampling different paths and actions in the system without actually ever coming to understanding it. If the reader is focused in the *finite,* in the concrete status or configuration of a system at a given time, she won't do more than follow the systems cues and act according to them, thus not being able to probe the system and to discover its mechanics. If the reader's experience is, on the other hand, diluted by the *infinite*, too many inarticulate contacts with the system do not allow to turn potential into knowledge. In either case, the reader risks failing to understand the system.

The procedural modality needs inputs that may be acquired by both stances, sometimes following the system and conforming to finitude, other times diverging and following the infinite. The development of a theory of the system requires the dialectic balancing of these opposite tensions. The first is supported on the *system as encountered* (Upton, 2015), which in its turn is the framework from which unfolds the *system as understood*, breeding the *system as experienced* from where finally narrative and meaning emerge. However, from this synthesis, and as a consequence of the ergodic weight of both the finite and the infinite, the reader also risks *anxiety*, to which Kierkegaard called the *dizziness of freedom*.

Traditional textual and aesthetic analyses are usually coupled with permanence and stability, usually of form or, if this is transient, at least of structure. Permanence and stability are attributes of the finite, with the infinite character of processor-based systems leading to continuous transformation and renovation, not only of surface but very often also of structure. This frequently inhibits (or at least limits the potential of) classical approaches to their study and usually favours analyses that are supported by procedurality and that lean towards artificial aesthetics.

Designing to Support Virtuosic Interpretation

Artists, designers, and content creators that want to use these new media to their fullest extent therefore need to understand how relevant their surface and subface become, not only in the process of creation (*allopoiesis*, mechanics), but also in their development (*autopoiesis* , dynamics), and in their effective communication with other systems, whether human or otherwise (aesthetics).

Creators need to be aware of at least three levels of semantics — logical, lexical, and procedural — that are involved in processor- based forms, because this is fundamental to understand how the process of interpretation of these media forms is developed. Understanding processor-based media as semiotic forms that continuously breed *algorithmic signs* (Nake & Grabowski, 2006) is vital if one intends to design to support *virtuosic interpretation*.

This is something that can be achieved by using code descriptions, procedural descriptions, or pseudocode (Berry, 2011, p. 52) in the surface of the works. Examples of this approach can be found in some of the previously mentioned works. On *Every Icon* (1997), John F. Simon Jr. describes the process developed by the artwork in a caption appended to the display running it:

> *Given:* a 32 × 32 Grid; *Allowed:* any element of the grid to be black or white; *Shown:* Every Icon.

Similarly, Casey Reas offers procedural descriptions of the systems generating the artworks in the *Process* series. An example, from *Process 18*, reads as:

> A rectangular surface filled with instances of Element

> 5, each with a different size and gray value. Draw a quadrilateral connecting the endpoints of each pair of Elements that are touching. Increase the opacity of the quadrilateral while the Elements are touching and decrease while they are not. (Reas, 2012)

Without presenting code in the surface, these works render reasonably detailed explanations of the morphogenetic processes, allowing the reader to more swiftly understand, and therefore simulate, their workings.

Explicit code can also be presented in the surface of the works, as Pall Thayer does in the *Microcodes* series of code poems:

> *Sleep*
> 31. March 2009
> #!/usr/bin/perl
> sleep((8*60)*60);
> (Thayer, 2009)

What this approach may gain in clarity and directness, it may of course compromise by forcing readers to actually read the programming language in which the code is written — Perl, in the case of *Microcodes* —, and to mentally interpret it, something that sometimes may be highly complex and other times impossible.

But the designer may perhaps be more likely to succeed if she considers the artificial aesthetic experience in all its complexity and recognizes that the code-level of a system's mechanics are but a starting point for the emergent phenomena of the dynamics and aesthetics. The designer may therefore opt to plant procedural clues in the surface structures of the system, or at the very least allow whatever procedural clues that may already be in place as a natural consequence of the system's operation to be understandable and as clearly readable as possible.

Designing for the procedural modality implies being aware of how a system's mechanics will generate a phase space, and how this will in its turn form horizons of action that may change during runtime and as a consequence of the interaction with the reader and other systems. These horizons of action will in their turn breed horizons of intent in the reader, and these are even more dynamic and fleeting. If the horizon of action is the set of all points in the phase space that are readily accessible to the reader, given the particular local constraints, the horizon of intent is the set of those states that the reader *believes* can be "valid, attainable, and desirable in the near future" (Upton, 2015). They are not defined by the system's constraints but rather by the human's, and they are highly dependent on the context.

Still following Upton, we may think of the *system as encountered* defining horizons of action, and the *system as understood* spawning horizons of intent through semantics, interpretation, and the procedural modality. Keeping this in mind, carefully balancing repetition and novelty, entropy and information in the experiences that are being designed becomes crucial for the success of processor-based media forms, and for the emergence of meaningful experiences.

If lexical and logical interpretation of a system may of course vary between readers, the degree of variability of the procedural interpretation can be equally large. Reader interpretation is inevitable, and despite variable degrees of accuracy, there is hardly the possibility for incorrect interpretation, but rather a space for multiple, and concurrent, interpretations of a system.

To understand how vast this field of possibilities can be, and to minimize inaccurate interpretation, creators may perhaps take a cue from the iterative processes developed in interaction design and, when possible, field test prototypes with potential users. As we learn from human-centred design methodologies, creators should not rely solely on their own interpretation of a system and on their own interactions, as these are compromised by their personal histories, references, and biases. The theories of a system to which readers arrive are very personal and contextual. They emerge from the interactions between complex systems and therefore can only be discovered by enacting those interactions.

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