ON PROCEDURAL DISSEMINATION AND ARTIFICIAL AESTHETICS (NOTES TOWARDS A PHILOSOPHY OF COMPUTATIONAL MEDIA)

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Resumo
Os media procedimentais têm características que os distinguem dos media clássicos e que os levam a desenvolver relações muito particulares com os seus leitores. A principal destas é a forma como a sua camada procedimental se descobre através de um processo de *interpretação virtuosa*, e como este fomenta a empatia e a transferência de mecânicas do sistema para a mente do leitor. Este artigo debruça-se sobre como este processo é desenvolvido, e em como estes media conduzem à disseminação de um tipo de experiência estética que lhes é único, mas curiosamente semelhante a outros processos cognitivos desenvolvidos pelos humanos.

Abstract
Procedural media possess traits that stand them apart from classical media, and lead them to foster a very peculiar set of relationships with their readers. Chief among these is how their procedural layer is discovered through a process of *virtuosic interpretation*, and how this allows for empathy and for the transference of their core mechanics from the computational system to the reader's mind. This paper focuses on how this process is developed, and how these media conduce to the dissemination of a type of aesthetic experience that is unique to them, but remarkably similar to cognitive processes that humans develop towards each other.

1. Procedural Media

There's a proliferation of terms that describe what we may call *procedural media*. *Processor-based* and *computational* are two that come close to describing their nature, while the commonly used *digital* is more apt to describe their encoding.

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Procedural media can be defined by their reliance on processes or *effective procedures*, descriptions of tasks that are to be executed by a human, a mechanical system, or a computer.[1] These effective procedures can be somewhat vague, particularly when there is a human operator that is able to use their own volition to make decisions that affect the outcomes of the processes; or they may be quite detailed, if they are to be executed by machines.[2] In any case, effective procedures do not need to be "effective" in the sense of succeeding in a task, rather, they are termed *effective* if and when they are computable (Boden, 2004, p. 89).

Currently, procedural media are very often algorithmic, digital, and deployed in computers, because of the ubiquity and relative economy of these systems and their dominance of the *technium*[3] (Kelly, 2010) or of the *machinic phylum*[4] (DeLanda, 1991). They have become central to our culture, society, and economy, and their relevance tends to increase. These media forms are cheaper, more replicable, and more adaptable than classical media forms, and they are able to generate an ongoing degree of variability and novelty that make them seem even richer and more complex (Eyal, 2014).

1.1. Characteristics of Procedural Media

Procedural media, and the digital environments we craft from them, are protean and dynamic, and can be described in a multitude of, not necessarily compatible, ways. An early and still germane description was enunciated by Janet Murray (1997, 2012), who posits that digital environments are *procedural*, *participatory*, *spatial*, and *encyclopaedic*. The first two of these characteristics are responsible for what we vaguely describe as their interactivity (Schubiger, 2005), while the latter two contribute to our feelings of immersion.

1 In this context, we can use the term *computer* either in its contemporary sense, as well as in its historical sense, describing human operators that followed a predefined set of rules to calculate, or *compute*, a result.

2 Analogue, digital, or computational.

3 The *technium* is how Kelly describes "the greater, global, massively interconnected system of technology", extending "beyond shiny hardware to include culture, art, social institutions, and intellectual creations of all types" (2010, p. 12).

4 DeLanda describes the *machinic phylum* as the "cauldron of nonorganic life" (1997, p. 260) that he also describes as the *mecanosphere*.

Manovich (2001, 2013) describes them resorting to five principles: *numerical representation*, *modularity*, *automation*, *variability*, and *transcoding*; the first two being the basic principles from where the remaining three stem. Numerical representation defines how everything is composed of the same digital code, and modularity describes their "fractal structure" and how, because all elements in a procedural artefact are coded and stored independently, they can be independently retrieved and manipulated. Automation, variability, and transcoding then describe the consequences of these. Firstly, how systems can create or modify media objects algorithmically (Carvalhais, 2016, p. 37), partially removing human intentionality from the process. This contributes to the fluidity of media objects, that are not hardwired into a unique structure but allow for a variety of combinations and reformulations. Finally, these coalesce into transcoding, "the most substantial consequence of the computerization of media" (Manovich, 2001, p. 45), i.e. the conceptualisation of procedural media as consisting of a cultural layer and a computer layer, their mutual influence, and how this breeds a composited culture that blends human and computational meanings. This is the strongest effect of the algorithmic revolution (Floridi, 2014; Nake, 2016).

1.2. **The Dual-Layered Nature of Processor-Based Media**

The procedural nature of these media objects can then be described by their runtime behaviours, using characteristics as their *dynamics*, *determinability*, *transiency*, *access*, *linking*, *user functions*, *modes*, *autonomy*, and *class* (Carvalhais, 2016). Their surface or sensorial structures can be described by any of the multitude of systems usable for classical (or non-procedural) systems. There is of course no thing as a digital image (Nake, 2016, p. 12). Whatever procedural systems output must be made physical and analogue to be perceived by humans. As such, various processes of digital-to-analogue conversion must be developed, otherwise we are left with no perceivable outputs. In fact, regardless of their procedural nature, no media forms may operate independently of some material form. We may therefore conceptualise procedural media as having a dual-layered nature of a "surface-and-subface" (2016, p. 13). The *surface* being the perceivable analogue materialisation, the *subface* the procedural, immaterial, very often digital, essence. The two layers are inextricably intertwined, and if the subface by itself cannot constitute the entirety of the work, it becomes an increasingly relevant part of it, by reducing the significance of single images or artefacts, demoting their specificity and individuality, promoting them to members of a class of artefacts that may be output by a system.

Classical artefacts[5] are characterised by self-sufficiency, contingency, and their *being-in-itself*[6] (Sartre, 2003). Procedural artefacts, as Frieder Nake also seems to recognise, are on the other hand the *nihilation*[7] of the previous forms. They can be conceived as *beings-for-themselves* and, as much as classical artefacts are characterised by permanence and existence, they are characterised by freedom,[8] as they may make choices, and even literally *make* themselves. Classical artefacts are invariable, self-contained, static,[9] whereas procedural artefacts are subject to change.

So, we may think of the surface as related with being-in-itself, while the subface represents the properties associated with being-for-itself, and the potential for transcendence. Procedural media are, much as humans, subface. And, as humans, they cannot dispense with surface, and it is through it that our involvement with them starts.

2. **From the surface to the subface**

Our contact with the surface starts with our senses. They allow us to perceive form, sound, texture, etc., but they also allow us to pick up on clues of the subface through what Stephanie Strickland describes as a "mathematical modality" that lets us perceive structures such as rhythm and harmony, and the "struggle between mathematical abstractions and words" (2007, p. 36). This should be understood as the "intellectual and intuitive understanding of structure and process, and the aesthetic pleasure that is felt through it" (Carvalhais, 2016,

5 We will designate as "classical" the non-procedural artefacts or media objects that are only constituted by a surface.

6 For Sartre (2003), being-in-itself (*être-en-soi*) is the self-contained and fully realised being of objects in the external world, whose mode of existence simply *is*.

7 In Sartrean terms, *nihilation* is the internal negation of the in-itself, from which the for-itself depends.

8 We may go so far as to say they are *condemned to be free*.

9 Even if they are time-based, cf. Carvalhais (2016).

p. 257), and this is why we have previously proposed to name it the *procedural modality*. We don't regard it as a process related with logic and logical semantics but rather with what we may call of *procedural semantics* (Carvalhais & Cardoso, 2017). Through the procedural modality one may perceive causal relations that may be in the origin of the system's behaviours. And, as it happens with simple machines, once one procedurally understands the system, one achieves a sense of wonder that is much unlike other aesthetic experiences.

Simple analogue machines can be good case studies for how the procedural modality works. When one witnesses the workings of, or interacts with these machines,[10] one naturally tends to develop some perception of their functional model. And this functional perception frequently is a significant part of the aesthetic experience of the machine. As an example, the wonder caused by optical toys such as the Praxinoscope or the Zoetrope is not only due to their ultimate effect – the animation produced – but also due to our understanding of the proximate cause of its mechanics and dynamics. Therefore, we are engaged not only by the final sensorial result of these media forms – the perceivable forms, animations, rhythms and narratives – but also by an understanding of their systems, and how they are able to cause these effects. We are not only engaged in a *classical* aesthetic experience but also in what we may describe as an experience of *procedural* aesthetics.

2.1. **Developing Models**

Reading[11] procedural media then becomes not only about the *interpretation* of the contents of these media forms but also about *configuration* and *exploration*, the activities that support the other functions of the reader (Aarseth, 1997). It becomes an activity that is not only reliant on logical and lexical semantics but also on procedural semantics (Carvalhais & Cardoso, 2015b, 2017) and procedural rhetoric (Bogost, 2007). An activity that is not only concerned with understanding the surface and extrapolating from it but also on understanding the subface and following it to its consequences.

10 As well as many simpler mechanical media, or Pierre Lévy's *molar* media.

11 We use this term in a very broad sense, describing not only the decoding of textual media but all the experiences with media forms, including interaction.

What we perceive are very often not the actual implementation models of the systems but rather what we may call *mental models* (Cooper et al., 2014) of the systems. These are not strict of even necessarily correct functional models but they are economical, simple, or simplified heuristics that contribute to the understanding of the system's mechanics. Although mental models may approximate or even duplicate the actual processes in a system, they do not need to detail all aspects of the implementation model. They do not even need to be correct in their explanation of the system,[12] but only to be effective in allowing a causal understanding of the current and past behaviours of the system, and in predicting its future behaviours.

Because of the enormous differential in processing power and speed[13] between humans and computational media, full implementation models are very often not only not useful, as they may be impossible to develop[14] by humans. Even the simplest algorithmic processes are not able to be understood by most humans as complete implementation models. A work as e.g. John F. Simon Jr.'s *Every Icon* (1997b) is simple at a high level, sequentially filling each element of the 32 × 32 grid until all the 1.8×10^{308} possible icons are formed.[15] This is an understandable process, that is easy to follow and to simulate by most human readers. It is however a process that at the lower levels of implementation offers nothing too relevant to the reader's experience or understanding. How exactly the sequence and its rate of refresh is implemented in code, how the pixels are switched on and off, the details of the mechanics of the display, are not only very context dependent[16] as they are unnecessary for understanding the high level of the system.

12 This *correctness* meaning using processes that are similar to those developed in the system being read or interacted with.

13 As well as of the actual nature of the computational processes one develops.

14 I.e. they may be impossible to process in anything close to real time, this is what Wolfram (2002) names the *viability* of computations.

15 A process that, according to its author, at a rate of 100 icons per second may take 1.36 years to display all the variations in the first line of 32 pixels and several billion years to complete all the variations in the full grid (Simon, 1997a).

16 *Every icon* has, to our knowledge, at least two alternative versions, both crafted by the same author: a "wall hanging" version running on a Macintosh PowerBook170 and mounted in plastic acrylic, and a web based version developed in JavaScript. Each of these versions implements the same high-level process but does so employing what are certainly very different technical resources and therefore disparate low-level infrastructures.

So, when considering the development of models of the systems by readers, the questions we ought to ask are not regarding a thorough rebuilding and simulation of the system by readers but rather about how do readers develop approximate emulations of the system that lead them to the computation of similar or comparable outcomes.

The model building process is incremental, iterative, and developed through processes of trial and error (Carvalhais, 2013; Carvalhais & Cardoso, 2015a, 2015b). When confronted with the systems – and regardless of their typology, modes of interaction, etc. – readers attempt to understand their functional and causal properties by observing the surface of the medium and identifying significant actors (Cardoso, 2016), their actions and behaviours. At a first stage – and perhaps in most cases – this leads to the identification of previously known models that may be reused to understand the current context. This is consistent with the processes of formation of mental models. If the reader is already familiar with mechanics that may explain in whole or in part the phenomena that are being witnessed, these can usually be repurposed with a minimal effort. If there are no readily available models to the reader, then this may – albeit this process demands a significantly higher investment of time and energy – deduce new models from the phenomena that are witnessed, through a process of *virtuosic interpretation* (Carvalhais & Cardoso, 2017).

The models will then predict the behaviour of the system, its dynamics (Hunicke, LeBlanc, & Zubek, 2004), and these may be confronted with the actual outputs in subsequent readings. Each of these confrontations will allow to evaluate the quality of the predictions, i.e., how the outputs of the model match the outputs of the system, and to progressively revise the model, striving for a higher effectiveness in the predictions.

The end goal of this process is not necessarily to be able to explain in detail the workings of the system. Neither it is to build its accurate mental simulation. It is rather to *understand* the system in an intuitive way that allows the development of a procedural connection, to experience its subface and thus to achieve *empathy* with the system. As such, it is much alike the processes of developing *theories of mind* (cf. Metzinger, 2009; Ramachandran, 2011) or, generalising even more, those described by the recent paradigm in computational and cognitive neuroscience of Predictive Processing (Metzinger & Wiese, 2017).

3. **From the subface to the mind**

As we have seen, not all processes in a system are relevant to this experience. The reader will naturally focus on some processes and disregard others, but which is what is not always evident to the creators of the system. It follows that artists and designers need to make the effort of discovering the procedural foci of a system to maximise their discoverability and readability.[17] In simple(r) systems this may be a straightforward enterprise, but when systems articulate several mechanics, this may require more demanding efforts that may include field-testing and other techniques from interaction design such as A/B testing, usability evaluations, ethnographic research, etc. (Cooper et al., 2014; Krug, 2014).

Creators may then be able, to use Bolter and Gromala's (2003) terms, to informedly opt for the hypermediation or the transparency of processes. By understanding which processes are more aesthetically valuable, the workings of reader's perception, and their own authorial intentions, artists and designers will be able to better mould the procedural experience.

Through the procedural modality and virtuosic interpretation, readers may develop emulations of the systems and thus become something of co-processors, in the sense that they will compute in tandem with it.[18] They will most likely not develop the same algorithms, or the exact same procedures, but, given a long-enough process of trial-and-error and fine-tuning of the predictive emulations, they will manage to co-host if not the algorithm, at least the procedural foci of the artefacts. We may thus conclude that the goal of these procedural systems is perhaps not to be found in the code itself, nor in the code's dynamics and the surface effects these may cause, but rather in the dissemination or replication of their procedural foci, from the computational system to the (also computational) mind of readers.[19] Procedural media are then also being-for-others, as they travel from their own subface processes and surface existence towards the mind and consciousness of humans.

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17 Some strategies for enhancing the comprehension of the processes, and of building hints in the artefacts to assist readers in this process may be found in our previous papers (Carvalhais & Cardoso, 2015b, 2017).

18 We could almost say that they will be part of the system, co-processing it.

19 Cf. e.g. Oliveira (2017), Seife (2006), or Wolfram (2002).

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