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Beyond Vicarious Interactions: From Theory of Mind to Theories of Systems in Ergodic Artefacts

Miguel Carvalhais
ID+ / Faculty of Fine Arts, University of Porto, Portugal
mcarvalhais@fba.up.pt

Pedro Cardoso
ID+ / Faculty of Fine Arts, University of Porto, Portugal
pcardoso@fba.up.pt

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Procedural media allows for unprecedented modes of authorship and for the development of new aesthetic experiences. As artists and communicators, but also as readers and users of these systems, we should be aware that their aesthetic potential is not simply defined by direct interaction. Although direct interaction is one of the most perceivable components in the relationship between ergodic media or artefacts and their readers, one should not forget that the reader's interpretation and capacity to apprehend and simulate the processes developed within these artefacts is continuous, ever present and significant. In this context, this paper argues that not only ergodicity does not necessarily imply direct interaction, but also that non-interactive procedural artefacts are able to allow the development of ergodic experiences, not through direct interactions but rather through simulated interactions, by understanding procedural activities and developing mental analogues of those processes. We aim at raising this awareness, setting up the grounds for designing for what we call *virtuosic interpretation*, an activity that may be described as the ergodic experience developed by means of mental simulations.

1 Processor-based media

Digital technologies are becoming ubiquitous, replacing other media forms as very economic and reliable alternatives. They are excellent simulators of other media forms, but maybe because of this trait, they often fall short of being developed to their highest potential for the creation of new media forms. Therefore, a complete definition of digital media should not be solely based on their digital encoding but also on the fact that, being processor-based, these media forms are also essentially procedural.

Digital media may be developed in either *data-intensive* or *process-intensive* approaches (Crawford 1987), the first of these devoting most of the available resources to "moving bytes around" (Crawford 1987) in artefacts that "are based primarily on pre-recorded sound and/or image sequences, or on static texts or images that are selected or arranged during the interaction" (Kwastek 2013, 114) and mainly use their procedural capacities to select, rearrange, compose or give access to these assets. A process-intensive approach tends to produce artefacts where "sound and image data (...) will be generated in real time according to algorithms" (Kwastek 2013, 114) and where, even when data-intensive approaches are also used, the focus on procedurality is clear.

So we may emphasize procedurality in designating these media as *procedural* rather than simply *digital*, following Janet Murray's first essential property of "digital environments" (1997, 71) and her observation that a computer "is not fundamentally a wire or a pathway but an engine", designed to "embody complex, contingent behaviors" (1997, 72). As such, and continuing to follow Murray, we should regard authorship in these media as also being procedural, a mode of authorship where one writes "the rules by which the texts appear as well as writing the texts themselves" (1997, 152), where one creates "rules for the interactor's involvement" and "conditions under which things will happen in response to the participant's actions" (1997, 152). This turns the author into something of "a choreographer who supplies the rhythms, the context, and the set of steps that will be performed" (1997, 153), that creates not sets, scenes, or objects, but potential narratives to be discovered and enacted.[1] Procedural authorship therefore also underlines, and takes advantage of, the "principal value of the computer, which creates meaning through the interaction of algorithms" (Bogost 2008, 122), an ability that "fundamentally separates computers from other media" (Bogost 2008, 122) and that turns procedural media into a significantly different class of artefacts.

1 Murray often mentions "virtual worlds", a term that, although still useful, may be dangerous because of the way how it may ambiguously describe either the topology of the text, a procedurally simulated space or the diegetic spaces within it. More recently, Nick Montfort (2003) used the slightly less ambiguous term *simulated world* in his analysis of interactive fiction.

2 Interacting

The role of the reader[2] of these media is also necessarily affected. Murray describes how the "interactor, whether as navigator, protagonist, explorer or builder, makes use of this repertoire of possible steps and rhythms to improvise a particular dance among the many, many possible dances the author has enabled" (1997, 153) and how this leads readers to necessarily adopt something of a creative role within the system, although this is typically not a role equivalent to that of the author, or even not enough to qualify as co-authorship. Rather, Murray prefers to speak about *agency*, the power "over enticing and plastic materials" (1997, 153) "to take meaningful action and see the results of our decisions and choices" (1997, 112), and distinguishes it from mere activity, seeing how it "goes beyond both participation" (1997, 128), and becomes an aesthetic pleasure in itself.

Following Murray, Espen Aarseth (1997) speaks of the ergodic experience developed in artefacts where multiple user functions are possible to undertake. These are the omnipresent *interpretative* function; the *explorative* function, in which readers may make decisions regarding which spaces of the text's topology to access; the *configurative* function, in which textual contents may be created, selected or rearranged; and the *textonic* function, when contents may be permanently added to the text. Aarseth posits that artefacts where "a cybernetic feedback loop, with information flowing from text to user (through the interpretative function) and back again (through one or more of the other functions)" may be described as *ergodic*.[3] Therefore, having thus defined ergodic texts, we may conceive of other forms of ergodic media, where some of the user functions identified by Aarseth may be developed.

Allowing for interaction and agency, these media forms will be characterized by a relatively unpredictable usage, with the "string of events that occur during gameplay and the outcome of those events (...) unknown at the time the product is finished" (Hunicke et al. 2004), and the number of user functions involved, and their relative weight in the experience of the media forms may vary.[4] Hunicke, LeBlanc and Zubek propose that artefacts such as these[5] may be described in terms of three design stages they call *Mechanics, Dynamics* and *Aesthetics*, developed in consecutive levels during the artefact's design and discovered in reverse order by their readers. The perspective of the reader is therefore opposite to that of the author in any ergodic artefact. The author deals primarily with mechanics, "at the level of data representation and algorithms" (Hunicke et al. 2004) and consequently with dynamics, the runtime behaviour of the mechanics previously developed, which will ultimately result, at the aesthetics level,

2 Among all the possible and often confusing designations – user, reader, spectator, player, interactor, etc. – we will use "reader" in this text, albeit recognizing that this also describes a particular mode of engagement with a medium or artefact.

3 *Ergodic* is a term "appropriated from physics that derives from the Greek words *ergon* and *hodos*, meaning 'work' and 'path'. In ergodic literature, nontrivial effort is required to allow the reader to traverse the text." (Aarseth 1997, 1)

4 As Markku Eskelinen notes, in literature, theatre or film the dominant user function is the interpretative, but in forms as games it is usually the configurative (Bogost 2006, 108).

5 Their MDA framework was originally developed as "a formal approach to understanding games" (Hunicke, et al. 2004). Games are undoubtedly ergodic forms and the MDA framework has been previously used by ourselves (Carvalhais 2012b) and other authors (Ribas 2012; 2014b) to study interactive and ergodic media forms.

and twice removed from the author, in "the desirable emotional responses evoked in the player, when she interacts with the game system." (2004) Through the user functions, a reader interacts with the artefact at the aesthetics level, discovering the dynamics but normally not being able to burrow into the black box of the mechanics level.

With dynamic and continuously varying outputs that are largely unknown both to the author and the reader, we may consider the aesthetic value of interaction. Katja Kwastek notes how in data-intensive artefacts, readers may "seek to activate all the available assets" (2013, 114) in order to achieve a sense of completeness, because being used to linearity and completion in most media, we may also be "inclined to want to experience the 'whole' of a work" (2013, 114). In process-intensive artefacts, completeness may be found in exhausting "the underlying algorithms and the possibilities for interaction offered" (2013, 114), with the focus of the readers shifting from traditional aesthetics to an aesthetics of interaction and of performance (Ribas 2014a). This is particularly noted when readers are not engaged directly with the artefact but rather observe other readers during their interactions, a situation defined as "vicarious interaction" (Levin 2010). Of course that "sensual or cognitive comprehension can still take place in these cases" and the observer may discover "relations between action and effect, even if he is not actively involved", not developing the same experience as an active interactor, but being "able to observe and understand interaction processes that he would not have carried out" (Kwastek 2013, 94). Furthermore, the actual performance of the interactor may also be a factor to consider aesthetically, as Siegfried Zielinski discussed (2006, 138).

3 Not interacting

> Given a machine for producing text, there can be three main positions of human-machine collaboration: (1) preprocessing, in which the machine is programmed, configured, and loaded by the human; (2) coprocessing, in which the machine and the human produce text in tandem; and (3) postprocessing, in which the human selects some of the machine's effusions and excludes others. These positions often operate together: either 1 and 2; 1 and 3; or 1, 2, and 3; or 1 by itself, although the human operator need not be the same in different positions. (Aarseth 1997, 135)

All three of Aarseth's positions for collaboration require some direct human-computer interaction. His definition of ergodic text (or, by extension, an Aarseth-based definition of ergodic artefact) requires interaction with the human reader. Therefore, non-interactive media, even if processor-based, may be difficult to classify

as ergodic. In non-interactive artefacts – and, to an extent, in non-interactive states of otherwise interactive systems – the reader is apparently limited to the interpretative function and barred from developing any of the functions necessary to the ergodic definition. We however posit that a broader – and procedural – understanding of the nature of the interpretative function, may allow us to consider the experience of these systems as being ergodic.

4 Beyond vicarious interactions

While interacting vicariously, a reader may be able to intuit or understand the mechanical principles of a system, and to infer causal relations. This happens because by observation of the system's and the interactant's behaviours, the reader may identify regularities and patterns that lead her to expect specific reactions from both parties – from the artefact's outputs to specific actions of the interactor, and from these to particular outputs from the artefact. Although it may be questionable whether a true understanding of the artefact's mechanics is ever attained through vicarious interaction, or even through direct interaction when direct access to the code is not allowed, we may expect that if the outputs of the artefact exhibit regularities and its behaviours are somewhat determinable (Carvalhais 2010, 363), the reader may be able to develop a working model of the system that is capable of producing useful predictions regarding its behaviours or those of the pair interactant-system. This model may of course be based on false assumptions, or on the adaptation of familiar behaviours from other systems, but if it is demonstrably effective, it will also prove useful to the reader, allowing her to approach completeness in the experience of the system. As a result of vicarious interaction the reader may be able to peer through a system's aesthetics level and to develop hypotheses about dynamics and ultimately about mechanics. What then happens if interaction is removed from the experience?

When reading a dynamic and transient system with which one is not able to interact, in order to achieve a comprehension of its procedural level, and therefore of its behaviour, a reader needs to interpret beyond semantics, surpassing the traditional scope of the interpretative function. Besides the interpretation of text, images, sound and other sensorial modalities, procedural systems also allow for *procedural interpretation*. When interpreting texts, readers are "integrating details, forming and developing hypothesis, modifying, confirming, and abandoning predictions" (Douglas 1994, 175), and much of this is likewise possible to do at the procedural level.

When perceiving a system and following its outputs, a reader is not capable of directly accessing the prescriptive rules at the level of mechanics, but she is nevertheless able to make use of descriptive rules to create models that intend to explain or understand the phenomenological levels of the experience. While registering affordances on the artefact's outputs, the reader gradually identifies patterns of behaviour – starting with possible behaviours and following towards more likely or probable behaviours – and identifies relations between the perceived system and other systems or artefacts in the world.[6] Using the data thus gathered, the reader is then able to start developing mental simulations of the processes behind the surface units found in the artefact's outputs. The reader probes the level of mechanics, constructing hypotheses that are verifiable at the level of dynamics and allow to fine-tune the mental models.

These models do not need to be based on complete sets of data, and they do not need to be rigorous to the point of generating accurate predictions of the system's behaviours.[7] First and foremost, they need to pose testable hypothesis that can be verified with the system under observation or falsified by new findings, being then replaced by better hypothesis that ultimately contribute to a good working model of the system. This will then be gradually and continually developed by trial and error, by validation and falsification.

In the gradual understanding of a complex process from which the reader does not have but inferred clues, we may find an analogue to the process of developing theories of mind of other humans or human-like entities.[8] A theory of mind allows one to picture "the world from another person's vantage point" and to construct "a mental model of another person's complex thoughts and intentions in order to predict and manipulate [their] behavior." (Ramachandran 2011, loc. 2281) Based on known humans, familiar systems or mechanics, but also on other artefacts, and phenomena from the physical world, etc., humans speculate regarding mental processes, developing hypotheses that are confirmed or falsified based on the witnessed actions.

Through the developed simulations, and still from the stance of the reader, one tries to see the system from the designer's point of view, thus embracing its wholeness and fully understanding it. Interactive systems are "plastic objects" that need to be interacted with in order to be experienced and that pose the challenge of "extruding play and form, which are no longer located internal to the subject, but have to be performed" (Kirkpatrick 2011, 6) in order to be activated and to allow for an understanding of their "true structure" (Kirkpatrick 2011, 8). On the other hand, non-interactive systems, or systems in non-interactive states, do not

6 Cf. with Metzinger: "Everything we perceive is automatically portrayed as a factor in a possible interaction between ourselves and the world." (2009, 167).

7 Being very used to interact with macroscopic and *gnarly* systems in everyday experience, readers are accustomed to a certain level of analogue variation and noise in the expected outcomes of any system. Therefore, a prediction does not need to be exact, or totally accurate, it simply needs to be roughly approximated to be evaluated as valid.

8 As V. S. Ramachandran (2011) suggests, the capacity to develop theories of mind is not exclusive to humans and not only developed towards humans but also towards entities or systems that may exhibit behaviours, emotions or "mental states" comparable to those witnessed in humans (Zunshine 2006), with "many of us even project[ing] this onto objects." (Gazzaniga 2011, 158).

allow the user to investigate them directly through interaction, but their mental simulations developed by the user are far more plastic, versatile, and accessible. They allow for transformations, variations, and for a larger space of possibilities to be explored as a *theory of the system* is developed, a process during which one is not engaged with the artefact's diegesis or with a fiction but rather tries "to master its routines" (Kirkpatrick 2011, 8).

The process of validating the model can then be seen as leading the reader through an experience of traversal punctuated by epiphanies – when hypotheses are confirmed – and aporias – when hypotheses are disconfirmed – which may lead to the development of narrative (Aarseth 1997, 92) and even of drama[9] in artefacts that wouldn't otherwise be experienced as narrative (Carvalhais 2012a; 2013). Furthermore, every epiphany will activate the reward centres of the reader's brain, resulting in a pleasurable experience that will drive the enjoyment of the artefact and of the experience of its simulation.

5 Ergodic contemplation

We may thus propose that non-interactive systems, or systems in non-interactive states, regardless of the impossibility to develop explorative or configurative functions by the user, may also be seen as ergodic. The mental exploration and reconfiguration of analogues – or simulations – of the systems can be seen as a de facto ergodic experience, therefore procedural works are not limited to a classic interpretation because their variability, dynamism, and procedural nature allow for a new level of virtuosic interpretation of the artefact, that while seemingly contemplative is actually very active. As with other ergodic forms, procedural artefacts require the development of a nontrivial effort from the reader in order to find not one but many paths along the traversal of the procedural space of possibilities.

In the ergodic forms studied by Aarseth the reader is "constantly reminded of inaccessible strategies and paths not taken" (1997, 3), with each decision making parts of the content more or less accessible and building up uncertainty regarding the result of one's choices and to what may or may not be missed along the traversal. In procedural artefacts the questions posed by the reader point towards how many and how diverse those paths may be, and to a discovery of how the system – unaided by a user – tends to follow them. As a result of ergodic contemplation one is then led not to build up uncertainty but rather to increase information and knowledge regarding the artefacts mechanics and to regard the possibilities to be discovered at the dynamics and aesthetics levels.

9 The building up of expectations regarding a system and the violation of those expectations by the system, not only contributes to the validation of the hypotheses or models, but also builds meaning from disruption, as Krome Barratt notes (1980, 301).

If in other ergodic forms the reader faces the risk of rejection (Aarseth 1997, 4), the reader of a procedural artefact has to deal with the added risk of incomprehension, that is, of being unable to build a working theory of the system that may lead to useful predictions. Naturally, with the exception of the very simplest of systems, a total understanding of the processes is not only unattainable as it is utopian, and the reader should be reconciled with that.

6 Designing for virtuosic interpretation

While developing procedural systems that intend to foster ergodic interpretation, artists and designers should be aware that much of this process of building models and testing hypotheses is developed unconsciously. A conscious procedural close reading is certainly possible but in most cases – with perhaps the exception of game forms – should not be expected. One is then faced with the question of how to communicate processes, of how to design processes that are communicable to and discoverable by the reader.

Code descriptions, procedural descriptions or even explicit code may be presented either at or with the system. These may duly inform the reader and allow for the easier elaboration of models and predictions. An example of this approach may be found in John F. Simon Jr.'s *Every Icon*, a work presented with the following text:

> *Given: A 32 × 32 Grid*
> *Allowed: Any element of the grid to be black or white*
> *Shown: Every Icon*
> *(Simon 1997)*

More recently, C.E.B. Reas has developed several works in his *Process* series that are presented with textual descriptions of the elements in the pieces from which dynamic compositions emerge. Elements are "machines" composed by forms (as e.g. "Circle", "Line") and one or more behaviours (such as "Move in a straight line", "Constrain to surface", "Change direction while touching another Element", etc.). Each piece in the series is a process that "defines an environment for Elements and determines how the relationships between the Elements are visualized" and that is presented as "a short text that defines a space to explore through multiple interpretations." (Reas 2008) As examples, we may present:

> *Process 18*
> 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.

Process 17
A rectangular surface filled with instances of Element 5, each with a different size and gray value. Draw a transparent circle at the midpoint of each Element. Increase a circle's size and opacity while its Element is touching another Element and decrease while it is not. (Reas 2008)

Finally, explicit code may be found in "program code poetry" (Cramer 2001), of which the works in Pall Thayer's *Microcodes* (2009-2014) series are good examples:

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

If code or procedural descriptions are not presented to the reader, processes may be designed with repetition and (some amount) of regularity in mind. As an example, algorithmic processes that largely depend on pseudo-randomness may dissimulate their structure and processes under extremes of disorder that are far off from a readable and understandable level of *effective complexity* (Galanter 2003, 8; 2008; Lloyd 2006). A balance of repetition and novelty – to which randomness can certainly contribute (Leong et al. 2008) – can ease deduction, comprehension, and the following of processes, as well as (to a certain extent) the participation of the reader in the processes.

Finally, and as Steve Reich notes in *Music as a Gradual Process* (1968), *perceptible* and gradual processes facilitate the closely detailed reading of a piece.[10] Therefore, the pacing of the processes – and we must bear in mind that the timescales of modern computational devices and of human psychology and perception are very different – may also be instrumental in facilitating (or altogether allowing) ergodic interpretation.

But the processes should also be developed taking into account a series of perils or difficulties related to human interpretation of procedural systems – both natural and artificial – as e.g. being aware of psychological and perceptual illusions such as the *Eliza* effect[11] (Hofstadter 1995, 158) and the *Tale-Spin* effect.[12] The mental processes supporting some of these illusions should also be taken into account during development: *patternicity*,[13] "the tendency to find meaningful patterns in both meaningful and

10 "John Cage has used processes and has certainly accepted their results, but the processes he used were compositional ones that could not be heard when the piece was performed. The process of using the *I Ching* or imperfections in a sheet of paper to determine musical parameters can't be heard when listening to music composed that way. The compositional processes and the sounding music have no audible connection. (…) What I'm interested in is a compositional process and a sounding music that are one and the same thing." (Reich, 1968).

11 "…defined as the susceptibility of people to read far more understanding than is warranted into strings of symbols – especially words – strung together by computers. (…) We don't confuse what electric eyes do with genuine vision. But when things get only slightly more complicated, people get far more confused – and very rapidly, too." (Hofstadter 1995, 158).

12 "…denotes the converse situation [of the Eliza effect]. A very complex programming process is reproduced in such a simplified form that the complexity remains concealed from the recipient. Wardrip-Fruin's name for this effect refers to a 1970s story-generating computer program whose highly complex algorithms could not be discerned by the users." (Kwastek 2013, 135).

13 A phenomenon also known as *apophenia*.

meaningless data" (Shermer 2011, 5) and *agenticity*, "the tendency to infuse patterns with meaning, intention, and agency" (Shermer 2011, 5).

7 Summary & Future Work

The interpretative user function should be regarded as broader and more relevant to the aesthetic experience than what one may be led to believe from its usual association with non-ergodic texts. Procedural interpretation may allow the development of rough analogues of the explorative and configurative functions, when these are not present or possible in a given context, and lead to the transfer of algorithmic processes between the artefact and the reader and to the development of a *virtuosic interpretation*.

An awareness of these processes may thus lead creators to develop artefacts that may rely on them or at least aesthetically negotiate with them, so if from traditional aesthetics we move to an aesthetics of interaction, agency and performance, we now find these also coupled with a very relevant aesthetics of process and procedurality. This paper establishes the need for this awareness, enumerating some considerations for the design of the ergodic experience of *virtuosic interpretation*, while future research aims at expanding and uncovering new considerations, developing them into a formal set of principles and guidelines.

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