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Artificial Aesthetics

Creative Practices in Computational Art and Design

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6. AN ANALYTICAL MODEL FOR PROCEDURAL SYSTEMS

Digital objects are "a confusion of conceptual models, symbolic logic, algorithms, software, electrons, and matter", that exist "on the threshold of materiality" (Dunne 2005, 11). They are a diverse set of artefacts sharing a computational nature that diversifies the outcomes of their processes and their perceivable phenomena.

Whether or not it is possible to identify true computational art forms, as Steven Holtzman (1994, 241) defines them — art forms that one could not even imagine to have been developed without the capabilities and the expressive possibilities of computers — we may accept that sometimes, what we come to identify as characteristic computer aesthetics, result from a certain lack of capabilities. Computer functionality sometimes "reveals itself through technological limitations", with bottlenecks of speed, bandwidth or resolution that result in very recognisable aesthetics (Goriunova and Shulgin 2008, 113).

These constraints can be incorporated in the culture of the media and are consequently recreated and emulated, becoming superficial aesthetic layers and not structural outputs.[1] As black and white photography or film became choices and not the only possibilities; as grain, smudges or scratches in film became something other than marks of wear and tear and actual stylistic choices, so did low resolution or polygon count, limited colour depth, compression, aliasing or other marks of the past of digital media. They're no longer a "manifestation of genuine software aesthetics" (2008, 111) because computational aesthetics are universal, visually able to emulate the aesthetic characteristics of most (if not all) media.

Xenakis described his approach to composition as considering "sound and music as a vast potential reservoir in which a knowledge of the laws of thought and the structural creations of thought may find a completely new medium of materialization" (1992). For this purpose, an epithet as "'beautiful' or 'ugly' makes no sense for sound, nor for the music that derives from it" and the validity of a particular music should be assessed by "the quantity of intelligence carried by sounds". Xenakis distinguished the systems from the aesthetic ar-

1. They can be seen as not being outputs from the generative processes of a system, such as they were when their creation was subject to the technical limitations of a particular system, but rather as being created or affected by the transformational components of the system. In a sense, and adopting Chomsky's terminology, as technology evolves the signs cease to be the effect of the limited competence of the machines and start to become intentional products of the system's performance

tefacts they produced which suggested that aesthetic success was dependent on humans not on technologies (Ariza 2009, 66). This is an expectable point of view from a composer, trained to interface and isolate systems, structures and technologies, and their aesthetic outputs — happening as they do in different contexts and with different participants — but that one should perhaps not expect from other technologically grounded artists. Still, even for creators that depend on the technological realisation of the outputs, the conceptual aspects of a given system can weigh more than the aesthetic evaluation of the outputs per se. One wouldn't certainly experience the drawings of Cohen's AARON (1973) or Musgrave's landscapes in the same way knowing they were produced by a human rather than by a computer program. One wouldn't even be able to listen to *4'33"* without some previous knowledge of its conceptual foundation.[2]

Built from systems and computational procedures, digitally produced aesthetic artefacts can be seen as conceptual in essence. In computational art as in conceptual art, much of the artists' attention is focused on exploring different systems for their own intrinsic value, exploring ideas that become machines to "make the art" (LeWitt 1969). After these processes are defined, after ideas or concepts are in place, the actual construction of the work is a "perfunctory affair", something that although necessary, is nevertheless secondary to the conceptual part of the artistic process. In the domain of digitally generated artefacts, the actual construction of the work is also, at many levels, a matter of processes and ideas, of algorithms and code.

As with conceptual art, a considerable part of the aesthetic value is to be found at the level of ideas and not at the level of the actual construction of the perceived outputs. Therefore, as in conceptual art, we run into the problem that these ideas must either be carried explicitly, communicated *by* or *with* the artefact. When this doesn't happen the experience of the artefact will necessarily be lacking because it will be misinformed (or under-informed) and it will be up to the reader to find clues of the process in the outputs of the system.

Art is the external representation of computational processes created by the artist, and these can be seen as already being representations of something happening in the head of the artist (Laurel 1993, 30). Either way, the final rep-

2. One could argue that without the conceptual framing, *4'33"* would not even exist and that therefore it simply wouldn't be possible to hear. Defined singularly by conceptual aspects, *4'33"* is formed before the listening act, not during it, as would normally be expected. The focus of the listener has to be attuned to the typology of sounds that form the piece and not those that would normally constitute a musical composition (particularly one performed, as *4'33"* originally was, on a piano).

resentation will always be dependent on the representation existing at a code level but will not necessarily represent it, in the sense that it may not allow the reader to fully understand the structure and processes developed at that level. Viewers are placed in art contexts but may have no interaction whatever with the machines, other than by attempting to understand their rationale through their outputs. They are, as Saul Albert puts it, invited to examine how the artist's relationship with the machine affects her status as the artist, and theirs as viewers (2009, 91).

But unless the source code of a system is available and readable — something that may happen but is far from being the norm — and the reader is capable of understanding not only the code but also her role as user, the external influences affecting the system, etc., she will not truly be in the possession of enough information about what happens within the machine, much less about what may have happened in the artist's head, and about questions related to the openness of the artwork, of its possible links, metaphors and analogies.

This is the space of criticism, spreading beyond artists, artworks, and their motivations. This is a layer of interpretation that is often forgotten but that is very present as a direct consequence of the openness of an artwork, impacting not only its relationship with the audience but also greatly influencing the process that underlies it. That is why it is "important to understand that software is not just a technical component of digital art, it *is* the artwork and its code provides another reading of it" (Mansoux and de Valk 2008, 10).

One must raise questions concerning the extent to which the artist developed the code, not only which parts of the code were her creation — perhaps a minor question in the days of sampling, collage, and shared or open source code libraries — but to what extent the artist or designer is a skilled programmer, to which extent she understands the tools and the code and is *procedurally literate*, to follow the definition proposed by Michael Mateas[3] (2005). This is a challenge to practitioners as well as to readers and critics.

3. Its not so much a matter of historically framing a work, thus trying to understand what was feasible by a certain author at a certain time, but also to try to understand what was easier to produce by a given author at a certain time, with the set of tools that were available to her — tools that are not always immediately visible in the finished artefact. As Mateas puts it: "Procedurally illiterate new media practitioners are confined to producing those interactive systems that happen to be easy to produce within existing authoring tools." (2005) Although craft and technical expertise can always be difficult to discuss, particularly in the artistic context, it is clear that one must regard Musgrave's coded landscapes, created from algorithms that he devised and developed in an altogether different way from the countless similar images one comes across more recently, generated by plug-ins of 3D modeling software (that may happen to be developed from Musgrave's algorithms) that demand very little

This *metainformation* problem was present throughout the twentieth century. The more the conceptual aspects of the artwork or the artistic process were fundamental to reading the pieces, the more the lack of information on how to read and comprehend the work of art was felt. As a consequence, some fundamental artists of the twentieth century are unknown to audiences at large besides a somewhat small group of literati able to understand the context of creation and the framing of the pieces. This phenomenon happened in many artistic fields and persists in digital arts, operating as they are on similar grounds.[4] Stephen Wilson (2002) argues that the terms *digital* or *computer-based* may no longer be enough to describe a coherent aesthetic category, especially now that the power of digital systems allows one to create or emulate practically any output one can think of. He therefore suggests a broader approach, and uses the term *information arts*, shifting the focus from the medium or the tools to the process.[5] The question is not *what* one can do with digital tools, but rather *how* one can work with digital tools, which processes give rise to the work that is, itself, also defined as a process. Not what is ultimately output at the system's surface — although that is certainly important — but much more which structures are developed in the system, creating the outputs.

In order to perform an analysis of diverse computational aesthetic artefacts, we must therefore not rely exclusively on the physical characteristics of the outputs of the systems. As Blais and Ippolito note, artists working with procedural systems not only tolerate, as they even celebrate, outputs that are unruly or downright ugly, provided they allow them to "focus on the code itself as the object of interest" (2006, 21). If we follow Galanter's definition,[6] it becomes clear that we will face a dilemma previously identified by Cramer:[7]

(both in creativity or craft) to be deployed. This shifts the role of the creator (temporarily in some cases) to the role of a user, much in the same sense as someone using Mozart's *Würfelspiel* would not really be composing — as Mozart was when creating the game — but rather deploying the system and exploring the results of the possible combinations. The user was supplying the chance element and therefore she was indispensable to a particular instantiation of the game and to the particular output being produced, and so one may regard her as coauthoring the output, but never as its creator or composer.

4: Fuller and Morrison discussed the tensions in this relationship in two articles in *Mute Magazine*, in the end of the 1990s: *Ten Reasons Why the Art World Loves Digital Art* (Fuller 2009) and *Ten Reasons Why the Art World Hates Digital Art* (Morrison 2009).

5: Conversely, Dominic McIver Lopes proposes a distinction between digital art forms and "computer art forms" based in the definition of a computer art form as an item that "1) it's art, 2) it's run on a computer, 3) it's interactive, and 4) it's interactive because it's run on a computer." (2010)

6: See page 189.

7: "If software art could be generally defined as an art: 1) of which the material is formal instruction code, and/or 2) which addresses cultural concepts of software, then each of their positions sides with exactly one of the two aspects. If Software Art would be reduced to only the first, one would risk ending up a with a neoclassicist understanding of software art as beautiful

should these works be "evaluated according to code (form) or result (function)?" (Blais and Ippolito 2006, 24)

The correct answer probably lies within and across both views. Audiences, critics and creators should be procedurally literate. They need to be able to read and analyse computational artefacts, valuing them through their final outputs and through the processes that produce them, that may also be a part of the aesthetic experience.

Although one usually has no access to the code in order to read or criticise the artwork, one may try to infer from the experience of the artefacts enough information to understand the processes developed within it. In cases where information about the process is communicated with or in the artefact, like in Simon's *Every Icon*[8] (1997), it is easier for the viewer to incorporate knowledge about the core process (even when precise implementation details may be unknown) into an analysis of the artefact and its aesthetic fruition. The presentation of the core process becomes an integral part of the artefact, given that the visual representations emerging from the process may not be enough to communicate it as swiftly as the author would like.

Through the repeated experience of the artefact and of its multiple outputs one may in some cases be able to grasp part of the underlying process, even if this is not represented directly by, with, or in the artefact. This will be particularly feasible in cases where systems visualise processes, but more difficult if there is a high degree of randomness coded into the process or if this is using real-world data as a source of control. If *Every Icon* is a good example of the first, *Merce's Isosurface* (Levin 2004) may be a good example of the latter. This work was created from data captured from a performance by Merce Cunningham, and the motion of the rendered form is reminiscent of Cunningham's hand dance but, unless one is explicitly informed of the provenance of the data, it would be very unlikely to be inferred from the piece alone. In Verostko's plotted paintings no information is given about the algorithms or the production processes used in the work. Although occasionally the pieces can be presented

and elegant code along the lines of Knuth and Levy. Reduced on the other hand to only the cultural aspect, Software Art could end up being a critical footnote to Microsoft desktop computing, potentially overlooking its speculative potential at formal experimentation. Formal reflections of software are, like in this text, inevitable if one considers common-sense notions of software a problem rather than a point of departure; histories of instruction codes in art and investigations into the relationship of software, text and language still remain to be written." (Cramer 2002)

8. Simon composes a simple statement in the piece, adjacent to the grid where the process is set in motion: "Given: An icon described by a 32 × 32 grid. Allowed: Any element of the grid to be colored black or white. Shown: Every icon."

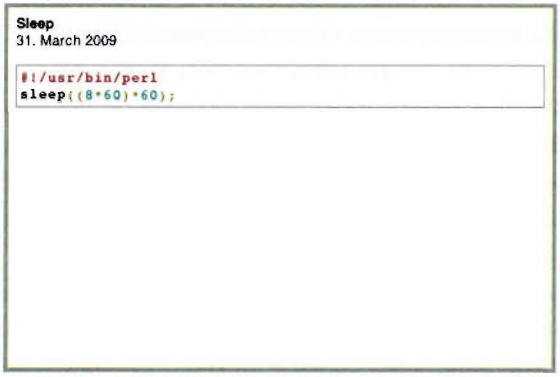

Fig. 41 Pall Thayer, *Sleep* (2009), from the *Microcodes* series (2009-2014).

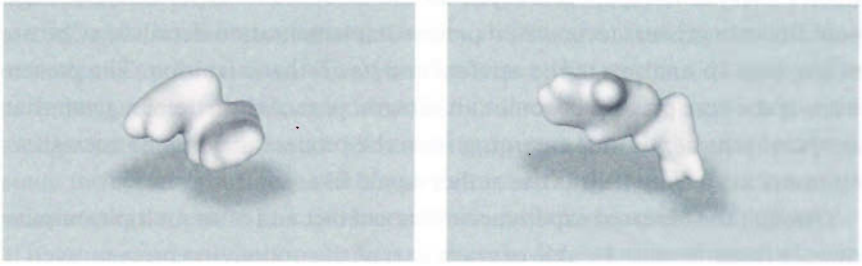

Fig. 42 Golan Levin, *Merce's Isosurface* (2009).

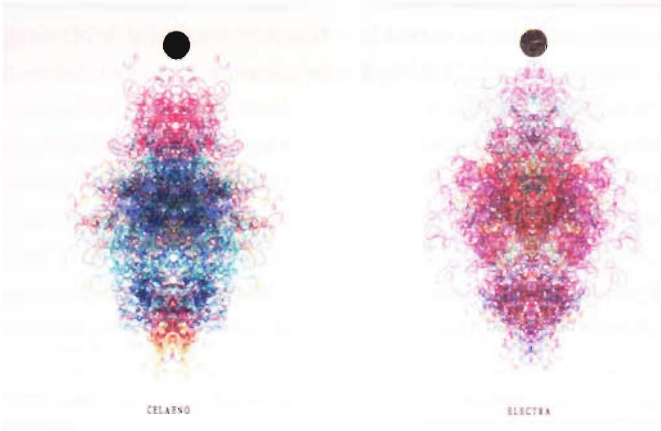

Fig. 43 Roman Verostko, *Celaeno* and *Electra* from *Seven Sisters: The Pleiades* (1998).

in the context of computer art exhibitions, due to the nature of their production — the use of paint and brushes attached to a multi-pen plotter driven by the artist's software — there aren't many signs of the structure's computational origin.

What one may grasp in these systems is not the actual code but an understanding of the piece's principles of operation and the ground rules that are enunciated by the code. What one will then need to understand in order to study the pieces are not programming languages per se, but the general programming principles and the behaviours coded through these. We can argue that what seduces in these works is not necessarily the finished physical emanations (however pleasing these may be) but rather, and much more, the way how each carries with it a process, a logic, a grammar, and a set of concepts that are inseparable (and in some cases indistinguishable) from the artefact itself. Besides other concerns central to the creation, interpretation and critical analysis of any aesthetic artefact, computational art uses code for speculative or critical ends (Blais and Ippolito 2006, 25), it perverts it, by turning the cold logic of algorithms into an expressive tool. This "playful perversity" distinguishes the artistic use of code from the technical usage, and turns computational art into something that is much more than art made *for* or *with* machines, and that is "highly concerned with artistic subjectivity and its reflection and extension into generative systems." (Cramer and Gabriel 2001) It follows that beyond and besides the sensorial aesthetic experience of the artefact, the narratives it may develop,[9] and the mechanical aspects of the system's operation,[10] one permanently needs to consider the system's mechanics (Hunicke, LeBlanc and Zubek 2004), its code layer, because it will ultimately generate the other layers. It is a fundamental part of both the aesthetic and the narrative experiences and it is at the core of the system's implementation. It also is, however, mostly invisible to the users and, in most cases, impossible to evaluate directly, therefore one has to rely on indirect information or on clues

9. One can argue that time-based experiential pieces always develop a narrative, although they may not *tell* a narrative, in the traditional sense one associates with narrative media. If, as Laurel proposes, we define experiential activities as those that, "such as computer games" are "undertaken purely for the experience afforded by the activity as you engage in it, while productive activities such as word processing have outcomes in the real world that are somehow beyond the experience of the activity itself (...) 'productivity' as a class of applications is better characterized not by the concreteness of outcomes but by their seriousness vis-a-vis the real world" (1993, 22-23), we should regard experiential pieces as always containing or being able to generate a narrative during their experimentation.

10. The mechanical aspects of a system mostly refer to whether the computational processes that are developed in the system are digital, analogue or hybrid, whether the system is self-running or if it depends on user input, etc.

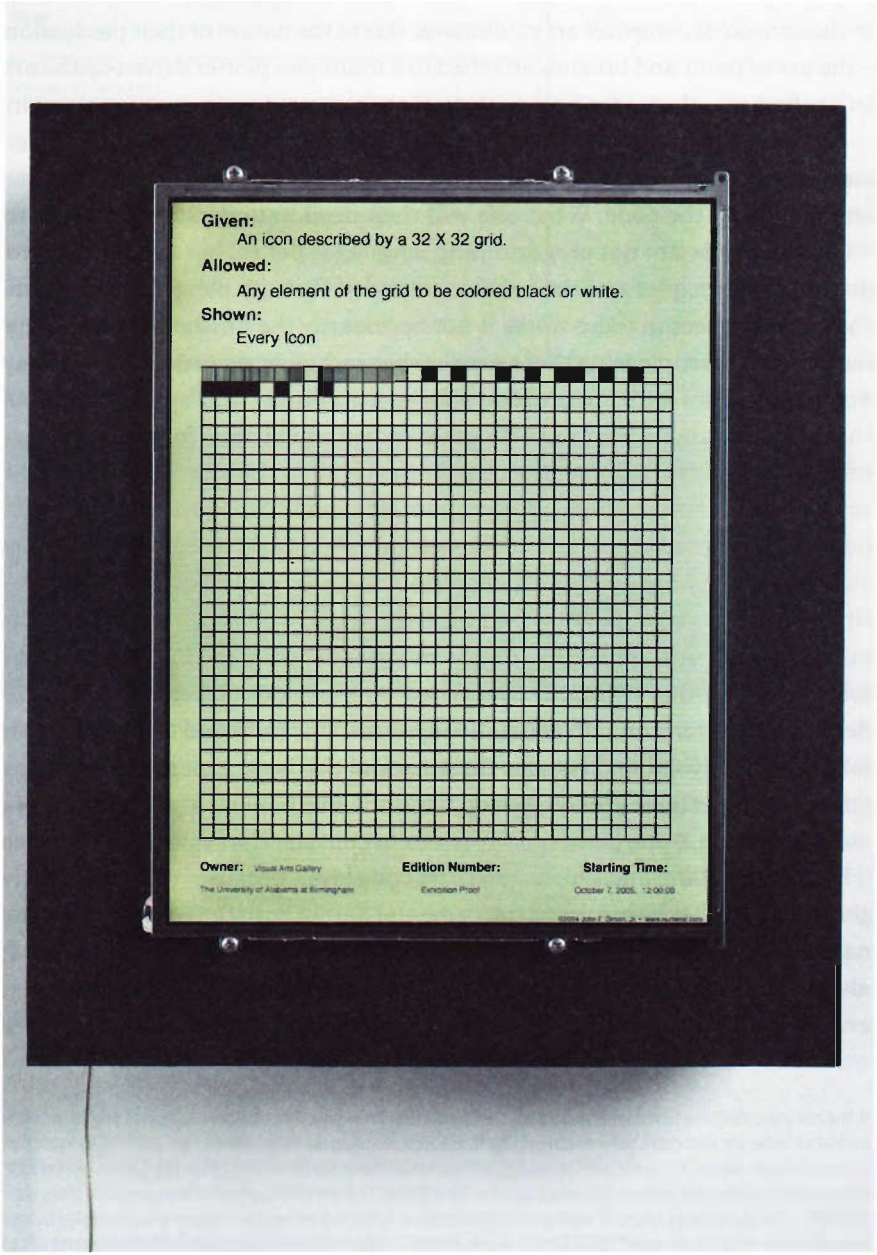

Fig. 44 John F. Simon Jr., *Every Icon* (1997).

presented by the system to hypothesise about it. One will have to develop an analysis not founded in code but phenomenologically based, using the outputs of the code to try to discern the processes that may be happening inside the black box of the system.

> (...) as an artist who writes code, I don't think that 'my medium' is the same as the 'viewer's medium'. My medium is the code. That's what I shape and manipulate to convey my 'message'. The viewer's medium can be something else. It could be the Internet or the computer or the screen, depending on how they regard the work. It could even be the code as long as I reveal it. But I'm not really in a position to dictate to the viewer what they may or may not refer to as 'the medium'. That's dependent on their own experience. Regardless, whatever I consider as 'my medium' has a big impact on the nature of the work itself. In many ways it defines and guides the creative process. (Thayer 2008)

AARSETH'S TEXTONOMY

The lack of established and rigorous terminology is a major problem in this field. On the one hand, as practitioners originate from various backgrounds, they bring along terminologies inherited from aesthetics, computer sciences, mathematics or life sciences that are not always compatible. On the other hand, several of the discovered phenomena are genuinely new and unprecedented, without clear references to other arts or fields of knowledge, thus lacking study and a clear nomenclature.

This nomenclature must deal with questions of authorship, technical issues, narrative, drama, cognitive aspects, interaction and agency. It must recognise computational aesthetic artefacts as a diverse group of objects and systems, with links not only to art and design theory and history but also to computer sciences, as many of its practitioners often operate across fields. It must also bear in mind that even if one could argue that to a certain extent everyone is minimally conversant with digital technologies, we can safely assume that most are knowledgeable in what is usually referred to as an *end-user* perspective, that is, in the usage of computer programs and platforms following models of operation that are largely dictated by the applications and their designers, and not in the production of code. People are well-versed in the usage of existing software, not in the creation of new software.

As digital technologies become ubiquitous, embedded in multiple devices and almost all media, they are increasingly produced by a combination of human and mechanical activities, and all arts tend to become cyborg arts, all communications to become cyborg communications. Aarseth defends that these need a "criticism and terminology with less clear-cut boundaries between humans and machine, creative and automatic, interested and disinterested" (1997, 134), with "unproblematic connotations", and grounded "on observable differences in the behavior" of artefacts and their users (1997, 59). He defends that the recent visibility of the so-called *new media* has inspired everyone to look at the old media in a new light and that what resulted from these observations was the conclusion that the *stability* of the traditional media is "just as metaphysical and illusory as the (...) claims of a new electronic writing that alters the functions of (...) communication in singular and revolutionary ways". All media share properties and modus operandi, regardless of their digital or analogue foundations, therefore, for "reasons of formality", physical differences should not be given substantial status in a terminology for their study. Aarseth defends an approach that configures the terminology functionally, making it less dependent on ad hoc perspectives and contexts of implementation and giving place to a more discerning model, based on empirical observations, and able to accommodate future media patterns.

Introducing his own effort to build a terminology, grounded in an analytical model that provides a typology of textual communication, Aarseth describes previous efforts to create typologies that reflect media diversity. He mentions Jan Bordewijk and Ben van Kaam's typology of four modes of information *traffic patterns: allocution, consultation, registration*, and *conversation*. Richard Ziegfeld's (1989) comparison of the elements of interactive fiction with those of other media, introducing a variety of *software options*, such as movement, simulation or interaction. Finally, he notes Joyce's (1988) distinction between explorative hypertexts and constructive hypertexts that "can be changed, added to, and reorganized" (1997, 60), a classification that proved particularly useful to the user functions section of his model.

Grounded on these three models, Aarseth proposed a new *textonomy*, a typology of textual communication. He tried to establish a basis for a common terminology and the basic concepts that apply to all the objects under consideration. The first step in doing so is defining the focus of the analysis — textuality — therefore defining the meaning of text, or "what circumstances al-

low us to describe a certain object as a text" (1997, 62). *Text* itself is something without a universal definition, to which disciplines "both within and outside of literary theory attach different meanings", but that nevertheless needs a pragmatic and broad definition.

> A text, then, is any object with the primary function to relay verbal information. Two observations follow from this definition: 1) a text cannot operate independently of some material medium, and this influences its behavior, and 2) a text is not equal to the information it transmits. Information is here understood as a string of signs, which may (but does not have to) make sense to a given observer. (Aarseth 1997, 62)

In addition to textons and scriptons,[11] a text also consists of a *traversal function*, "the mechanism by which scriptons are revealed or generated from textons and presented to the user of the text." It is important to note that a text's scriptons "are not necessarily identical to what readers actually read, which is another entity (...) and not determined by the text", scriptons are what an *ideal reader* would read if she were to strictly follow the linear structure of the textual output.

In order to describe a text according to its mode of traversal, Aarseth proposed a set of seven variables: *dynamics, determinability, transiency, perspective, access, linking* and *user functions*, each with a range of possible values. These variables and values taken together create a "multidimensional space of 576 unique media positions"[12] (1997, 64) and any text classified by this typological model will therefore have a profile identifying it as belonging to one of these.

Employing correspondence analysis (CA), a branch of exploratory data analysis, Aarseth analysed categories and variables as well as objects, trying to link categories and objects, singling out variables that may "describe substantial differences between the textual modes" (1997, 61).

Mapping the data gathered from the CA, he didn't find clear signs of a dichotomy between printed and electronic texts. Among the 23 texts that were

11. Aarseth found it useful to distinguish between strings as they appear to the readers and strings as they exist in the text itself, given that these may not always be the same: "For want of better terms, I call the former *scriptons* and the latter *textons*. Their names are not important, but the difference between them is. In a book such as Raymond Queneau's sonnet machine *Cent mille milliards de poèmes* (...) there are only 140 textons, but these combine into 100,000,000,000,000 possible scriptons." (Aarseth 1997, 62)

12. $576 = 3 \times 2 \times 2 \times 2 \times 2 \times 3 \times 4$.

analysed, 10 were printed (as diverse as *Moby Dick*, the *I Ching* or the *Cent mille milliards de poèmes*), and their distribution in the analysis largely overlapped with the group of electronic texts. In fact, it was clear that the variation within each group was much larger than between the two groups.

Aarseth admitted that there were different ways to partition the analysis: between ludic texts, "that invite the user to role-play and to creatively participate", and "calmer, more contemplative texts"; between texts dominated by "intratextonic dynamics and the exploring user function" and static or unpredictable texts; between hypertexts and texts characterised by the interpretative function and no linking (1997, 72-73).

Concluding, Aarseth questions whether we could be witnessing yet another reconfiguration of the always contested and problematised concept of text. He questions if one should use the same term for "phenomena as diverse as *Moby Dick* and MUDs? Or for that matter the *I Ching* and *Moby Dick*? If the answer is yes, we face some hard rethinking about the subject of media analysis." (1997, 74) Searching for common features to all the samples, he argues that the main question is related to user activity, as any text directs its users, by convention, mechanism or social interaction.

> The reader is (and has always been) a necessary part of the text, but one that we now realize can (or must) perform more than one function. If these are all texts, perhaps the word reader no longer has any clear meaning. However, if the answer is no, we still have to construct a viable terminology to describe the literary games and rhetorical rituals we can observe both in the new media and in the old papery ones. There is still much to be said for the concept of text, and the various samples examined here in no way invalidate the category. The important lesson to be learned from discontinuous and forking texts is that when two readers approach a text they do not have to encounter the same words and sentences in order to agree that it probably was the same text. (Aarseth 1997, 74)

Based on this analysis, Aarseth discussed the question of what to call these texts, dismissing the hypothesis of calling all electronic texts hypertexts as not useful, "considering the wide variety of textual types (many of which are already known by other names, such as MUDs and adventure games)" (1997, 75). Hypertext may be a useful term when applied to the structures of links and nodes that support forking texts (whether electronic or paper-based), but is

far less useful if it includes all digital texts, regardless of their structures. He therefore suggests the term *cybertext* for texts "that involve 'calculation' in their production of scriptons" (1997, 75).

ON A MODEL FOR PROCEDURAL MEDIA

Calculation, algorithms, or effective procedures, must be at the basis of a definition for a typology of procedural aesthetic artefacts. We will leave the discussions around terms such as *media* or *artefacts* for other grounds as in this context, both terms can often be used interchangeably.[13] Particular works may be conveyed through a variety of distribution technologies, each constraining the work to a particular form and to specific limitations in the final sensorial output, but one may argue that the work conveyed by all is fundamentally the same, in disregard of medium-specific metamorphosis it may be subjected to. In this sense, many of the artworks and aesthetic artefacts that we will discuss are *notational*, as proposed by Nelson Goodman, who distinguished between *autographic* works, such as paintings and other unique objects bound by the authority of their producers and by the specific medium in which they are produced and communicated,[14] and notational works, that he called *allographic*.[15]

> Music, of the typical Western kind, is notated, and the creation of the notation Goodman calls the "execution" of the work, but it still needs to be "implemented" through performance to properly exist. This idea of implementation is given considerable prominence. A novel is implemented by being printed, published, promoted, circulated, and ultimately read. A play is implemented through performance before an audience in a theater, an etching by the taking of impressions, a painting perhaps by being framed and hung. A work is somehow incomplete until it has fulfilled its

13. We generally prefer to use *media* when referring to the communication technologies and *artefacts* when referring to the contents of communication or to the actual pieces, to what one may call the work of art or the communicational object, regardless of the particular media through which they are conveyed (whenever that distinction is possible). And we have to grant that the distinction between media and artefacts, media and systems or between media and works is very often confusing, especially in those cases where the work *is* the medium.

14. Not a broadly defined medium like oil painting, marble or other stone but the specific molecules of the medium in which they are produced, a specific stone, not a type of stone, specific paints or canvas...

15. We may make a note for implementations of allographic works that become authographic works, such as first editions prints of books or original manuscripts that were later reproduced. Of course, in this sense, the manuscript or a first edition of *Don Quixote* are not equivalent to the latest paperback edition, but it is the medium and the tangible (and historical, in this example) artefact that creates the difference, not the *Quixote*, the literary work.

> communicational destiny: execution is the making of a work, but implementation is what makes it work. (Lee 2006, 33)

We wouldn't go as far as to state that allographic works completely remove the authorial authority from the equation, but we could say that traditional authorship is increasingly turning into what Murray calls *procedural authorship*. Our definition cannot be grounded in the set of signs used in the communicative act, nor in the particular kind of information exchanged with the system, therefore the simple definition of an "object with the primary function to relay verbal information" (Aarseth 1997, 62) will be as useful (or useless) as any definition mentioning visual, aural or any other specific kind of information.

What we can retain from his definition are the two observations, that we can rephrase as: 1) an aesthetic artefact cannot operate independently of some material medium, and this medium influences its behaviour, and 2) an aesthetic artefact is not equal to the information it transmits. We should however bear in mind that this rewording is (perhaps too simply) just replacing the somewhat undefined object of Aarseth's study, *text*, with the apparently even less defined object of this study, *aesthetic artefacts*. But, we can question, is *aesthetic artefact* an adequate definition?

What is an aesthetic artefact? It is something concerned with beauty or its appreciation[16] and something that is man-made (directly or otherwise) and not naturally occurring in the world. It is then necessarily a communicational artefact, in the sense that it either deploys information to convey the aesthetic effect or that it uses the aesthetic effect as a resource for communication. The particular information or classes of signs used by the artefact are certainly relevant to its analysis under an aesthetic perspective, but this analysis would have to focus on, and depend upon, semiotics and semantics. Therefore, the analysis of a sound-based artefact would necessarily differ from the analysis of a text-based artefact, despite many hypothetical similarities at the level of which processes may be developed within the pieces. We propose that the analysis can be developed at the level of the processes and that, despite obvious disparities at a sensorial level, similarities may be found between pieces driven by similar processes.

16. From the Greek root of the word, *aisthetikos*, from *aistheta* 'perceptible things', from *aisthesthai* or to 'perceive'.

We are not defending that an analysis based on procedural aspects should replace one focused on other aesthetic features, as we wouldn't defend that an aesthetic analysis should replace a broader cultural or contextual analysis. What seems clear as more procedural artefacts are produced, as they reach broader audiences and as they become part of the mainstream of the arts, is that the analysis of their procedural aspects should also become a part of their study.

> The typological approach is one way to question conceptions about texts, readers, and the limits of such concepts. Its reductionist perspective makes it easy to check, criticize, modify, or even reject if necessary. The larger categories attained by this method explain themselves through their construction, and the problem of industrial-rhetorical terminology that haunts so much of the current theoretical discussions of the new media can thereby, we hope, be avoided. The same approach could probably be used in other typological studies of cultural phenomena (...) (Aarseth 1997, 74)

Taking a cue from Aarseth's proposal, we may try to develop a typology for procedural aesthetic artefacts, striving to find common characteristics among the diversity of these systems. We will depart from Aarseth's textonomy, already focused as it is on the *calculations* that happen beyond the artefacts, in the system's *black boxes*, more than on their sensorial outputs.

THE VARIABLES

DYNAMICS

Dynamics, the first variable in Aarseth's typology, describes the contrast between the behaviours of scriptons in a *static* text, where they are constant, from that observed in dynamic texts, where "the contents of scriptons may change while the number of textons remains fixed (...) or the number (and content) of textons may vary as well" (Aarseth 1997, 63). A hypertext such as *Afternoon* will present a fixed number of scriptons and textons, while a game like *Colossal Cave Adventure* will present a fixed set of textons but a variable number of scriptons that are the result of different texton combinations determined by the progress of each individual play. Other systems, like MUDs, have an indeterminate number of textons. Aarseth therefore classifies *Afternoon* as a static

text, *Colossal Cave Adventure* as displaying *intratextonic dynamics* (IDT) and a MUD as displaying *textonic dynamics* (TDT).

This variable may be difficult to apply to non-text based artefacts, consisting of various classes of signs,[17] and particularly to temporal media. But we should nevertheless undertake the experience. Whenever a system presents a fixed number of signs and of their combinations,[18] we will be able to classify it as *static*. This will be the case in printed works, but also in time-based artefacts such as linear videos, where in spite of temporal dynamism very often we do not witness the introduction of new elements or articulations.

Where Aarseth analyses the difference between textons and scriptons, we will need to focus on a similar but broader distinction found in these media. Signs may exist at various levels in aesthetic artefacts: the entire artefact may be interpreted as a single sign, as it may be interpreted as being composed of several signs, much like texts, which as described by Aarseth, are composed of scriptons that are composed of textons, a topological description that partitions the text into units that are relevant to the analysis being undertaken (1994, 61).

When considering signs in a non-textual artefact,[19] we will need to distinguish two broad classes[20] that are also not clearly defined: those we could perhaps call *macro-signs*, or simply *signs*, and those that can be seen as the micro components from which signs are built.[21] The first can be roughly compared to Aarseth's scriptons[22] and can be understood as those forms that are directly perceived in the system's output, while the later are the parts from which these are built.[23] These are not necessarily indexes, icons or symbols[24] (Callahan

17. *Signs* as something that stands for something else, as discrete units of meaning, a definition that not only includes words (textons and scriptons) as well as images, gestures, scents, tastes, textures, sounds or any other way through which information can be communicated as a message.

18. However freely the reader or user can roam between these, and regardless of whether the signs are dynamic in time, or *transient*, as we shall see.

19. Or for that matter in a multimodal artefact that includes text but is *not* exclusively composed of text.

20. This is not a semiotic analysis, distinguishing between iconic, plastic (colors, shapes, textures) and linguistic signs, but rather one that tries to understand how, in the heterogenous artefacts we are studying, all these are articulated and where they stand in the hierarchy of the system's structure.

21. This bears some resemblance to Nake's tension between macro- and micro-aesthetics, macro- and micro-elements, or signs.

22. Although they can very often be seen as being the entire sensorial output of the system — which in Aarseth's model would correspond to the whole text — this does not contradict the model.

23. In a sense the first can be seen as the gestalt components of the artefact and the later can be seen as structural components.

24. *Icons* are a class of signs whose signifier keeps a direct analogy with what is represented, *indexes* keep a causal relation of physical contiguity with what is represented, and lastly, *symbols* are related with what they represent merely by a conven-

1994), although they may be (and usually are) on the way to become either of them, or they may forever stand in the delicate balance between realism and abstraction, as expressed by Wassily Kandinsky (2008). They will generally not be the technological structural components, like pixels or voxels, but will be built from these, and will stand in the middle-ground between these and the signs. We can understand this e.g. in *phiLia 01* (2009), where the forms that are perceived at the surface of the system are constructed from several circles (of regular diameters but varying colour, and moving in the space of the composition) or, as one could also put it, emerge from the behaviours of these.[25] It is tempting to (however simplistically) compare the two roles of forms and components to Chomsky's deep and surface structures when referring to the structure of sentences or messages, although we are reluctant to appropriate terms from linguistics, these designations are attuned to the phenomenon we are trying to describe.

We can then maybe talk about *surface forms* and *deep structural forms* or, after Krome Barrat's nomenclature (1980), call them *surface units* and *deep units*. What is important in this context is to name the phenomena and not the actors that create it. Consequently, to the value that Aarseth calls intratextonic, when scriptons change but textons do not, we can call *surface unit dynamics* (SUD) or simplifying, *surface dynamics*. This will describe systems where a fixed number of deep units are articulated in the production of several (or varying) surface units. *PhiLia 01* is such an example, as is *Every Icon*.

Finally, in a phenomenon equivalent to what Aarseth calls textonic dynamics, we will find that in some systems the deep units change autonomously or can be changed by the user, invariably effecting the surface units. This we can call *deep unit dynamics* (DUD).

An example of a system that displays deep unit dynamics is the *Perpetual Storytelling Apparatus* (von Bismarck and Maus 2009), "a drawing machine illustrating a never-ending story by the use of patent drawings" (2009) fetched from online databases. The basic procedure starts from the parsing of a text, looking for nouns and verbs to be used as keywords for a search for patents

tion. This classification, first proposed by Charles Sanders Peirce remains somewhat controversial and is often criticised, but is nevertheless useful for the study of images and of the different kinds of images so, according to Martine Joly it is still commonly used (2008, 39).

25. There are a dozen or so components in the system, all of them moving across the plane and reacting to the user's inputs and to each other. These leave traces that ultimately compose the perceivable form.

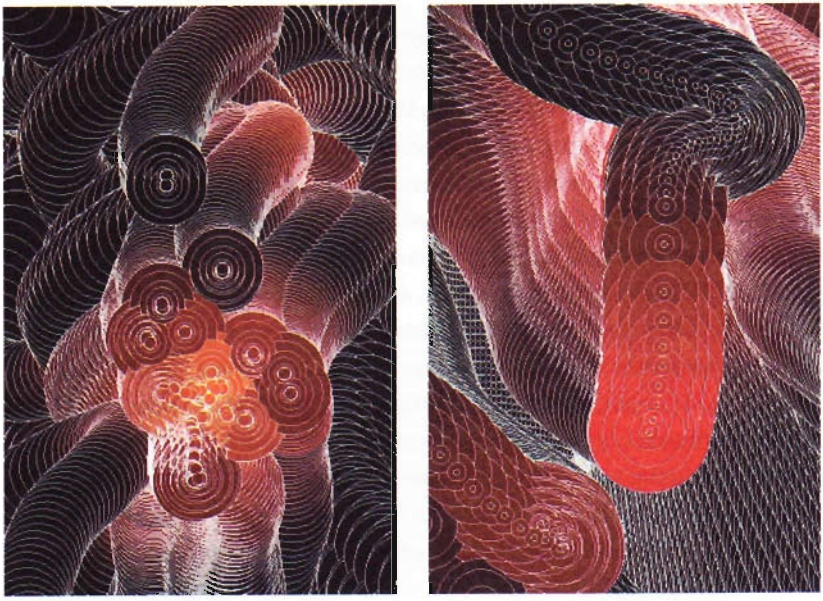

Fig. 45 LIA, *phiLia 01* (2009).

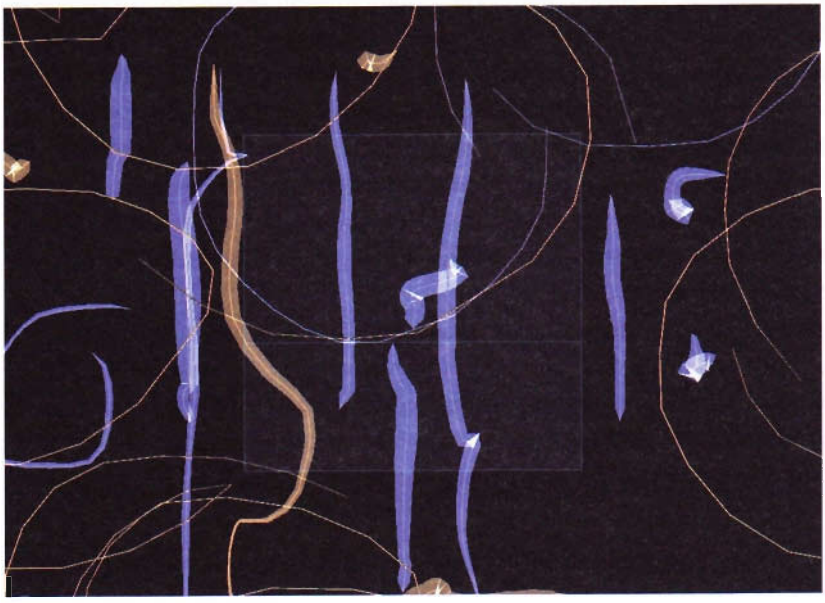

Fig. 46 Golan Levin, *Yellowtail* (2000).

in public-access online databases. Relating patents found through the search and the references that these patents contain to prior patents, the system is able to semantically connect the drawings, using them to create large-format compositions.

Although the *Perpetual Storytelling Apparatus* outputs by plotting on paper, one should perhaps regard it as being closer in essence to a screen-based system rather than focusing on the more obvious physical similarities with for example Verostko's paintings. The *Apparatus* emphasises the performative aspect of the system[26] over its outputs, while Verostko's paintings, or the drawings produced by AARON (Cohen 1973) are aesthetic artefacts per se, finished works in a sense. We can argue that much like the *Apparatus*, systems like Jean Tinguely's *Méta Matics* or Leonel Moura's *Robotic Action Painter* (2006), although producing outputs that are physically independent from the system, are not created as artistic devices intended to produce artworks but rather as artworks that produce aesthetic outputs. Therefore, if with Verostko or Cohen the final outputs of the systems are the works of art and the systems that produce them are in a sense produced to produce art, with Tinguely, Moura, or von Bismarck and Maus, the systems are the works of art and it is their operation that is focused on by the authors when communicating their work, while the outputs created can sometimes almost be seen as byproducts.

Concluding the analysis and repurposing of the dynamics variable, we arrive at an apparent contradiction in classifying temporal media such as film or audio as static.[27] If we regard the global structure of the artefacts and particularly the fact that the immutability of that structure creates a canon whose invariability defines the identity of the piece, we can see how adequate such a description can be.[28]

26. Comprised by the software, the data, the plotter and the paper where the output is drawn.

27. Something that Aarseth himself already did, classifying some digital texts, such as Jenny Holzer's *I Am Awake at the Place Where Women Die* (1993) as static, although their experience is necessarily temporal, in the sense that the contents of the projection are altered during the reading. The overall number of textons, and the articulation of these into scriptons is however fixed.

28. It is not that the artefact does not change — what we perceive of it permanently changes, repeated viewings of the artefact may lead to different experiences (as in *Afternoon* or other hypertexts) — but the structure over which the experiences are developed is unchanged.

Fig. 47 Julius von Bismarck & Benjamin Maus, *Perpetual Storytelling Apparatus* (2009).

Fig. 48 Oliver Laric, *Moving Pixel Portrait of Aleksandra Domanovic* (2006).

DETERMINABILITY

Determinability concerns the stability of an artefact's traversal function. For Aarseth a text is *determinable* if the scriptons adjacent to every scripton are always the same, otherwise it will be *indeterminable*. He describes how in "some adventure games, the same response to a given situation will always produce the same result" while in others, the results will be unpredictable due to random functions (1997, 63). Applied to a broader universe of aesthetic artefacts, determinability may describe whether multiple readings, interactions or instantiations of the same artefact will result in exact repetitions of the same experience or if, on the contrary, they will evolve differently.[29] *Determinable* systems will repeatedly behave similarly and will allow for the reenactment of previous experiences, while *indeterminable* systems will sometimes lead the traversal function as much as the user, pulling the experience into unknown territories.

Every Icon, *Agrippa*, *Moving Pixel Portraits* (Laric 2006) or *Three Buttons* (Leegte 2005) are examples of determinable systems. The first two present the user with a sequence of events that regardless of their intervention or other factors (given that the systems are not susceptible to external influences and do not include inner sources of randomness or variation) is repeatable.[30] Laric's and Leegte's works, although allowing for a multiplicity of configurations to be developed from their initial states, respond linearly and predictably to the user's interaction, without deviation, allowing the user to perfectly reproduce any sequence of interactions, thus reproducing the configurations they develop.

Contrasting with these, systems like *Page 0*, *phiLia 01*, or *Yellowtail* (2000) can be classified as indeterminable, in some cases due to randomness creating varying and unpredictable behaviours, in other cases due to the fine degree of control that the systems allow, as a consequence of which, repeating the exact same outputs may become an impossibility.[31] Finally, if the systems rely on information fetched from other sources other than the user — the real world, online databases, other users (in synchronous or asynchronous time) — the determinability of the system may be directly connected to the determinability or lack of it in that information.

29. Let us presume that the user's behavior is repeated without changes or variations, of actions, sequence or timing.
30. At least theoretically in *Agrippa*, provided one could have access to multiple copies of the work.
31. If the actions are timed to the millisecond, or tracked to a tenth of a millimetre it may be impossible for users to repeat exact sequences of actions because the motor control necessary to do it would be beyond human reach.

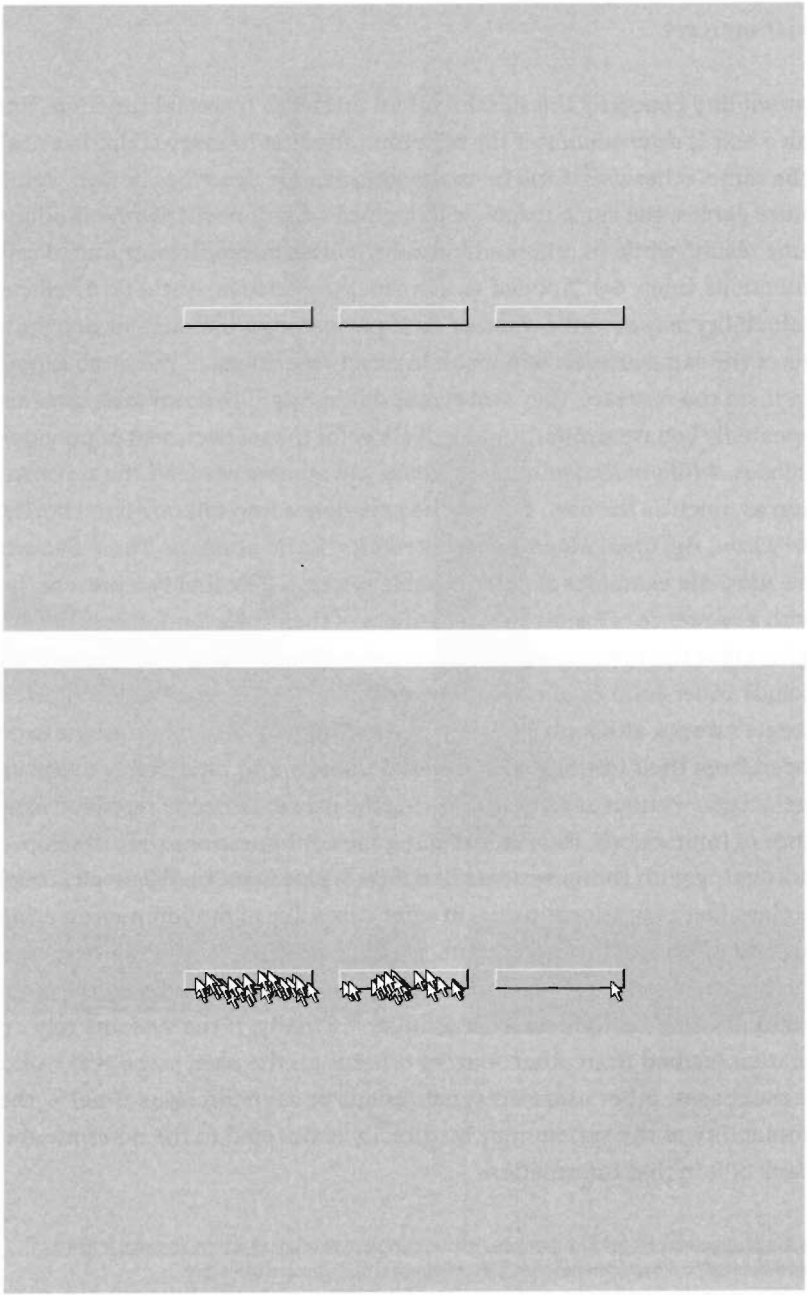

Fig. 49 Jan Robert Leegte, *Three Buttons* (2005).

We can question if there is a relationship between dynamics and determinability. We could maybe expect static systems to always be determinable — which of course happens to be true in linear videos, printed pieces or some hypermedia systems like *My Boyfriend Came Back from the War* (Lialina 1996) or *Afternoon* — but that is not universal, both in Aarseth's analysis and in our own. Two of the texts that Aarseth classifies as being both static and indeterminable are the *I Ching* and Saporta's *Composition N° 1*, texts that rely on randomisation procedures for their reading. Systems displaying surface unit dynamics can be found to be determinable — such as *Agrippa* or *Every Icon* — or indeterminable — as *Page 0*, *30×1* or *Vanitas* (Harvey and Samyn 2010) — mostly depending on whether they make use of randomisation procedures to organise their deep units. Artefacts displaying deep unit dynamics are typically indeterminable.

TRANSIENCY

Transiency is related to the temporal existence of an artefact. "If the mere passing of the user's time causes scriptons to appear, the text is transient; if not, it is intransient." (Aarseth 1997, 63) *Agrippa* is a good example of a transient text, relentlessly scrolling by regardless of the user's actions, while many hypertexts passively wait for interaction. Most time-based outputs are transient, while those outputs that are not time-based are in general intransient, as exemplified by *My Boyfriend Came Back from the War* or *Page 0*. Drawing machine systems like the *Perpetual Storytelling Apparatus* are transient, although the artefacts that they produce are intransient and a system such as *temporary.cc*, although not producing time-based outputs, can be classified as transient because each output is ephemeral within the system, that continues to evolve as other visitors access it through the World Wide Web.

PERSPECTIVE

Aarseth's *perspective* focuses on the text requiring the user to play a strategic role as a character in the world that is described by the text, in which case the text's perspective is *personal*, otherwise being *impersonal*. This variable looks at how the reader becomes an actual character in the narrative and as such may be allowed to shape it directly.

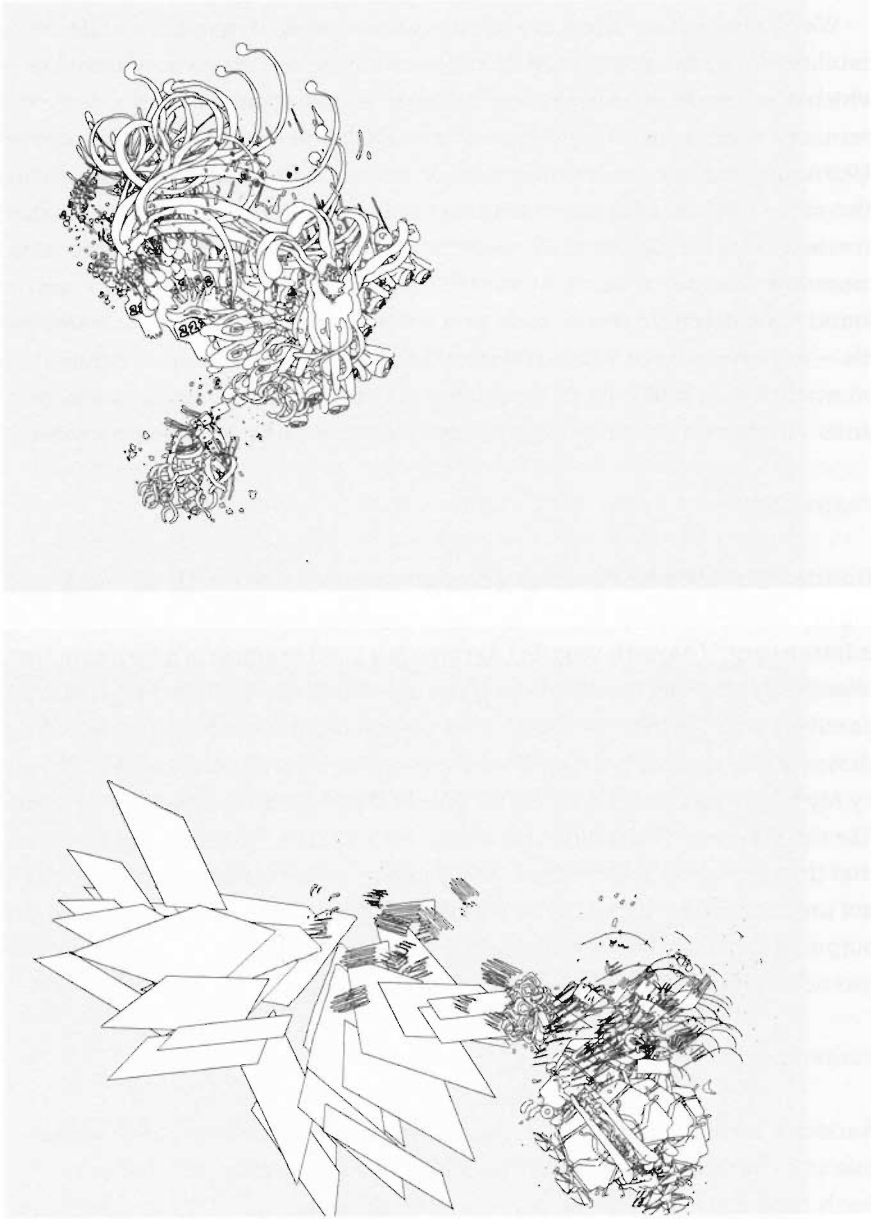

Fig. 50 James Paterson, *Page 0* (2004).

It is difficult to repurpose this variable for systems where a narrative is not explicitly created. Even though we can certainly identify narratives in contexts that are not traditionally regarded as being narrative, such as for example in simulations,[32] one should perhaps only consider a system to offer a personal perspective if it creates a narrative where the user is allowed to step in, becoming a fundamental part of it, either as a character or as some sort of a diegetic operator.[33] This is largely the domain of games or game-like systems, and even in these it is not always clear in which cases the player becomes a character in the narrative and therefore when the perspective becomes personal. Manipulating the events through interaction is hardly the same thing as embodying or becoming a character in the narrative. In hypertexts like *Victory Garden* (Moulthrop 1992) or *Afternoon*, readers have substantial power to control the narrative, through their choices and the unique traversals of the text, but despite this, they never become a character in the narrative.

We can perhaps find a clue in systems where users interact and allow the system to appropriate their likenesses, digitising images of their bodies and including them in the outputs, becoming surface units, as in *Text Rain* (Achituv and Utterback 1999), or *Inner Forests* (Kontopoulos 2007), where the viewer's shadow is appropriated and used as a surface where trees and shrubs grow.

These systems exemplify the incorporation of users into the displays of the pieces (Bolter and Gromala 2003, 12), where the "visitor immediately discovers [that] she herself becomes the show", that the piece becomes "as much an expression of its viewers as of its creators (...) [and] is about the process of its own making." Still, if we wish to comply with the spirit of Aarseth's model, we will have to classify these as impersonal, as neither develops something that can be remotely described as a conventional narrative or a diegesis. Even if the users participate and leave traces of that participation in the system, they are not incorporated in a manner that is remotely similar to what happens in a narrative where the user becomes an acting character.

32. Frasca notes that simulations are indeed narrative, in that "for an external observer, the outcome of a simulation is narration." He privileges simulation, that provides an interactive experience, over narrative, that provides a more distant and less direct experience. This is what Murray identifies as immersion. (Bogost 2006, 98)

33. In games as *The Sims* (Wright 2000) or *Civilization* (Meier 1991), the player does not play a character or a group of characters but rather controls the diegetic world, thus influencing the behavior of all the characters in the game and the unfolding of the narrative. In these games we could conceive of the player's role as (and it is often described as such) god-like, because of the relative omnipotence towards the characters of the game and the distance that is simultaneously kept from them.

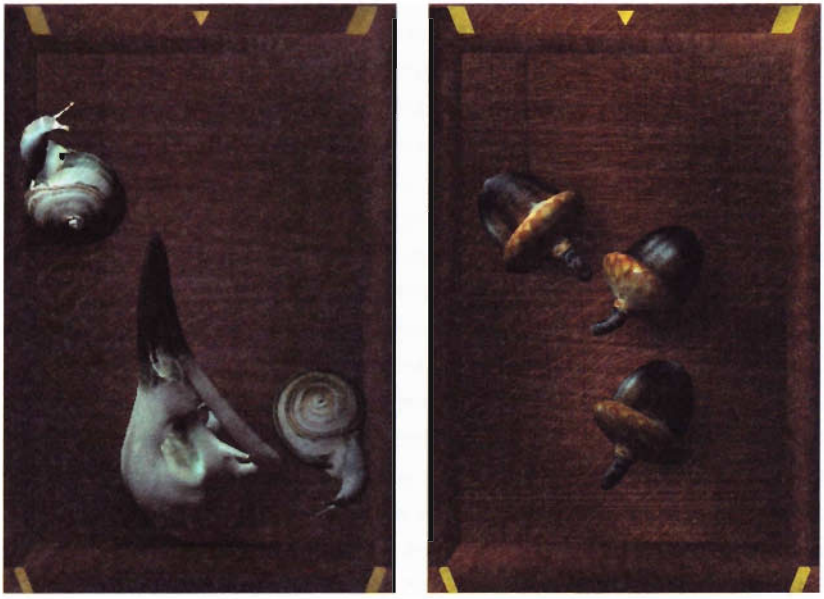

Fig. 51 Auriea Harvey & Michaël Samyn, *Vanitas* (2010).

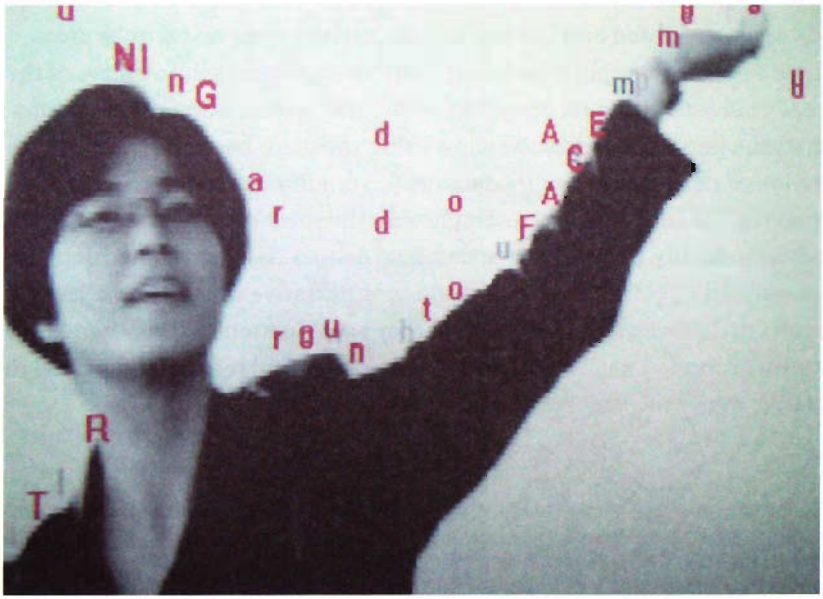

Fig. 52 Romy Achituv & Camille Utterback, *Text Rain* (1999) interactive installation. Screen detail. Photo courtesy of the artists.

ACCESS

Access refers to whether "all the scriptons of the text are readily available to the user at all time" (Aarseth 1997, 63), in which case the text is *random access*, otherwise the access is *controlled*.

> In a codex novel, you may turn to any passage at any time, directly from any other point. In a hypertext such as Victory Garden, to get to a specific passage you must typically follow an arbitrary path involving other specific passages before you get what you want. (Aarseth 1997, 63)

Access is a topological variable that can seem related to transiency, as it will be natural to consider that transient systems have controlled access. We may think that transient and linear systems such as video may be random access, provided the user is not kept from scrubbing the playback or, to put it another way, provided that the user has control over the temporal flow of the system and is not forced to a predefined pace. In this context, the same work may have different access modes depending on how it is presented. In an exhibition or public projection, a transient linear work can be classified as having controlled access, while if the same work is viewed on a personal computer, the user may randomly access contents. Regardless of these contexts, we have classified linear video as works with controlled access. Independently of how specific delivery technologies may transform access, linear video works are generally created with a presumption of controlled access, of a unidirectional and predetermined arrow of time. Systems that output static images were classified as random access when the images themselves are the final works,[34] as in Verostko's case, or as having controlled access in other cases, such as the *Perpetual Storytelling Apparatus* or Tinguely's machines, when the sum of all the images that are produced can be considered as part of the work.

LINKING

Linking classifies the organisation of a text "by explicit links for the user to follow, conditional links that can only be followed if certain conditions are met, or

34 And the scope of the random access is of course within each image, not across all the outputs of the system.

Fig. 53 Michael Kontopoulos, *Inner Forests* (2007).

Fig. 54 Paul Prudence, *Talysis II* (2009).

by none of these" (Aarseth 1997, 64) when no links exist. In Aarseth's model it describes the existence of a hypertextual topological structure and of its working process. Texts such as the *Cent mille milliards de poèmes*, *Composition N° 1* or traditional paper-based literary works present no linking, hypertexts such as *Victory Garden* or *Hopscotch* present explicit links that direct the user in the traversal,[35] while other hypertexts such as *Afternoon*, the *Colossal Cave Adventure* and several MUDs present conditional links.

Linking describes the topology of the system, not specific tools or resources available to the user in the traversal. In this sense, conditional or explicit linking will be related to the existence of devices or rules that lead the traversal. Random access systems can present explicit links (as is the case of *Hopscotch*) but they cannot, however, present conditional links, as these contradict the possibility for random access. Controlled access systems may present any of the three linking values.

In non-literary systems linking can also be identified whenever the user is able to navigate through different possibility spaces within a system, as in *Page 0*, with explicit links, or in *temporary.cc* with conditional links.[36] Systems like *Yellowtail*, *phiLia 01* or *Inner Forests* all present explicit links, because they place the users in possibility spaces that they are allowed to leave and to where they are not able to return (as access is controlled).[37]

USER FUNCTIONS

Finally, Aarseth's typology describes the user functions present in each text, besides an omnipresent interpretative function.

> The use of some texts may be described in terms of additional functions: the explorative function, in which the user must decide which path to take, and the configurative function, in which scriptons are in part chosen or created by the user. If textons

35 Regardless of the medium — print in Cortázar or screen in Moulthrop — as linking describes the structures that guide the traversal function of the text. Gibson's *Agrippa* is also, according to Aarseth, explicitly linked.

36 This is a debatable classification, to say the least, and as we will again see in the next variable, one that is related to the nature of the process developed by each of the pieces. *Page 0*'s linking is explicit because linking to a new state is all that the piece allows the user to do and because those new states are virtually infinite and potentially repeatable. In *temporary.cc*, the configuration reached after each link is not repeatable and dependent on a series of user actions.

37 Navigation through these possibility spaces is controlled by the users, not by the system, through clearly labelled buttons or other interface controls in the system or through gestures and/or activities acted by the user (as in *Inner Forests*).

> or traversal functions can be (permanently) added to the text, the user function is textonic. If all the decisions a reader makes about a text concern its meaning, then there is only one user function involved, here called interpretation. (Aarseth 1997, 64)

The explorative user function is exemplified by texts such as *Afternoon, Victory Garden* or *Hopscotch*, that are assemblies of discrete parts intended to be navigated by the reader. The configurative user function is found in works such as *Cent mille milliards de poèmes*, *I Ching* or a system like ELIZA, where the reader is able to arrange the order of the parts and to create, shape, or influence the navigable structure in more than just moving across it, such as in explorative texts. The textonic user function is exemplified by MUDs.

Aarseth's four user functions are useful to specify the nature of the interactions with the texts. He emphasises the interpretative function, but doesn't elect it as primary to all the others, rather asserts its omnipresence and concurrence with the remaining. User functions are not always dominated by interpretative interests and goals, as in video games, where one interprets in order to "be able to configure and move from the beginning to the winning or some other situation, whereas in ergodic literature we may have to configure in order to be able to interpret." (Eskelinen 2001)

We can consider that users of a computational system always perform the interpretative function, in the sense that they need to decipher the surface units created by the system. If Aarseth defined ergodic texts as those "in which at least one of the four user functions, in addition to the obligatory interpretative function, is present", we find that the objects of this study are very often defined as requiring nothing more than the interpretative function, in all cases where no interaction is required from the user or reader or when this interaction does not affect the outputs produced. *Agrippa* or *Merce's Isosurface* are similar in this aspect, characterised by the exclusivity of the interpretative function.

Page 0 requires the user to act on the system through a simple action that can almost be likened to turning a book page: the reading process advances, but the page turn is not shaping the narrative.[38] Unlike the printed book, however, in these controlled access systems the user's simple action becomes explorative

38. One will never know for certain whether the user's actions are influencing the system without further investigation of the workings of the system or without a prolonged experimentation period. In *Page 0* one is led to believe that all compositions are created randomly and independently of the time between actions, of the place or location of the clicks, and that the user's actions are simply triggering the refresh, not parametrising it.

because she's accessing spaces and structures to which she previously had no access. If however the user's input is used constructively,[39] one may identify a configurative user function. As a rule, we then find that when the user's actions are navigational, accessing spaces of configurations that are not created with her intervention, we have an explorative user function. When the user's actions are creating new spaces of configurations, we have a configurative user action.

In works as *temporary.cc*, we find a user function that may seem explorative but that upon closer inspection is found to differ in one fundamental way: each action has an inexorable and indelible effect on the system, causing it to progress towards a point of no return, to generate outputs that will never again be experienced.[40] The operational knowledge that is communicated about these two pieces could therefore lead us to classify them as *textonic*, in Aarseth's sense. In the context of this work we could perhaps rename this user function as *structural*, because the user will be able to manipulate deep units or traversal functions, permanently adding either of them to the artefact.

GOING BEYOND AARSETH

In Aarseth's typology we find the following variables and values:

VARIABLE	VALUES
Dynamics	Static, IDT, TDT
Determinability	Determinable, indeterminable
Transiency	Transient, intransient
Perspective	Personal, impersonal
Access	Random, controlled
Linking	Explicit, conditional, none
User function	Explorative, configurative, interpretative, textonic

39: Regardless, one might add, of the user's awareness regarding that constructive contribution.
40: In *Page 0*, although the chances for repetition are astronomically small they are nevertheless higher than zero. In *temporary.cc* the hypothesis of a repetition is actually zero.

We are now able to repurpose them for a broader context as (new values in *italics*):

VARIABLE	VALUES
Dynamics	Static, *SUD*, *DUD*
Determinability	Determinable, indeterminable
Transiency	Transient, intransient
Perspective	Personal, impersonal
Access	Random, controlled
Linking	Explicit, conditional, none
User function	Explorative, configurative, interpretative, *structural*

Although this set of variables enables the analysis of systems whose outputs are not strictly textual, one wonders whether new variables should be added to the set in order to achieve a more complete typology for the artefacts under consideration. Before turning our attention to this problem we should however consider if all these variables are useful in the context of this study or if some may be redundant or may provide us with a negligible amount of information. We have therefore applied the adapted model with all seven variables to a series of systems, analysing the obtained results. These systems were selected amongst the works mentioned in previous chapters and selections requested from three collaborators experienced in creation, teaching, criticism and curation of media and computer arts. We requested lists of personal favourites that they would classify with the rather vague *generative* descriptor, although not necessarily computer-based but computational in nature. At a second stage we proceeded to repeat the analysis by selectively removing the variables that we suspected might have marginal value in the model, so we would be able to understand their relative weight in the model's effectiveness.

Finally, we considered the expansion of the model through a series of other possible variables that might describe characteristics of the systems that were not accounted for by the variables in Aarseth's model. We then classified all the pieces, trying to assess whether all variables were applicable to all systems and if their inclusion in the typology resulted in a qualitative increase.

WORKS UNDER ANALYSIS

The set of works under analysis comprises cybertexts, as well as projects in evolutionary art, interactive environments, installations and typographic illustrations, *drawing tools*, non-interactive visual generators and digital prints, data and music visualisation systems, print illustrations and graphic design, generative films, linear videos, sculptural works and web art, in a total of 54 works dating from 1961 to 2010:

- Raymond Queneau, *Cent mille milliards de poèmes* (1961);
- William Gibson, *Agrippa (a book of the dead)* (1992);
- Christa Sommerer & Laurent Mignonneau, *A-Volve* (1994);
- Karl Sims, *Evolved Virtual Creatures* (1994);
- Olia Lialina, *My Boyfriend Came Back from the War* (1996);
- Magnus Bodin, *Cent mille milliards de poèmes* (Web version) (1997);
- John F. Simon Jr., *Every Icon* (1997);
- Matthew Lewis, *Sketch* (1998);
- Roman Verostko, *Seven Sisters: The Pleiades* (1998);
- Romy Achituv & Camille Utterback, *Text Rain* (1999);
- Golan Levin, *Yellowtail* (2000);
- Soda,[41] *Soda Constructor* (2000);
- Marius Watz, *Amoebaabstract 01* (2002);
- Marius Watz, *Amoebaabstract 02* (2002);
- Marius Watz, *Amoebaabstract 03* (2002);
- Andy Huntington & Drew Allan, *Cylinder* (2003);
- Jared Tarbell, *Substrate* (2003);
- Mark Napier, *Black & White* (2003);
- Andreas Müller, *For All Seasons* (2004);
- David Lu, *Droom Zaacht* (2004);
- James Paterson, *Page 0* (2004);
- Jared Tarbell, *Happy Place* (2004);
- Meta, *Emeral* (2004);
- Jan Robert Leegte, *Three Buttons* (2005);
- Leonardo Solaas, *Dreamlines* (2005);

41: Ed Burton.

- Mario Klingemann, *Ornamism* (2005);
- Miguel Carvalhais, Pedro Tudela & LIA, *30x1* (2005);
- Alex Dragulescu, *Extrusions in C Major* (2006);
- Boris Müller, *Poetry on the Road* (2006);
- C.E.B. Reas, *Process 16* (2006);
- Jonathan Harris & Sep Kamvar, *We Feel Fine* (2006);
- Oliver Laric, *Moving Pixel Portraits* (2006);
- C.E.B. Reas, *Process 18* (2007);
- Eno Henze, *Der Wirklichkeitsschaum* (2007);
- Golan Levin & Zach Lieberman, *Reface [Portrait Sequencer]* (2007);
- LAb[au],[42] *Pixflow #2* (2007);
- Meta, *Folia* (2007);
- Michael Kontopoulos, *Inner Forests* (2007);
- Andreas Nicolas Fischer, *A Week in the Life* (2008);
- Andreas Muxel, *Connect* (2008);
- Brandon Morse, *A Confidence of Vertices* (2008);
- Karsten Schmidt, *Enerugii* (2008);
- Karsten Schmidt, *Print magazine August 2008 cover design* (2008);
- Universal Everything & Karsten Schmidt, *Forever* (2008);
- Universal Everything & Karsten Schmidt, *Nokia Friends* (2008);
- Erik Natzke, works from the *Colors of Nature* exhibition: *Found, Rouge, Shine* and *Crimson* (2009);
- FIELD,[43] *Animations for Aol. Rebrand* (2009);
- Golan Levin, *Merce's Isosurface* (2009);
- Julius von Bismarck & Benjamin Maus, *Perpetual Storytelling Apparatus* (2009);
- LIA, *phiLia 01* (2009);
- Paul Prudence, *Talysis II* (2009);
- Zach Gage, *temporary.cc* (2009);
- Auriea Harvey & Michaël Samyn, *Vanitas* (2010);
- Han Hoogerbrugge, *The Inability To Solve a War at a Cocktail Party (an Awkward Dance with Mr. Henri van Zanten)* (2010).

42: Manuel Abendroth, Jérôme Decock, Alexandre Plennevaux, and Els Vermang.
43: Marcus Wendt and Vera-Maria Glahn.

INITIAL ANALYSIS

DETERMINABILITY

All the systems that are procedural but not computational, that are presented or documented not as the system itself but as outputs of a system, were classified as *static*. This was the case with pieces such as *Sketch* and *Seven Sisters: The Pleiades*, but also with *Cylinder* or with linear video works such as *A Confidence of Vertice's* or *Merce's Isosurface*. Although initially we considered classifying them as SUD, upon closer scrutiny we concluded that this would be a mistake. Linear videos are transient, but they are *static* because all the articulations displayed during the time of their playback are preset in the structure of the video, and can be precisely repeated anytime they are replayed. Conversely, and because it is not a linear video but a text displayed to be read in real time, in a contextual and singular articulation, *Agrippa* was classified as SUD.

Perpetual Storytelling Apparatus was classified with DUD because it fetches information from online sources, using it directly in its outputs. *Page o* was classified with SUD because it is clear that the system is not creating and composing *new* drawings (as AARON and other systems are, in which case it would have DUD, as they do) but rather only recomposing a set of preexisting drawings.

Connect was classified as *static* as although it is a kinetic sculpture, its parts are arranged in fixed articulations.

TRANSIENCY

Droom Zaacht could be classified as *intransient* because user's actions are necessary to vary its outputs. One of its drawing machines (machine four), however, permanently animates the structures that are drawn, leading to its classification as *transient*.

Inner Forests presents an interesting example of a transient system that becomes intransient as soon as the user acts. The user contributes to the system by lending her projected shadow but by not doing anything else besides observing the system's actions over that shadow. If no visitor is present, the system does not act but if a visitor is present and active, the system also does not act, remaining still while waiting for the visitor's stillness.

Fig. 55 Matthew Lewis, *Sketch* (1998).

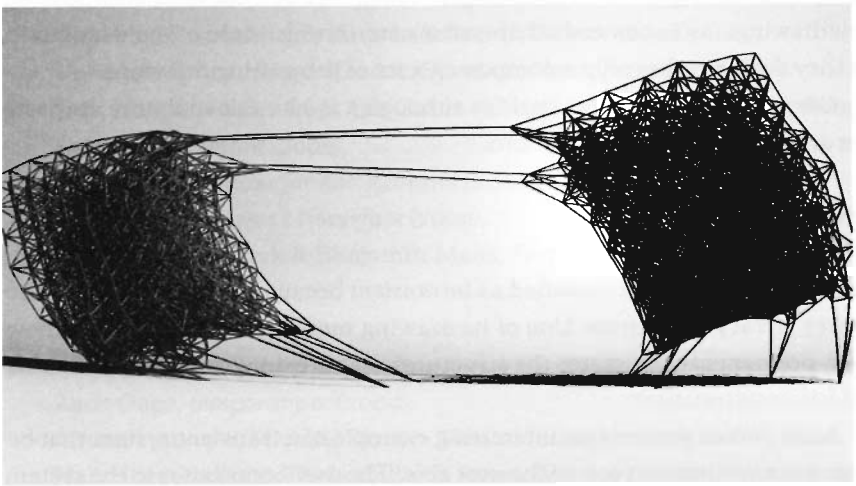

Fig. 56 Brandon Morse, *A Confidence of Vertices* (2008).

ACCESS

All video systems that were not explicitly designed to be interactive were classified as having *controlled access*, and not the *random access* allowed by playback systems. With this we recognise that although digital media tends to permit a very high degree of manipulation, that manipulation is not always a part of the pieces produced for a particular medium. Unless otherwise made explicit, most audiovisuals are usually made to be experienced linearly. Although their distribution technologies may allow for pausing, skipping, etc., the pieces are conceived with controlled access and linearity in mind, and this control is an intrinsic part of their aesthetic nature, informing the composition, the narrative, and many other aspects of the piece. Controlled access determines the time and rhythm of the piece and once one manages it — by pausing, rewinding or otherwise manipulating the video — one may actually be considered to be fundamentally altering the artefact and starting to experience an altogether different artefact (or at least a different version of that artefact).

LINKING

All systems that allow the user to reset the current configuration or evolution of the output and to restart the process, thus exploring new fields of possibilities, were classified has having *explicit* linking. This was the case of *phiLia 01* or *Ornamism*, as well as *Amoebaabstract 02* and *03*, while *01* was classified as *conditional*. There is a reset mechanism programmed in *02* and *03*, while on *01* the reset is automatically performed by the system once a lack of interaction is detected. Therefore, linking is still partially controllable by the user but it is not always available. *Inner Forests* deploys a system similar to *Amoebaabstract 01*, but is not dependent on a time-out and therefore was classified as explicit.

USER FUNCTIONS

While non-interactive systems are largely interpretative, we found it difficult to define whether those systems where the interaction is kept to a bare minimum — typically reduced to a single click or gesture to restart the process, eventually defining new variables in the process, such as *Page 0* or *Substrate* — should be classified as interpretative, configurative or even as explorative, given how

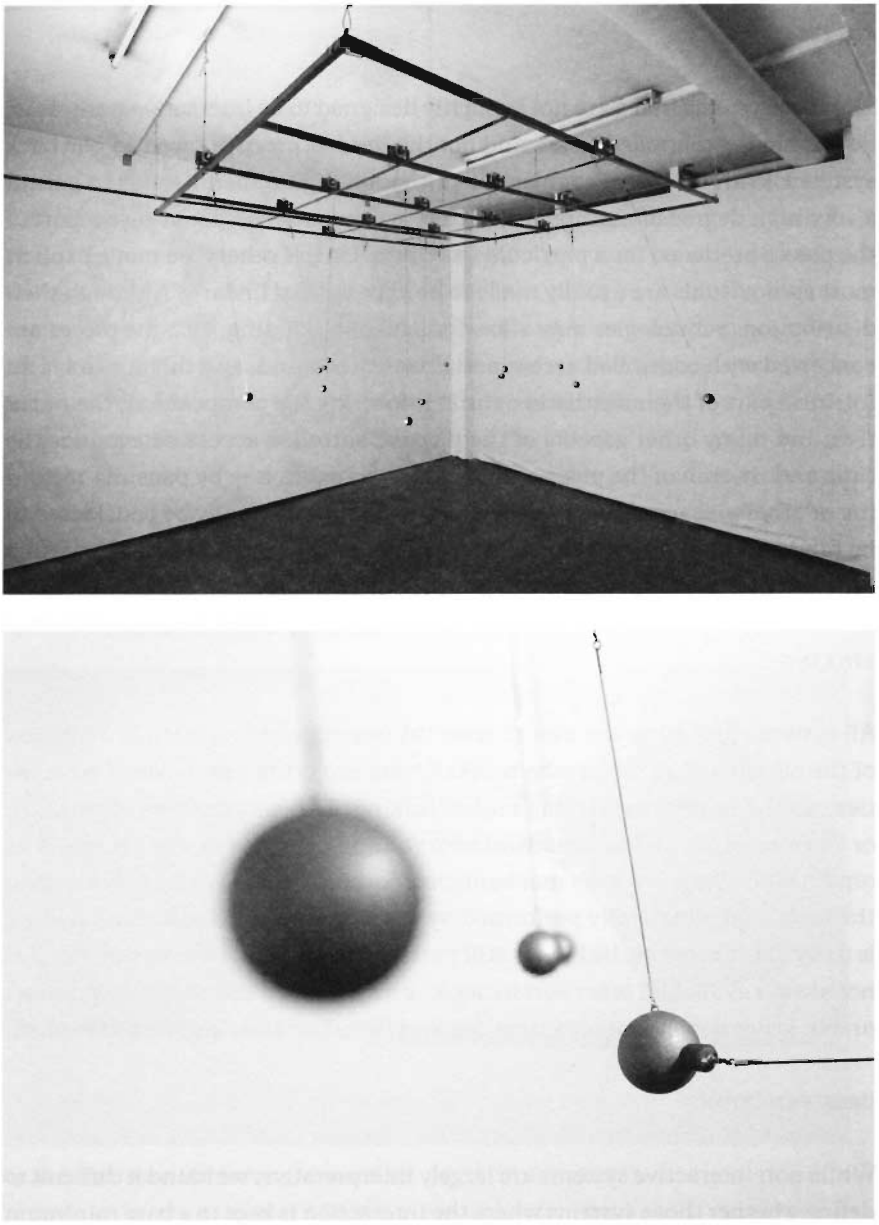

Fig. 57 Andreas Muxel, *Connect* (2008).

reduced the human input is. The fact is that in spite of the simplicity of the user's actions, they may nevertheless have a noticeable effect. We have therefore found it adequate to classify a majority of these systems as *configurative*.

During the development of our analysis we found that there was a less than clear distinction between the configurative and the structural user functions. Following Aarseth's model we should rule user functions as structural only when and if the user's configurations can be permanently added to the system. In cases where the user contributes to physical (and therefore permanent) outputs this may be easy to evaluate but in all other cases it is very difficult, if not downright impossible, to understand the longevity of the added information, how and when it may be diluted, discarded or replaced by the system or by other users. It is also difficult to evaluate the amount of control that a user may have over these configurations, because structural additions should, in principle, be controllable and not, as in *temporary.cc*, uncontrollable.[44] We have therefore decided to simplify the model and to allow only for three user functions, merging the original *structural* and *configurative* user functions into a single *configurative* value.

MULTIPLE CORRESPONDENCE ANALYSIS

Having established that we were able to replicate the results from the CA performed by Aarseth (1997, 68-69), we submitted our initial analysis to a CA, testing different sets of Aarseth's variables and interpreting the clustering of the pieces in the plots, trying to evaluate: 1) if clusters were formed; 2) how significant they might be, that is, which pieces were found in each of the clusters, how similar these were among themselves or how diverse were pieces that might be in the same cluster (or even sharing the exact same point in the plot) and that, owing to marked differences perhaps shouldn't be. A certain amount of clustering was naturally interpreted as being positive, after all, it only seems natural that pieces as linear audiovisual works should be tightly plotted, and the same can be said of printed or fabricated artefacts or static images. Our first conclusion was that the perspective variable was not adding any meaningful information to the analysis, so we discarded it from this model.

44. A case in which, we may argue, the configurations are created by the system upon the user's action, not by the user, with her actions.

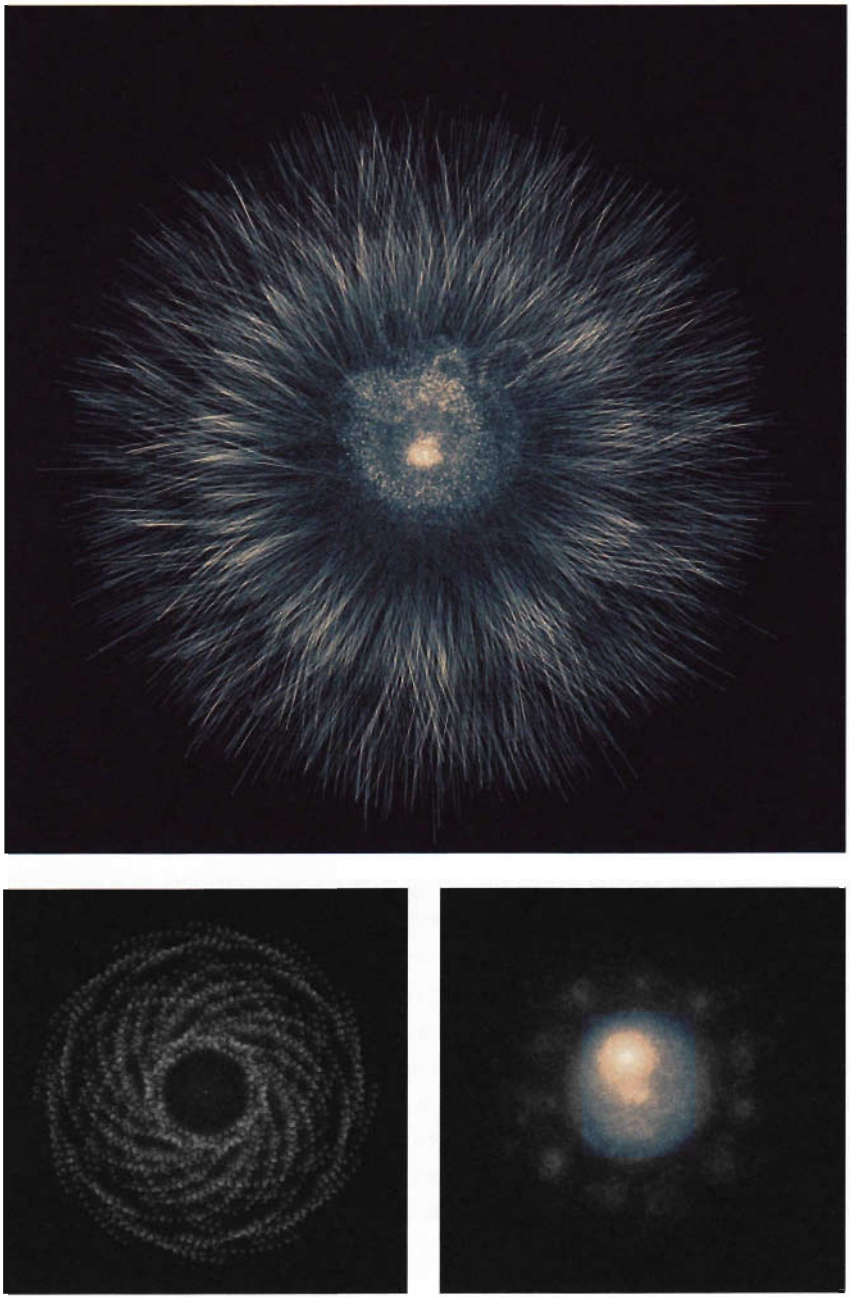

Fig. 58 Mario Klingemann, *Ornamism* (2005, 2014 remix).

With the remaining repurposed seven variables, we found that the model plotted satisfactory results but that if the clustering was logical it was nevertheless somewhat excessive, creating a divide between the explorative user function and the remaining functions and between transient and intransient systems. We tested a number of potential new variables in the model, the majority of which tried to describe characteristics of some of the systems under analysis but did not prove to be universally applicable to the set, or were found to describe aspects that were not deemed significant, or did not contribute to the effectiveness of the model. From all the potential variables, tentative classifications of the set of works, and the ensuing correspondence analysis led us to add three new variables to the six repurposed from Aarseth: *modalities, autonomy* and *class*.

THE NEW VARIABLES

MODALITIES

Modalities was considered as an attempt to quantify the levels of perception involved in the sensorial outputs of the systems. This is not dependent on the number of dimensions in which the outputs of the system are formed, and is also not an assessment of the medium through which a piece is created. Rather, following the phenomenological approach to these systems, the study of modalities concerns the reception of their outputs.

We follow a physical and sensorial definition of modes, closely bound to the different regimes of human sensorial perception, as proposed by Whitelaw (2008) and by Blesser and Salter (2007). It is noteworthy that Stephanie Strickland (2007) expands the definition of modality to include not only visual, audial and haptic manners of expression, but also motion and mathematical structures such as rhythm, harmony, etc., and the "struggle between mathematical abstractions and words" (2007, 36). A mathematical modality should not be understood in the Pythagorean sense or tradition, as a correspondence between art (or aesthetics) and mathematics in terms of numerical *harmony* but as the intellectual and intuitive understanding of structure and process,

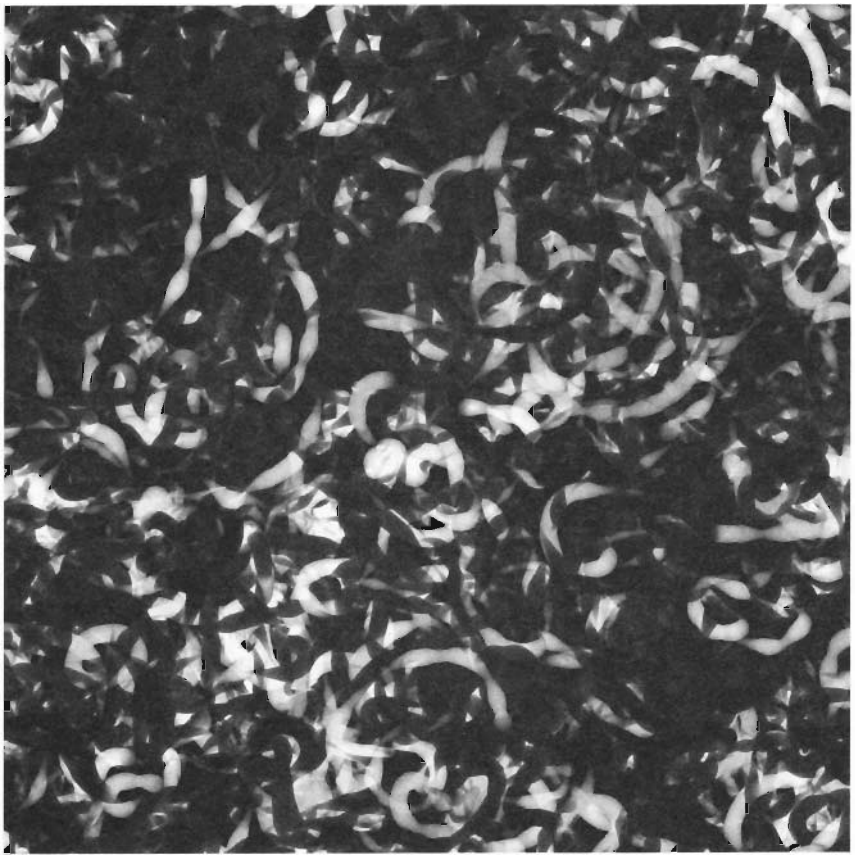

Fig. 59 C.E.B. Reas, *Process 16* (2006).

and the aesthetic pleasure that is felt through it.[45] It is the beauty of abstract understanding, not of bodily contact but of intellectual perception.[46]

We have therefore considered five modalities: *visual, audial, haptic, movement* and *procedural*. Pieces were considered to use the haptic modality when involving the direct manipulation or physical contact by users. *A-volve* involves the direct manipulation of a water tank where the "creatures" are projected and where they can be interacted with, while *30×1* exists in a large space that needs not only to be explored by the visitors but that also leads them to feel the environment (its temperature and its variations, the moisture in the air, the variations in lightness of the different rooms, etc.), and therefore creates a more complex sensorial experience where proprioception also plays a role.

We chose not to regard interaction itself as a modality, as there were already other variables that described user functions, linking and access and that by doing so were in effect describing parts of the interactive experience. The mere existence of interaction was also considered not enough to classify a system as haptic. Whenever systems were executed in computational devices and used their standard input devices — keyboard, mouse, touch screen, etc. — although there is involvement of the sense of touch, we did not consider this to endow the system with the haptic modality, because such interaction devices are not part of the piece itself but of the computational system running it, and their usage is, in most cases, transparent to the user. These devices are familiar, functional and generic, and usually, are "not perceived as aesthetically effective components of a work." (Kwastek 2013, 144) In this sense we should classify as haptic those systems where the sense of touch and the user's body are involved in non-conventional and hypermediated ways. The same principle was applied to printed or physical artefacts.

45 Daniel Dennett notes how humans always tend to search for a design stance in inanimate objects and an intentional stance in animate objects. The first tries to assign a purpose to an object while the latter tries to understand the motivations of animals or humans (which were, evolutionarily speaking, the two main classes of animate objects with which humans cohabited). The mathematical or procedural modality can be seen as the result of these stance identifiers in human perception (qtd. in Pinker 1999).

46 Sometimes we can consider that it is not only the strict (or literal) understanding of the process that triggers the procedural mode but also the curiosity about the process. Although it may not be apparent, or immediately understandable, what the process behind the system is, it may nevertheless be clear that there is some logic in the development of the outputs, that there is ultimately a cause driving the system. Therefore, we can consider that the outputs of the system offer some clues, or communicate, its procedural nature.

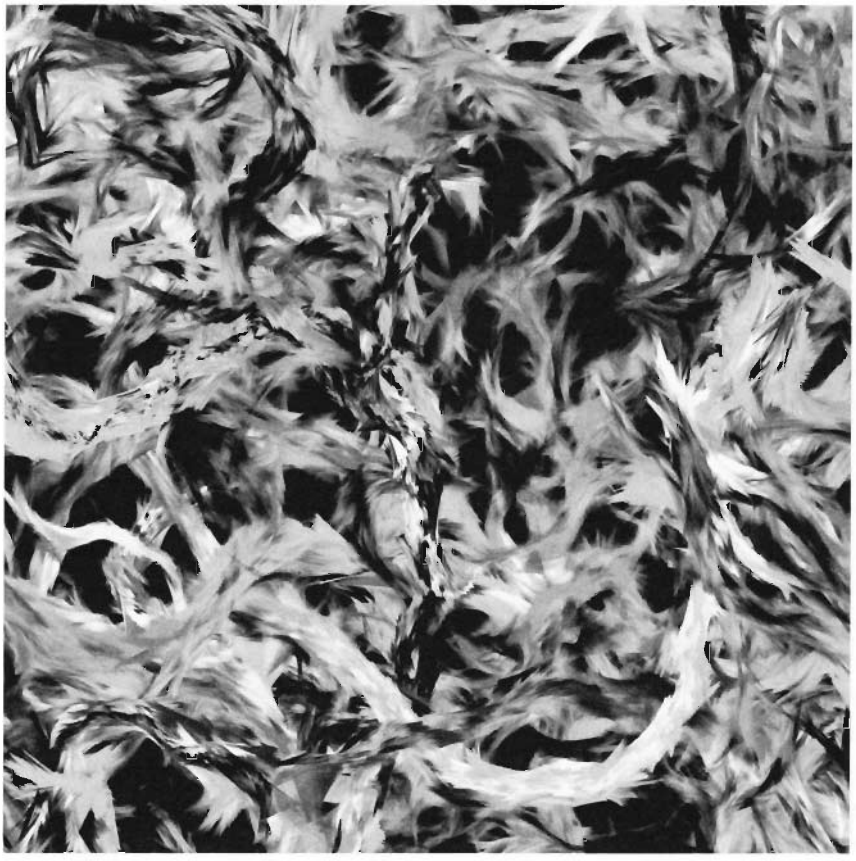

Fig. 60 C.E.B. Reas, *Process 18* (2007).

AUTONOMY

By *autonomy*[47] we understand a system's capacity to generate novelty, to be creative at least to some degree, without resorting to external input[48] (whether machinic, human or both).[49]

Autonomy is what injects life into a system (Bateson 1979, 127). It is also what makes generative works become less human and more artificial, more machine-authored (Ariza 2009, 64). Autonomy of the systems, even if only apparent, contributes to the perception of a transparency of technology, balancing out the opacity caused by interaction (Bolter and Grusin 1999, 33), and systems to which authors confer varying degrees of freedom by granting them autonomy are able to produce subjectivity in ways that non-autonomous systems are not. This is a continual process of becoming (Doruff 2008, 119), not a simple act of being.

Autonomy is a step towards autopoiesis,[50] literally, the *self-creation* of the system and/or its outputs. As with creativity and intelligence, by classifying a system as autonomous, we are not proposing that it is truly, absolutely autopoietic in a strict sense. This would, among other things, imply that the systems would be able to bootstrap themselves, and that they would be *totally* generative.[51]

The progression[52] of systems towards autonomy is explained by Jacques Tisseau through the *Pinocchio metaphor*, describing systems that become au-

47. Literally the "*control of the self*, from the Greek *autos* (self) and *nomos* (a law)" (Bateson 1979, 126).

48. This should be minimally clear in the system's operation. Otherwise one cannot, of course, understand when the system is fetching information from the World Wide Web or other external sources of information. Likewise, internal databases or lookup tables (as those in the *Arca Musarithmica*, for example) should be seen as being part of the system and thus of its autonomy.

49. We are not classifying the capability to pass a Lovelace test, although it would naturally be described by this variable.

50. Also from Greek roots, *autos* and *poiesis* (the creation or production).

51. That the systems would be autonomous not only in the sense of defining their own progress and choices during the processes they execute but also autonomous to the point of actually being able to program themselves. In a sense this would be the ultimate generative, and machine authored, system, one that has no human intervention whatsoever during not only all the stages of the execution but also of the programming of the system. "The autonomy of an autopoietic system constitutes its minimal cognition. We must remember that an autopoietic system is a composite unit, much like an element-producing network in which the elements 1) via their interactions, recursively regenerate the network of production which produced them and 2) construct a network in which they exist by building up a frontier with their external surroundings via their preferential interactions within the network. Autopoietic systems possess the properties of emergent systems as they are able to create natural phenomena independent of those from which they were generated." (De Loor, Manac'h and Tisseau 2009, 325)

52. We are wary about using this term in this context, because it may imply a directed evolution, some sort of teleology. In human-authored systems this will inevitably be the case but not necessarily in machine authored, autopoietic systems (as wasn't certainly also in biology).

tonomous and that thus free users (or creators) from controlling them (2001, 8). He proposes three classes or types of autonomy for a system: sensory-motor autonomy, where "each entity is provided with sensors and effectors that allows it to get information and respond to its environment"; decision-making autonomy, when "each entity makes decisions according to its own personality (its history, intentions, state and perceptions)"; and execution autonomy, when "each entity's execution controller is independent of the other entities' controllers" (2001, 35). He also proposes three lines of thought to understand the autonomy of systems: autonomy by *essence*, by *necessity* and by *ignorance*. The first of these characterises biological organisms, the second involves the recognition of changes in the environment or context, while the latter simply "reveals our current inability to explain the behaviour of complex systems through the reductionist methods of an analytical approach" (2001, 29).

Simply put, we classify as *autonomous* those systems that contain or generate[53] the data they need to work and that, in doing so, produce novel outputs. All other systems, fed by external sources of information, are classified as *data-driven*. Outputs in static media, or those that are classified as *static* according to their dynamics, should — as far as possible — also be classified according to these principles. Verostko's *Seven Sisters: The Pleiades* can be classified as autonomous, while *My Boyfriend Came Back from the War*, *Cylinder* or *Poetry on the Road*, because they map real-world data or are only usable through externally fed information, which of course also includes the user's input, are classified as data-driven.

INTERSTICE: AUTONOMY AND THE PLEASURES OF DIGITAL ENVIRONMENTS

A system's autonomy can be regarded not only as the amount of control conferred to, or appropriated by it, but also as a transfer of some amount of agency to the system. Returning to Murray, (1997; 2012), we find a description of digital media in terms of the pleasures that are characteristic to them, of their own "unique patterns of desire" as expressive media. Their "own way of giving pleasure, of creating beauty, of capturing what we feel to be true about life; its own aesthetic" (1997, 94). These pleasures are *agency*, *navigation* and *transformation*. From these, it is the first that matters most in this context.

53 A distinction that is not always possible to make by merely observing a system in operation.

> When things are going right on the computer, we can be both the dancer and the caller of the dance. This is the feeling of agency. Because of the vague and pervasive use of the term interactivity, the pleasure of agency in electronic environments is often confused with the mere ability to move a joystick or click on a mouse. But activity alone is not agency. (...) Agency, then, goes beyond both participation and activity. As an aesthetic pleasure, as an experience to be savored for its own sake, it is offered to a limited degree in traditional art forms but is more commonly available in the structured activities we call games. (Murray 1997, 128-129)

By transferring some agency to the system and by endowing it with some autonomy, we could suppose that the system would loose some of its potential to pleasure. We can however propose that an increase in the system's autonomy may create an additional pleasure besides the triad enunciated by Murray: a procedural pleasure, that we can relate to the presence of the procedural modality in a system. As Rucker proposes, observing physical computations is a simple human pleasure (2005, 103). As well as generative artefacts, there are systems where the potential number of states is so high that it becomes impossible to repeat any given state[54] but where, in spite of this, one can intuitively grasp[55] an operational logic, a course of action. In procedural systems one can understand a statistical tendency for certain outputs to be produced, some attractors where the outputs tend to fall. One is rewarded when the systems behave according to our expectations, and frustrated if failing to correctly (or approximately) predict the behaviours. Simple systems do not reward the viewer at this level, because by being so straightforward they do not imply a significant effort, and the reward is, as in so many cases, proportional to the effort. This is related to, but goes beyond what Dominic McIver Lopes calls "active appreciation" of an artwork (2010, 41) but it is also different from an interactive engagement with the system, because there are no physical bidirectional

54. Or at least where it is very difficult to predict any future state from the current state of the system.

55. *Grasping*, not understanding, seems like a more adequate verb to use in this context, because one does not necessarily understand all the details of the processes well enough to be able to rebuild it (or even to explain it to other observers or to oneself) but, as the computational beings that we are, we can follow the processes, react to their algorithmic nature and even, as Hofstadter suggests (2007), somehow emulate the algorithm, by running in our brains processes that are similar (if not even identical in some cases) to those that are deployed in the system. In most cases this does not happen consciously, but it nevertheless happens, and it leads one to expect that the outputs of a procedural system will evolve in what is their 'natural' way, that which is dictated by their code and literally 'followed' by the observer (here turned to a coprocessor). "Computer art runs on computers, so if brains are computers then some computer art runs on brains." (Lopes 2010, 48-49)

exchanges of information (where those exchanges happen, they exist in a single direction, from the communicating system to the viewer).

When Duchamp remarked that *the spectator makes the picture*, he was referring to how strenuous an activity the appreciation of art may be. One needs to look, listen, read, "try out alternative interpretations of what is perceived, import relevant knowledge about authorship, genre and history, and imbue the whole process with personal associations, if they're relevant" (Lopes 2010, 41), one needs to fill in missing information and details of objects that are represented, to move the body to experience spatial structures (Manovich 2001, 56) and with these artefacts, to try to further fathom the system and even come to emulate it.

CLASS

The computational *class* to which a system's output belongs can also be used for its classification. Following Wolfram (2002) and Rucker (2005), we can approach this variable through at least three understandings.

We can inspect the outputs, trying to recognise the typical patterns created by class 1 to class 4 computations. This will probably lead to a classification of most systems as either class 2, whenever the outputs present static structures, or as class 4 whenever they develop evolving and localised structures. In this case we will only find class 1 computations whenever the outputs are absolutely uniform (a filled or empty canvas) and class 3 only in truly random outputs. In this case we will be classifying the computational class of a system by trying to infer its properties from its outputs.

We can alternatively use the information processing interpretation of the computational classes to classify the systems according to their capacity to process or preserve information. This will be difficult to infer from the system's outputs alone, whenever one is not able to interact with the system directly, or to witness its real-time operations, thus hindering the classification of all the artefacts that do not develop real-time computation.

Finally, we can try to classify the outputs according to the class of computation that they may develop or represent. In this sense we can classify most of the static intransient outputs as class 1, most of the static transient outputs

as class 2[56] and all those outputs that exhibit complex behaviours as class 3 or 4. The structure of the outputs can then determine whether the system is classified as class 3 — random, totally unpredictable — or class 4 — structured, at least locally and at least partially predictable.[57] We have chosen to follow this last approach.

ANALYSIS

We arrived at a model comprised of nine variables and their 26 possible values, that we used to analyse the 54 works, classifying them according to all variables.

VARIABLE	POSSIBLE VALUES
Dynamics	Static, SUD, DUD
Determinability	Determinable, indeterminable
Transiency	Transient, intransient
Access	Random, controlled
Linking	None, conditional, explicit
User function	Explorative, configurative, interpretative
Modalities	1 – 5
Autonomy	Autonomous, data-driven
Class	1, 2, 3, 4

56. Class 1 is found in printed or otherwise physically immutable objects while class 2 is found in time-based, transient, outputs. Class 2 systems can be regarded as cyclic outputs that once replayed repeat the same pattern of surface units. There are of course exceptions to this rule of thumb, most notably *Connect*, a static, transient and yet indeterminable system that was classified as class 4.

57. Rucker develops a somewhat similar interpretation, stating that "in classical (prequantum) physics, a vacuum is the simplest, most orderly kind of matter: nothing is going on. A crystalline solid is orderly in a predictable, periodic way. And fluids such as liquids or gasses are fairly disorderly, more along the lines of being class three. Matter is computationally at its most interesting when it's near a phase transition, as when a liquid is freezing or coming to a boil. Matter near a phase transition to some extent has a nested class two structure, with similar kinds of features occurring at widely different scales. But the phase transition structure is very dynamic, with information-laden patterns moving about, and is, I believe, best thought of as class four." (2005, 115)

	DYNAMICS	DETERMINABILITY	TRANSIENCY	ACCESS	LINKING	USER FUNCTIONS	MODALITIES	AUTONOMY	CLASS
1. *Cent mille milliards de poèmes*	S	D	I	R	N	CF	3	A	1
2. *Cent mille milliards... (Web)*	DUD	I	I	C	C	CF	1	A	2
3. *Agrippa (a book of the dead)*	SUD	D	T	C	N	IF	3	A	2
4. *A-Volve*	DUD	I	T	C	C	CF	5	DD	4
5. *Evolved Virtual Creatures*	DUD	I	T	C	N	CF	3	DD	4
6. *My Boyfriend...*	S	D	I	C	C	EF	2	DD	2
7. *Every Icon*	SUD	D	T	C	N	IF	3	A	2
8. *Sketch*	S	D	I	R	N	IF	2	A	1
9. *Seven Sisters: The Pleiades*	S	D	I	R	N	IF	2	A	1
10. *Text Rain*	SUD	I	T	C	N	CF	4	DD	4
11. *Yellowtail*	DUD	I	T	C	E	CF	3	DD	4
12. *Soda Constructor*	DUD	I	T	C	E	CF	3	DD	4
13. *Amoebaabstract 01*	SUD	I	T	C	C	CF	3	DD	4
14. *Amoebaabstract 02*	SUD	I	T	C	E	CF	3	A	4
15. *Amoebaabstract 03*	SUD	I	T	C	E	CF	3	A	4
16. *Cylinder*	S	D	I	R	N	IF	2	DD	1
17. *Substrate*	SUD	I	T	C	E	CF	3	A	4
18. *Black & White*	SUD	I	T	C	N	IF	3	DD	2
19. *For All Seasons*	SUD	I	T	C	E	CF	2	DD	2
20. *Droom Zaacht*	DUD	I	T	C	E	CF	3	DD	4
21. *Page 0*	SUD	I	I	C	E	EF	2	DD	4
22. *Happy Place*	SUD	I	T	C	E	CF	3	A	4
23. *Emeral*	S	D	I	R	N	IF	1	A	1

	DYNAMICS	DETERMINABILITY	TRANSIENCY	ACCESS	LINKING	USER FUNCTIONS	MODALITIES	AUTONOMY	CLASS
24. *Three Buttons*	DUD	D	T	C	N	CF	2	DD	2
25. *Dreamlines*	DUD	I	T	C	E	CF	3	DD	4
26. *Ornamism*	SUD	I	T	C	E	CF	3	A	4
27. *30×1*	SUD	I	T	C	N	IF	4	A	4
28. *Extrusions in C Major*	S	D	I	R	N	IF	2	DD	1
29. *Poetry on the Road*	S	D	I	R	N	IF	1	DD	1
30. *Process 16*	SUD	I	T	C	N	IF	3	A	4
31. *We Feel Fine*	SUD	I	T	C	E	CF	3	DD	4
32. *Moving Pixel Portraits*	S	D	I	C	E	CF	3	DD	2
33. *Process 18*	SUD	I	T	C	N	IF	3	A	4
34. *Der Wirklichkeitsschaum*	S	D	I	R	N	IF	1	A	1
35. *Reface [Portrait Sequencer]*	DUD	I	T	C	C	CF	3	DD	2
36. *Pixflow #2*	SUD	I	T	C	N	IF	3	A	4
37. *Folia*	S	D	I	R	N	IF	1	A	1
38. *Inner Forests*	DUD	I	T	C	E	CF	3	DD	4
39. *A Week in the Life*	S	D	I	R	N	IF	1	DD	1
40. *Connect*	S	I	T	R	N	IF	4	A	4
41. *A Confidence of Vertices*	S	D	T	C	N	IF	2	A	2
42. *Enerugii*	S	D	T	C	N	IF	3	DD	2
43. *Print cover*	S	D	I	R	N	IF	1	A	1
44. *Nokia Friends*	DUD	I	T	C	N	IF	4	A	4
45. *Forever*	SUD	I	T	C	N	IF	3	DD	4
46. *Colors of Nature*	S	D	I	R	N	IF	1	A	1

	DYNAMICS	DETERMINABILITY	TRANSIENCY	ACCESS	LINKING	USER FUNCTIONS	MODALITIES	AUTONOMY	CLASS
47. *Animations for Aol.*	S	D	T	C	N	IF	3	A	2
48. *Merce's Isosurface*	S	D	T	C	N	IF	2	DD	2
49. *Perpetual Storytelling Apparatus*	DUD	I	T	C	N	IF	3	DD	4
50. *phiLia 01*	SUD	I	T	C	E	CF	4	DD	4
51. *Talysis II*	DUD	I	T	C	N	IF	2	A	4
52. *temporary.cc*	DUD	I	T	C	C	CF	2	DD	1
53. *Vanitas*	SUD	I	T	C	E	CF	4	DD	4
54. *The Inability to Solve...*	SUD	D	T	C	N	CF	3	DD	2

A correspondence analysis of the data was developed, and the results of the first two synthetic variables were plotted, accounting for over 65 percent of the total variance in the data.

NUMBER	EIGENVALUE	INERTIA	CUMULATED
1	0.342199	54.1	54.1
2	0.054562	8.6	65.7
3	0.032972	5.2	68.0
4	0.023009	3.6	71.6

By plotting the multiple component analysis, we found that there was a fairly regular distribution of the systems along the four quadrants, with the highest number in the northwest quadrant (18 pieces), and the lowest in the southeast quadrant (10 pieces). The initial number of systems was not evenly distributed by a predetermined number of diverse typologies or genres, and this is certainly reflected in the plot. If we choose to regard each dot where mul-

tiple systems are plotted as a possible typology,[58] we can then count dots and not individual systems. Still, we find that the northwest quadrant is still the most populated (11 dots), and the southeast is again the less populated (7 dots).

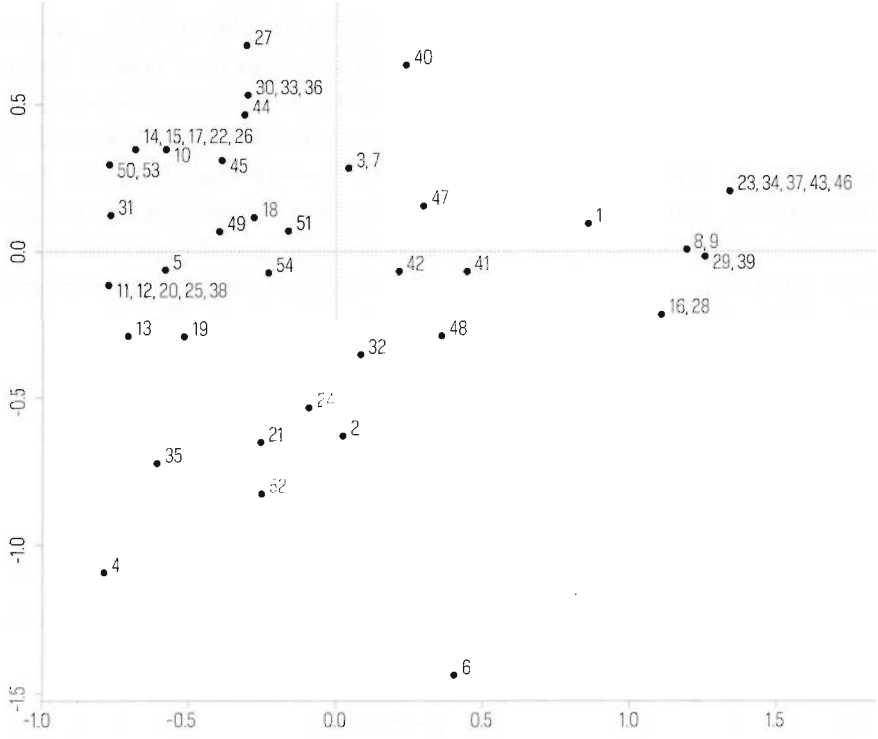

Fig. 61 Plot of the first two synthetic variables of the Multiple Component Analysis (MCA) with nine variables, showing only the systems.

Somewhat predictably, we find that the periphery of the graph is taken by systems such as *A-Volve* [4], *30×1* [27] and *Connect* [40], works that already stood somewhat apart from the rest of the selection. The more isolated piece is *My Boyfriend Came Back from the War* [6], which also happens to be the only narrative hypertext in the set. Still, as we shall see, although distant from the centre of the map, it is still plotted in a logical location.

58 Which naturally means that they share the same exact values for every variable in the analysis. This happens in nine cases, three of which cluster as many as five systems.

The east edge is populated by printed or other static outputs, while the west is predominantly populated by interactive systems. If we circumscribe the areas occupied by interactive and non-interactive systems, we find that they do not overlap and create two very defined islands in the graph.

Looking closely to the determining categories encompassed by each of these areas may allow us to understand which values are most typically associated with each group. In the east quadrant we find that the non-interactive pieces are mostly static, determinable, intransient and randomly accessible, with no linking, and characterised by the interpretative user function. The interactive systems in the west quadrant are characterised by deep unit dynamics, conditional linking and explorative and configurative user functions. They also tend to concentrate more modalities and to develop higher computational classes.

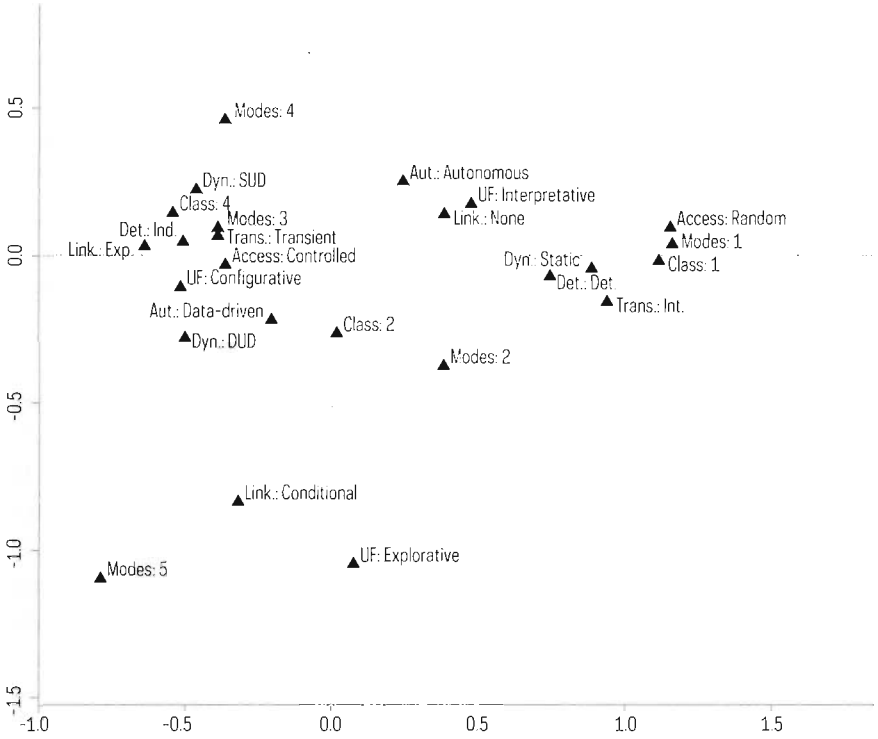

Fig. 62 Plot of the first two synthetic variables of the MCA with nine variables, showing only the categories.

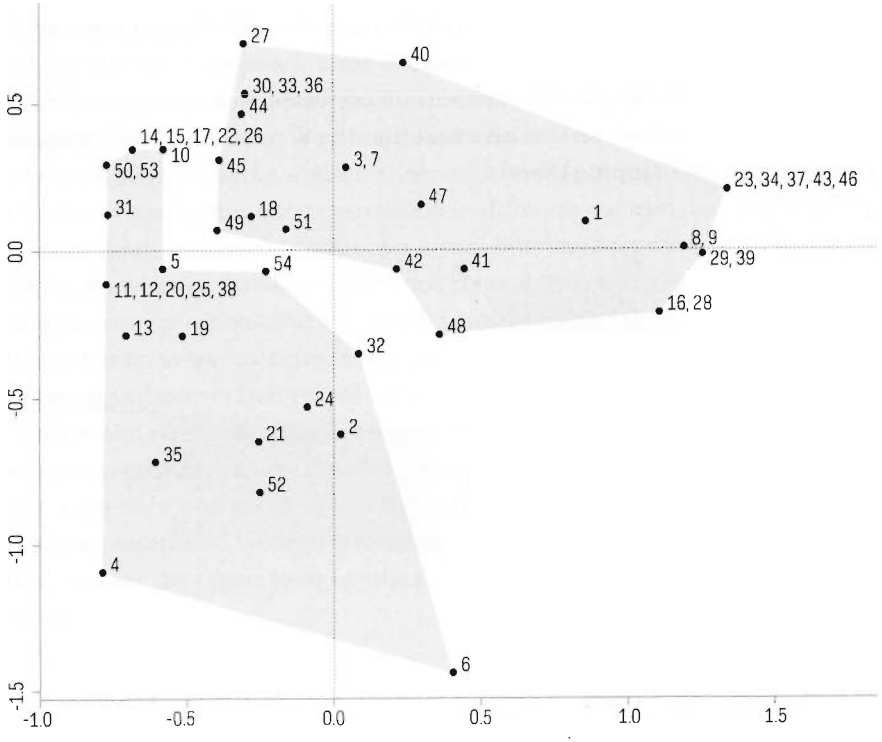

Fig. 63 Interactive (south-west quadrant) and non-interactive (north-east quadrant) systems.

The only system that in this circumscription calls our attention because of its relative placement is Queneau's *Cent mille milliards de poèmes* [1], in the centre of the non-interactive *island*. Albeit not a traditional one, this is the only book among the pieces that we studied. A semiotic definition of interactivity may state that an "interactive work is a work where the reader can physically change the discourse in a way that is interpretable and produces meaning within the discourse itself" (Andersen qtd. in Aarseth 1997, 49), and thus may seem to justify an interpretation of books as potential interactive artefacts. If however we follow the definition presented by Schubiger, that an interactive system is one that supports communication in both directions, from user to system and back (2005), or that of Andrew Lippman, who sees interaction as "mutual and simultaneous activity on the part of both participants" (qtd. in

Aarseth 1997, 49), then we must certainly not consider a book as an interactive device or its text as an interactive system.[59]

Should we circumscribe the systems whose outputs are computer-based and those that are not, we will also find that the areas create two clearly defined and non-overlapping islands.

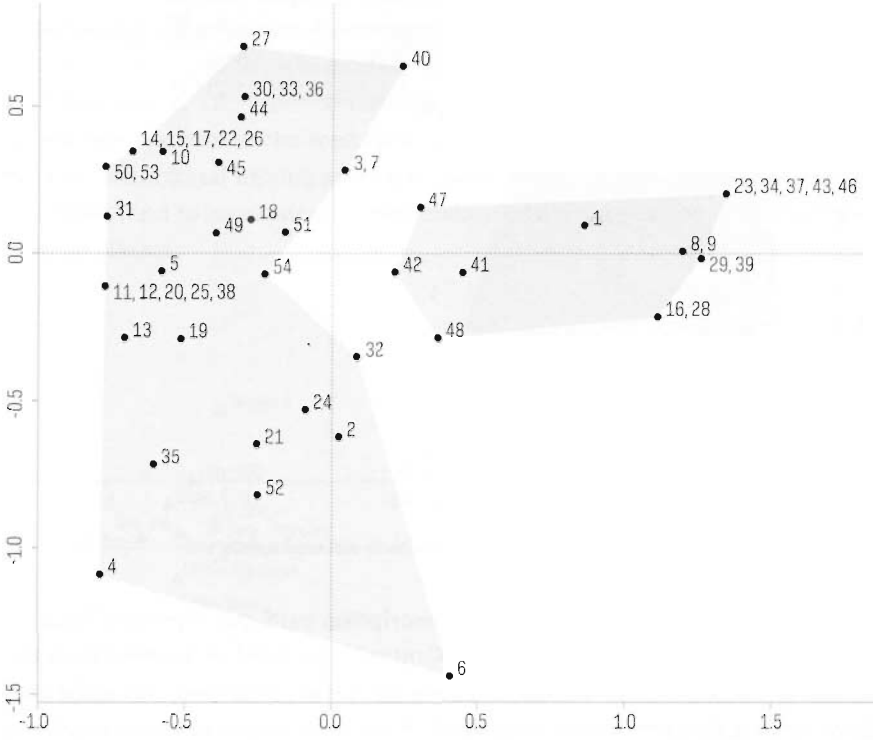

Fig. 64 Interactive (south-west quadrant) and non-interactive (north-east quadrant) systems.

The plot does not allow us to infer much about an eventual genre partitioning of the systems, and we wonder whether this can be seen as a shortcoming of the model or if, on the other hand, genres in computational media are simply too undefined, broad or blurred to be able to recognise encompassing genre

59. A book is never capable to react or respond to a user, although the user can certainly interpret its (rearranged) contents as responding to a certain question or change of context. As what happens with the *I Ching* or with a game of Tarot, where the user thinks that the reconfiguration of the system or the random selections are meaningful when in reality it is the interpretation of those changes that creates the meaning.

definitions that may be applied to multiple pieces. If we look at the groups of pieces plotted in the exact same coordinates, we find that even when trying to fit traditional genre descriptions such as *sculpture*, *painting* or *drawing*, the boundaries are not clear. We can for example find two of the most rapidly identifiable sculptural works, *Cylinder* [16] and *A Week in the Life* [39], plotted in the vicinity of each other but nevertheless in different coordinates, and sharing their respective positions with two visual-only outputs that could be classified as *drawings* or *illustrations*. We do find that all linear videos are plotted in neighbouring positions, but still not sharing the same exact coordinates, something that is far more common among printed or plotted outputs. It is also interesting to discover that two of the pieces where a certain directionality (and irreversibility) of time is patent — *Agrippa* [3] and *Every Icon* [7] — share the same coordinates and are therefore plotted in the same location. Although at first sight they may seem to be very different systems, working in somewhat different media and belonging to different genres or artistic typologies, under this analysis they seem to be identical, pertaining to the characteristics under study.