## Tracing Autonomy & Artistic Significance: Towards an Alternative Framework for Analysing & Comparing Generative Art



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#### ABSTRACT

Generative art continues to gain the interest of artists, scientists, and critics. Analysing and comparing generative art, however, is often an ambiguous practice. This is due to two factors: 1) the commonly used definition of generative art is broadly defined, which puts a large variety of works under the same heading. 2) As an attempt to mitigate this, various methods for classifying and comparing generative art are developed, but these only facilitate a descriptive analysis of the generative systems within an artwork, and neglect the role & contribution of those systems to the work as a whole. This complicates meaningful analysis, comparison, and discussion on generative art. In this research, we aim to formulate an alternative perspective for analysing generative art, in order to develop a better understanding of what generative art includes, where 'the generative' aspect in a work takes place, how the generative relates to other aspects in that work, and how this differs from the generative in other works. To do so, we propose a framework and two concepts: "autonomous ability" (AA) and "artistic significance" (AS). The framework examines 1) what elements (generative and nongenerative) are involved in the artwork, 2) what the role is of these elements within the artwork, 3) how autonomously these elements are able to execute this role (i.e. level of AA), and 4) how artistically significant the contribution of this role is to the artwork as a whole (i.e. level of AS). We apply the framework to a selection of eight generative artworks to test its working. Next, we compare the results of all analyses with each other. Notable findings are that a) in most artworks the levels of AA and AS are not aligned, but distributed over elements, b) the generative elements in a work often appear not to be the most autonomous, c) more (external) elements than expected play a role in the generation of a work, and d) artworks that are not traditionally considered as generative art, do appear to have generative properties when analysed through our framework. We conclude that these findings argue for an even broader notion of what can be reckoned as generative art & what we include as its "systems", and that this might challenge our idea of how autonomous these creative systems truly are.

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### 1. Introduction

Over the past years, generative art has gained an increased interest of artist, as well as scientist, and critics. Recent developments in Machine Learning, such as Generative Adversarial Networks (GANs: type of neural networks for unsupervised learning that can analyse variations in a dataset and produce comparable output) (Goodfellow, et al. 2014), have introduced new methods for making art that is computer generated, giving new impulse to the field of computational creativity and subsequently the discussion about creativity, authorship and authenticity. Next to that, the current boost in Non-Fungable Token technology (NFT: digital representation of a real world collectable art piece, encoded with blockchain technology. Functions as a proof of ownership) (ArtJam, 2021b) has sparked a remarkable generative art "fever", as platforms such as Art Blocks, a project on the Ethereum blockchain through which on-demand custom digital artwork can be generated via an algorithm (ArtJam, 2021a), have introduced novel ways of creating, collecting, and trading art, which is currently chancing the notion of art as a commodity. And lately a growing number of makers (both professional artists and enthusiastic hobbyists) is engaging with generative methods and tools, such as these GAN's, NFT's, and permutation algorithms, for their creative practice, as these become more and more accessible to a larger audience. The artworks generated through these technologies are flooding online portfolio platforms like Adobe's Behance, but are also well represented at art & media festivals globally, and recently have even entered the traditional art auction houses (like the GANproduced painting "Edmond de Bellamy" that was sold for \$432,500 at Christie's in 2018) (Vincent, 2018), showing that generative art is a field and practice that is here to stay, and continues to provide both an interesting scope of work and discussions.

#### 1.1. What is generative art?

So, what exactly is generative art? Generative art is commonly defined as art which is (partially) produced by systems which are to some degree autonomous (Galanter, 2003). Most will think of computational systems, in this case, or perhaps even artificial intelligence: systems that are able to operate or learn - to some degree - independently. Famous examples of generative art, are the works of early computer art pioneers, such as Frieder Nake, Lillian Schwarz, Manfred Mohr and Georg Nees, whom in the 1960's with the introduction of the computer and programming languages, started experimenting with the computer and algorithms for artistic practice, resulting in manifold artworks throughout history. Other well known examples of generative art are John Conway's zero-player game "Game of Life" (1970), a 2D cellular automaton in which cells exhibit a certain behaviour (interact and evolve, live or die) based on a predefined set of rules, or Harold Cohen's AARON, an Artificial Intelligence system that Cohen engineered and learned how to draw autonomously. Since its first version from 1971, AARON has made numerous drawings, and is the longest-running continuously maintained AI system in history (CHM, 2016). More recent examples of generative art are Manolo Gamboa Naon (making colourful, complex visuals through code), Michael Hansmeyer (creating architectural pieces through generative methods), Katharina Brunner (producing compelling mathematical shapes with the programming language "R", often used for statistical computing), and Anna Ridler (making works though GAN technology, to question the working of AI).

However, generative art per definition also includes art that is *not* computer generated, yet still produced by an autonomous system. Examples of these are the works of Sol LeWitt whose Conceptualist work is made by predefined rules, Jean Tinguely's self-drawing machines, or even Islamic tiling, that uses - still unknown mathematical principles as base for making intricate geometrical shapes and patterns.

As the examples show, there is a very wide variety of works that we reckon among generative art. The broad definition of generative art somewhat allows for this: it not only includes many different types of 'generative artworks' under the same heading (e.g. both non-computer generative and generative computer art), but arguably also blurs the many differentiations that exist *between* generative artworks, such as style, discipline, or media.

It's not surprising therefore, that in the past decades multiple attempts were made to classify, structure, evaluate and compare generative art forms. Various researchers, art critics, and makers in the field have formulated their viewpoints on what to include under generative art and how to understand it, resulting in multiple schools of thought. We will address the main viewpoints and their characteristics later in this study.



"Edmond de Belamy, from La Famille de Belamy" (2018), a GAN-generated painting by the French art collective Obvious. Picture: © Christie's, retrieved via Cohn (2018).



Matritzenmultiplikation Serie 32 (1967), Frieder Nake. Image retrieved via Zentrum für Kunst und Medien Karlsruhe (n.d.).



Example of an untitled AARON drawing, ca. 1980. Image retrieved via Computer History Museum (2016).



Mural Drawing (2014), by Sol LeWitt. Image retrieved via VTIFF, 2014)



Mosaic Virus (2019). Triptych of GAN images, by Anna Ridler. Image retrieved via ANNA RIDLER (n.d.)



Sixth Order (2012), by Michael Hansmeyer. Physical columns fabricated after virtual models created with algorithms. Image retrieved via The White Review (2017).

These different viewpoints on generative art, however, make meaningful analysis and comparison of generative artworks difficult, and subsequently a meaningful discussion about generative art. Moreover, most of these viewpoints entail descriptive frameworks, that define what systems or processes are at play in the artworks, but leave little room for questioning the creative role and contribution of these systems or processes to the artwork as a whole. This leaves possible interesting and valuable questions for analysis of generative art unanswered. For example: what exactly is "generative" in an artwork? And where in the artwork does this take place? How does this generative element relate to other elements involved in the work? Can we, for example, define different degrees of "generativity" in or between artworks? And for that, can certain artworks be more generative than others, or in different aspects?

We would argue that an alternative way of looking at generative art can help define this, which, ultimately, could facilitate a better understanding of what generative art is, what 'the generative' comprises in different works, and how this can differ amongst artworks. This might help meaningful evaluation and comparison of generative art, and possibly reveal novel insights about generative art that previously were unnoticed.

Therefore, in this research we aim to to come towards an alternative framework for analysing and comparing generative art, that hopefully introduces a new viewpoint and new insights for generative art for makers, curators, researchers. We will do this by first shortly map the existing schools of thought on generative art and their frameworks. to examine what theories these contain, where they complement or contradict each other, what they add to the discussion around understanding of generative art, and what they leave untouched. We will then propose two concepts through which to analyse generative art and introduce a framework to perform the analysis with. We will apply this framework on a selection of generative artworks to test it and examine what it would result in. We will reflect on the outcomes and discuss its contributions and limitations to the debate on analysing generative art.

### 2. Theoretical Framework

Currently, three main schools of thoughts, or theories, exist on how to look at Generative Art. We will review these in this section briefly, but will first elaborate on the most used definition of Generative Art in these contexts.

One of the most cited definitions of generative art is the definition introduced by Philip Galanter (researcher, curator, and artist). Galanter states that: "Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art." (Galanter, 2003, p. 4). Galanter sharpens this definition with the addition that: "First, note that the term generative art is simply a reference to how the art is made, and it makes no claims as to why the art is made this way or what its content is. Second, generative art is uncoupled from any particular technology. [...], generative art may or may not be "high tech." (Galanter 2003, p. 4). This definition implies that generative art should be understood as a method for making art, not as an art movement

that disseminates an ideology. And second, that the concerning system with which the artwork is produced, can involve (or lack) or any form of technology.

Since Galanter, many theorists & artists involved in the research and practice surrounding generative art have adopted and applied this definition (Monro 2009, Dorin et al 2012). Some albeit in a slightly different formulation (Boden & Edmonds mention generative art as: "Both in music and in visual art, the use of the term has now converged on work that has been produced by the activation of a set of rules and where the artist lets a computer system take over at least some of the decision-making (although, of course, the artist determines the rules)" (Boden & Edmonds, 2009, p. 24), but all with an evident emphasis on how generative art involves some sort of autonomous system, and some level of control that is attributed to this system for creating the work. Considered that this definition is widely agreed upon in the field, we will use this in our research as well. In the next chapters, we will elaborate on the existing main schools of thought on generative art, examine how these apply this definition in their frameworks, and shortly discuss what these include.

# 2.1. Philip Galanter - Complexity Paradigm

Galanter (2003, 2008, 2016, 2019) proposes to view generative art from a systems and complexity theory influenced paradigm, first introduced in his article "What is Generative Art" (2003). Over the years, Galanter has extended and validated this way of looking in the context of emerging technologies, as for example in the case of Deep Learning (2019). His papers are still influential in the field of generative art research, hence we will briefly reflect on his theory.

According to Galanter, "systems are the defining aspect of generative art". With systems, Galanter means complex, dynamic systems that inhibit "a large number of small parts or components that interact with similar nearby parts and components." (Galanter, 2003 p. 5). These local interactions are generally non-linear, tend to exponentiate rather than add-up (whole is greater than sum of its parts) and often lead to selforganisation, in which no master control or external agent being is in charge. Examples of complex systems Galanter mentions are the weather, stock markets, fractals, the brain (biology) and the mind (psychology), ecosystems (animals, cells, cultures & societies), and often develop in "ways that are dramatic, fecund

catastrophic, or so unpredictable as to seem random." (Galanter, 2003).

Galanter questions if all systems are alike, and if not: how to distinguish these. His ambition is to "understand the commonalities systems exhibit across all scales and hierarchies" (Galanter, 2003). With his framework he provides guidelines to categorise different types of systems that can be used to make generative art, and subsequently to distinguish various types of generative art as well. Galanter uses concepts such as high/low information content, compressibility, and randomness, as tools to categorise generative systems along two axes: from highly ordered to highly disordered, and from simple to complex. Galanter defines a sweet-spot on these axes, a measure he calls "effective complexity" (EC), for systems that inhibit an interesting balance between order, disorder, and structural complexity. He states that artists will understand that "an audience will quickly tire of both a highly ordered and a highly disordered aesthetic experience because both lack any structural complexity worthy of their continued attention. The intuition that structure and complexity increase somewhere between the extremes of order and disorder leads us to the consideration of "effective complexity"" (Galanter, 2003).



Galanter's complexity scale, with examples of generative systems (Galanter, 2003)

In short, with his viewpoint Galanter aims to provide a context to understand generative art in, i.e. complexity & systems theory, and a method to sort various types of generative systems along a 'complexity' scale, for which he introduces order, disorder and effective complexity as organising principles. However, we wonder how valuable it is to define the degree of 'complexity' of a system for analysing and comparing generative art. Why only focus on the system, and not on other factors in the work? And why only assess its complexity as a defining factor? We think it is limiting to solely review a system's inner workings' without taking its output into account too. Moreover, we think a detailed description of how these systems are applied in the artwork and next: what the generative properties of this system attribute to the artwork as a whole is left untouched in Galanter's theory.

# 2.2. Boden & Edmonds - Taxonomy of Generative Art

Another influential theory of looking at generative art is provided by Margaret Boden & Ernest Edmonds (2009). In their paper, they distinguish different *types* of computer art via a theoretical tool. They define a taxonomy of subcategories of computer art, with explanations and examples, after which they question for every category *"whether the appropriate aesthetic criteria and locus of creativity are the same in each case"* (Boden & Edmonds, 2009).

The eleven categories they formulate have the following definitions (summarised after Boden & Edmonds, 2009):

**1. Ele-art** involves electrical engineering and/or electronic technology.

**2. C-art** uses computers as part of the art making process.

**3. D-art** uses digital electronic technology of some sort.

4. CA-art uses the computer as an aid (in principle, non-essential) in the art-making process.5. G-art works are generated, at least in part, by some process that is not under the artist's direct control.

**6. CG-art** is produced by leaving a computer program to run by itself, with minimal or zero interference from a human being<sup>\*</sup>.

**7.** Evo-art is art evolved by processes of random variation and selective reproduction that affect the art-generating program itself.

**8. R-art** is the construction of robots for artistic purposes, where robots are physical machines capable of autonomous movement and/or communication.

**9.** In I-art, the form/content of the artwork is significantly affected by the behaviour of the audience.

**10.** In **CI-art**, the form/content of some CG-artwork is significantly affected by the behaviour of the audience

**11. In VR-art**, the observer is immersed in a computer-generated virtual world, and experiences it and responds to it as if it were real.

(Boden & Edmonds 2009, p. 37-38).

Contrary to Galanter's view, "systems" as such are not focus of attention in Boden & Edmond's way of categorising generative art. Instead, Boden & Edmond way of looking is more a medium specific 'filter' in which key points for subcategorisation are the different types of media, or more specific: technology, that was applied in creating the artwork.

This taxonomy does allow comparison of computer and generative artworks, however on a more high-over dimension than for example Galanter's complexity paradigm. A more detailed look into the underlying processes and systems of generative art is not facilitated by this taxonomy. This makes Boden & Edmonds' theoretical tool more of a detailed observation and description of the 'current' computer art landscape, primarily focused on the means or technical applications used for creating the artwork itself, without revealing much about the granular elements that are at play in generative art.

What is interesting however, is that Boden & Edmonds propose that the 'system' at play, especially in CG-art and CI-art, has a broader notion than systems in, for example, Galanter's conception of systems. Boden & Edmond's name that aside from the program running the art work, there are other factors involved in making the artwork the artwork: "what counts as the artwork when the uniqueness is due not only to a richly generative computer program but also to the contingent (and ephemeral) behaviour of a participatory human audience?" Boden & Edmond's thus speak about the *art system*, in which "the artist, the program, the technological

<sup>\*</sup> Note: They chose to reject their earlier, stricter definition of CG-art (i.e. "art produced by a program left to run by itself, with zero interference from the human artist") (Boden & Edmonds, 2009).

installation (and its observable results), and the behaviour of the human audience" (2009) are all compromised as part of it. We think this is an interesting way of looking at generative art that might be valuable.

# 2.3. Dorin et al. - Dynamic Processes

Another, more recent, framework for analysing generative art is proposed by Dorin et al. (2012). According to Dorin et al., generative art systems are constituted by four main components: entities, processes, environmental interaction, and sensory outcomes. They formulate a framework which allows for a careful dissection of these components, in which:

**1. Entities** are the subjects upon which a generative artwork's processes act.

Entities may exist in structured or hierarchical relationships with one another, leading

to the creation of new composite entities. Entities have characteristic properties that play a crucial role in the generative process. Examples: spatial, temporal and formal attributes (for example position, age and colour).

**2. Processes** are the mechanisms of change that occur within a generative system; they necessarily involve entities that perform operations on, or interact with, each other.

**3. Environmental interaction** involves flows of information between the generative process and their operating environment. This can also extend to higher-order interactions involving the artist or designer, e.g. the creator filtering or interactively modifying (iteratively redesigning) the system itself in response to its output.

**4. Sensory outcomes** are the experienced aspects of a generative work (hidden or directly available for perception).

(Summarised after Dorin et al., 2012)

With this, Dorin et al. enable the audience or critics with their framework to not only look at the individual subjects or media that are used in the artwork, but also to take into account the *dynamic processes* that are at play in the artwork between these subjects, as well as the external input (in

form of environmental interaction) for the artwork: things that in generative art are quite important.

In response to Boden & Edmonds, they state that the taxonomy Boden & Edmonds provide, does not allow for comparison of the underlying processes of generative artwork, for which they "prefer to give at least equal weight to the forms of the processes themselves, rather than focussing on the means by which the form is achieved" (Dorin et al, 2012 p. 243). Dorin et al. critique the effective complexity paradigm of Galanter for not enabling discussion about generative work other than its complexity, and that Galanter's framework is not creating enough outcomes to adequately analyse, describe and compare and critique generative artworks. To aid the critical understanding of these systems and their processes, they pose that first a decent understanding & literacy of generative systems has to be established, for which their framework provides a format. However, other than stating in their framework that "one still has to make critical decisions of where to draw the line between entities, processes, interactions and output" (and that thus other readings of these systems are still possible), Dorin et al. do not provide any guidelines for critical analysis of the art works themselves. This eventually makes their framework rather descriptive than critical, just like the schools of thought by Galanter and Boden & Edmonds.

# 3. Problem Statement & Approach

We state that the definition of generative art posed by Galanter and widely cited by other researchers. is so broadly defined that it puts an incredibly wide variety of artworks under the same heading. We think that this does not help in understanding the many different forms, and likely also the many different types of generativity amongst generative artworks. However, as we have seen in the previous chapters, the existing frameworks that are proposed for classifying generative art only approach generative art from a descriptive point of view, and do not allow for a more in-depth critical analysis of what the generative in a work contains, and what it contributes. We aim to develop a framework that does answer this, and formulate the following approach for this.

In our view, the definition by Galanter of generative art implies two types of "degrees" that

are seemingly at play within the artwork. We hope to illustrate this as follows. First, if generative art involves a (partially) autonomous system of some sort, then this implies that there is a degree to which that system itself is able to operate autonomously. What does this autonomous behaviour entail? How autonomous is this truly? Can we define multiple levels of autonomy in these systems across generative artworks? And second, if generative art is art that is (partially) produced by these systems, then this implies that there is a degree to which the system's output is important for establishing or creating the artwork as a whole. If so, to what extend is the output of the generative system used in the artwork? And what is its creative importance within the artwork?

These seem quite fundamental aspects of generative art, if we follow its commonly used definition. Yet, as we have seen in the previous chapter, the current existing theoretical frameworks on generative art do hardly take these two factors into account. These existing frameworks all provide a useful base to talk about generative art, and as mentioned above, have very valuable contributions on different levels in the discussion about generative art. But they do not address how autonomously the systems that are involved in the artworks can operate, what their function is within the artwork, and moreover, what the contribution of their function is to the artwork as a whole. We think this is interesting, because quite literally - by definition these factors seem to play an important role in generative art, and thus as we would argue - also in how we see, understand, and compare generative art. Wouldn't it be valuable to take these factors into account for analysing generative art? Can we look at generative art from this perspective? That is: can we find differences or similarities between "the generative" that is at play in generative artworks, by focussing on a) the role of that element in the artwork, b) how autonomously it is able to perform this role, and c) how important this role is for the artwork as a whole?

We would state so. We think these could be interesting questions to answer for generative art, and possibly offer an alternative way to dissect, define, and compare the role of the generative in and amongst artworks. Therefore we introduce two concepts in this study. First, the degree to which a generative system is able to operate autonomously, which we will call its *"autonomous ability"*. And second, the importance of the systems' creative contribution to the artwork as a whole, which we will call its *"artistic significance"*. We propose to analyse generative artworks through the lens of these concepts, in order to try and find answers to the questions posed above, and explore if we can come towards interesting new insights about 'the generative' in art. For this approach we introduce a framework for analysis, in which the concepts of autonomous ability and artistic significance are included. We will illustrate this framework in the following chapter.

### 4. Methodology

If we want to view generative art through the lens of the autonomous ability and artistic significance of the generative systems, we first need to define what we exactly mean and hope to question with those terms, what in the artwork we will examine with it, and how we frame that. In this chapter we will illustrate the decisions we propose to incorporate in the analysis, and eventually introduce the framework itself.

#### 4.1. Autonomous Ability

With the autonomous ability of an aspect in the artwork, we aim to indicate how independently this aspect can operate or execute something without external help or input. This can mean setting things into motion, performing a task, or initiating or creating something (i.e. having emergent properties), depending on the generative system itself. Where or when does it require input from the artist, or the audience? How autonomous is it able to operate if these factors weren't there?

Next to these examples of more practical execution however, also the degree to which the system can make *its own choices* independently are part of autonomous ability, as well as how much *creative freedom* the system has in these choices. Is the output of the generative system already decided? And if so, by whom? How much leeway or agency does the system have to influence this output space?

Ultimately, in the analysis we aim to explore if certain levels of independence can be defined for this, and subsequently degrees of autonomous ability.

#### 4.2. Artistic Significance

With artistic significance of an aspect in the artwork, we aim to indicate what the creative

contribution is from the generative to the artwork, and how artistically important this contribution is for the work as a whole. What did the system add to the artwork, or what did it create? How does this contribution compare to the other aspects that make up the work? In terms of scale, but more importantly: also in terms of quality (how creative, original, surprising is it?). Could the artwork be still the artwork, if the system's input and its characteristics were not there?

In short: how "important" is the system for creating its output? And how artistically significant is that output to the artwork as a whole? We would argue that deliberately distinguishing *output or performance* of the generative system from the *artwork as a whole* helps to more clearly formulate the system's contribution to the work, and thus its artistic significance. For some works it might even be necessary, if the generative is not the only aspect in the work. This brings us to the following.

#### 4.3. Elements

To define a generative system's autonomous ability and artistic significance to an artwork, a good understanding of *what the actual artwork is* is required. What aspects does the complete artwork consist of? What part does the output or performance of the generative system take in this? For example, *is* this output or performance the artwork (i.e. the output equals the work)? Or are more factors involved, that constitute the total work? And, how autonomously are these in operating or creating their contribution?

One way of analysing generative art namely, is to focus exclusively on the generative system or even generative processes as such. One then isolates just that part of the artwork, and describes its properties, effects, influences on the outcome, etcetera. A similar method is seen in some existing viewpoints, for example Galanter's complexity theory framework or Dorin et al.'s framework with focus on the dynamic generative processes in the work. Yet, an artwork might consist of more than just 'the generative', whether it being systems or a processes. A work can be a mix of both generative and non-generative aspects, or might even contain more non-generative elements than generative. For example, Sol LeWitt's mural drawings. In these works both generative as non-generative aspects are incorporated, namely the set of written rules & instructions by LeWitt, the specific surface the drawing is created on, and the draftsmen themselves. All play an important role. Moreover, the interaction of both is important too, as the generative aspect of the written rules is dependent on the non-generative of the surface, and vice versa. Both make up the work, and have a certain dependency on each other.

What we hope to illustrate here, is that it is difficult, and even unfavourable, to only take into account the generative in artworks, and leave the non-generative out when analysing a work. Unfavourable, because it could be that in a work the *non-generative* aspects are from key influence on the generative aspects, which in that case, might affect how we regard the autonomous ability of that generative aspect. If one would only focus on the generative in this particular work, this dependency perhaps would be left unseen, affecting the outcome of the analysis. Moreover, not only the generative aspects in a work can be from artistic importance for the the artwork as a whole, but the non-generative aspects evidently as well. This should not be discarded for the same reason, as it might affect analysis as well. It might and reveal, for example, that the generative is from less importance for the actual work, than other non-generative aspects, which would be a fundamental difference in comparing works eventually.

Therefore, isolating solely the generative in an artwork would fall short for a thorough analysis. Other non-generative aspects might take up a just as important part in the artwork when it comes to autonomous ability and artistic significance. Therefore, we would propose to include both generative and non-generative aspects in the analysis. We will call these the *elements of the artwork* in this study.

Elements can be defined as the individual building blocks that make up the artwork: its most important parts, that all together make the work 'the work'. In case of generative art this includes a generative system of sorts. What generative system or systems are used? What separate elements does this system consist of? How does it work? What is its output? Next, the artwork (might) include nongenerative elements, as we just discussed. What are these? What media or tools are used? What characteristics do these parts have? This part of the artwork's elements, bears similarity to Dorin et al.'s component of "entities", which they describe this as "... the subjects upon which a generative artwork's processes act. They may be real or conceptual, simulated, physical, chemical, biological or mechanical. Entities are constituents that are (conceptually) unitary and indivisible, and whose functional relationships are not

typically expressed in terms of internal mechanisms. However, entities may exist in structured or hierarchical relationships with one another, leading to the creation of new composite entities." (Dorin et al., 2012, p. 244)

Next to these individual elements that are included in the artwork, however, is another element that is from influence to the artwork. Namely, the artist self. To define what level of autonomy, or what level of artistic significance an element has, a good understanding of the role of the artist is required. Where or when is the artist's input required to let the element create output? What does this input entail? And, what choices are made by the artist in making the final artwork? Was there selection, modification, curation involved before the piece became the piece? If so, at what level? Needless to say, in the same manner, this counts for the audience and other environmental aspects that might be involved in the artwork, such as performers or weather conditions, too. These elements can also influence or play a role in constituting the artwork. What role do these factors have? And how does this input make up the artwork? This bridges to the following.

#### 4.4. Roles

We have touched upon it already in some questions above, but we would like to highlight it explicitly. An element that is used in an artwork can also exist outside of the artwork (or in another artwork). In this case, it might have a different function, purpose, working, or meaning than its application and function within the artwork. For example, a genetic algorithm that is used in an artwork to create compelling visuals, is used in computational modelling for calculating and predicting biological phenomena. But, in a different artwork, the same algorithm could have the function to give input to a sound design. How this specific algorithm is used outside the artwork of analysis, might be completely different and irrelevant for how it is used in the artwork, but the fact that it has (or can have) another role *in another context,* might influence the analysis of the element in context of the artwork. In order to prevent this, it might be valuable to explicitly look at the role a certain elements plays within that particular generative artwork. This way, we can view the contribution of the elements more in context of the work itself, not in context of other usages of these elements.

What could be particular roles of an element in an artwork? For example, what is the purpose of the element in the artwork? Does it need to interact with other elements in the artwork? Provide input, or receive input? Does it need to perform or execute something?

Moreover, a role can also influence the status of the artwork, i.e. if the artwork is already completed, or not. For example, is the audience required to finish the artwork, e.g. in collaboration or in interaction with the generative system? Alternatively, is a generative musical composition already 'done' when the artist has finished writing it, or does it still need execution by other performers to let it become the artwork? In that case: is the role of the element to create the blueprint or composition of the work? Or, is it there to complete the artwork, and to create an instance of the artwork? Other factors that might influence the role of an element is the "mode" of the artwork: is the work generated (static, not evolving over time), or is it still generating (dynamic, evolving over time).

Subsequently, the quality and the contribution of these different roles (of both the artwork - being a composition or an instance - and of the artist, audience, or environment), can be analysed as well along the concepts of autonomous ability and artistic significance. Therefore, for analysis we propose to first define all the elements in the artwork, then evaluate what the roles are for each element within the artwork, and then analyse how autonomously these elements are able to perform these roles within context of the artwork, and how artistically significant their roles are for the artwork as a whole.

In summary, the steps and questions will look like the flow below:

- 1. What are the **generative and non-generative elements** in an artwork (what individual subjects, media, generative systems, dynamics, processes, artist, actors, and environmental input are at play)?
- 2. What are the roles of these individual elements (what is their purpose in the artwork? Is it there to create/instantiate something (emergent properties)? Does it need to interact with other elements in the artwork? Does it need to perform/execute something? Does it function as (or has to create) the blueprint/composition of the work. Or is it there to complete the artwork, or create an instance of the artwork?

- 3. How autonomously it is able to execute/ perform this role? (can it operate/execute independently? Where or when is the artist or audience needed to let it create output? What 'levels of independence' can we define for this? Can it make choices independently? And, does it have creative freedom in its role?).
- 4. How artistically significant this role is for the overall artwork? (how "important" is the element's performance for creating the output? And how significant is that output and performance to the artwork as a whole? Could the artwork be still the artwork, if the system's capacity/characteristics/input were not there? How important is its role for the artwork? And, what is the quality of its role/output (Creative? Original? Surprising?). And, in case of a composition or an instance of a work: how artistically significant are these compared to each other?

Answering these questions carefully and consistently for every generative artwork gives a good understanding of what plays a role in the artwork. It gives a base for eventually analysing the autonomous ability of the individual elements and subsequently its artistic significance. Moreover, applying an autonomous ability and artistic significance analysis can also be done for other elements that might not be taken into account often, but that might have a substantial role in the artwork as well, such as the artist, audience, environment. Assessing the autonomous ability of their roles, and subsequently the artistic significance of their roles, might come towards interesting insights.

This would give an even more thorough dissection of the generative artwork, and what is at play. It might disclose what differences and/or similarities exist between "the generative" amongst separate artworks, but might also help in making various dimensions of "generativity" in generative art explicit. For example, does the generative in this particular artwork lie on the level of the execution by the audience? How much "generativity" is held or performed by the artist self? Or, does its generativity exclusively lie on the level of the generative system? Making this difference explicit might, ultimately, aid comparison and evaluation of generative art.

Therefore, to define a generative artwork's "generativity" along the lines of autonomous ability and artistic significance of 'the generative' in the artwork, we suggest to cross these two terms with five 'pillars' or categories of elements, which we would argue are fundamental aspects to a generative art piece, namely: the artwork, the artist, the performer, the audience, the environment. Lastly, to highlight how all these elements interact together, or how they diffuse into each other, a sixth column is added, to discuss the sum of all parts. We will experiment in the analysis of selected generative artworks, if this is a useful and meaningful way to structure the framework for analysis.

Schematically, the framework would look like something below:

			// [ARTWORK], [	[year], by [artist] //		
	1. Artwork (its subjects, media, systems, individual parts, etc.)	2. Artist (the maker of the work)	3. Performer (the one(s) performing or executing the work)	4. Audience (the ones experiencing the work)	5. Environment (external input from the environment in which the work is situated)	6. Sum of parts (interactions, how all elements relate to each other, etc.)
ELEMENTS						
ROLE(S) of the elements in the artwork						
AUTONOMOUS ABILITY of the element to perform its role						
ARTISTIC SIGNIFICANCE of the element's role for the artwork						

In the next chapter, we will apply this framework to a selection of eight generative artworks, in order to illustrate how this framework can be used for analysis of generative art, what results it provides, and how these results and insights can be interpreted and used.

### 5. Analysis

For the analyses we aimed to select a small but representative set of generative artworks. The works should be relatively well-known, or that at least exist in the public realm and are well documented, to make sure the works are retrievable.

Some works in the selection are renowned as classic examples of generative art for various arguments, for which we are curious if those arguments can be found in the analysis with this newly proposed framework as well.

A variety of works is selected, both contemporary examples as older artworks. Diversity in art disciplines, as well as artistic background of the artist was aimed for. Regardless, the works chosen form merely a very small cross-section from the vast field of generative art, and are all rooted in the Western artistic canon.

Selected artworks for analysis are:

- 1. Mobile (ca. 1932) by Alexander Calder
- 2. Fidenza (2021) by Tyler Hobbs

- 3. Continuous Project Altered Daily (1970) by Yvonne Rainer
- 4. Structure de Quadrilatères (1985) by Vera Molnár
- 5. Memories of Passerby I (2018) by Mario Klingemann
- 6. Hot Pool (2010) by Driessens & Verstappen
- Seven Experiments in Procedural Animation (2018) by Karl Sims
- 8. In "C" (1964) by Terry Riley

#### Brief introduction of the artwork

The analysis of the artworks will be preceded by a brief introduction of each work, containing details on:

- the type of the work (sculpture, performance, print, etc.)
- specifics of the work (media, duration, location, etc.)
- Description and explanation of the work (how it works, how it is experienced, (if necessary) how it is made, etc.)
- Why we chose that artwork for analysis, and what we expect or hope to find by analysing it.

#### Analysis of the artwork

After the introduction, the analysis will follow. The analyses of the works are structured as follows.

The previously introduced matrix will be filled in according to the specifics of the artwork.

The matrix consists of 6 columns categories, and 4 rows.

#### Column categories:

1. Artwork (its subjects, media, systems, individual parts, etc.)

- 2. Artist (the maker of the work)
- 3. Performer (the one(s) performing or executing the work)
- 4. Audience (the ones experiencing the work)
- 5. Environment (external input from the environment in which the work is situated)
- 6. Sum of parts (interactions, how all elements relate to each other, etc.)

Rows:

(E) Elements: what element(s) are involved in the artwork?

(R) Roles: what role(s) do the elements have in the artwork?

(AA) Autonomous Ability: how autonomous can the element perform its role in the artwork? Used measurement for this, is a six-step scale ranging from "Not Applicable" to "Very High". Full scale being:

0: Not Applicable (N/A)

1: None

2: Low

3: Medium

4: High

5: Very High

(AS) Artistic Significance: how artistically significant is the element's role for the artwork as a whole? Similar to AA, the applied measurement for this, is a six-step scale ranging from "Not Applicable to "Very High".

First, all the cells in the row "Elements" will be defined, starting with the elements of the Artwork itself (Column 1), ending with the elements of the Sum of Parts (Column 6). It is possible that more than 1 elements for every column can be defined in an artwork. This will create "sub-columns" under the element category. Multiple sub-elements are most common under the Artwork column, but can also be defined for every other category. For example: next to multiple Artwork elements, a work can also consist of multiple Performers, or multiple Environments. The framework allows for adding these elements, so they can be included in the analysis.

Second, the row "Roles" will be defined, in the same order as the row "Elements" (first Column 1, then 2, until 6).

Third, the row "Autonomous Ability" will be defined, and fourth the row "Artistic Significance", all in the same order.

All cells receive a code tag, an alphanumeric string that corresponds to the column number (and if applicable: affix letter), and the row letter. This will help referring to cells and their content without forming wordy sentences in individual cells, keeping the matrix compact and concise.

Format of the code tag for each cell will thus be: [ColumnNumber + ColumnAffix]/[RowLetter(s)] Example, code tag for the cell describing the third Artwork Element is 1c/E. Code tag for the cell describing the autonomous ability of the first Environmental Element in the artwork, is 5a/AA. This way, each cell in every matrix has a unique code tag that can be used for referral throughout the matrix itself, and conclusions.

#### Conclusion of the analysis

After the matrix is completed, we will conclude our findings. Every conclusion will be structured as follows:

The generative - we will examine where the generativity in the artwork takes place. This is done relatively straightforward, by filtering in which cells of the row "Roles" in the matrix concepts appear like 'inventing', 'designing', 'altering', 'changing' 'creating', 'producing', or 'emerging'. We call these terms "generative concepts" in this framework. The presence of one or more of these generative concepts in a cell, indicates that the corresponding Element inhibits generative properties itself (i.e. is an active factor in creating & emerging something that was previously not there), which we then call 'generative elements'. Are generative concepts absent in the /R cells of an Element, then we call these passive or non-generative elements, meaning that the element can be part of a greater system that creates & emerges elements, or is a passive factor ('building block') in creating & emerging something).

Subsequently, we trace the code tag from cells with generative concepts in the rest of the matrix, to see if they reappear in other cells, and if so: where. If they reappear in other cells, we note this in the conclusion as an (inter)dependency. This way, we can evaluate the generative impact of the corresponding generative Element, on other Elements.

*The Autonomous Ability (AA)* - next, the autonomous ability of the generative elements will be determined. This will be done by filtering the content of the /AA-coded cells on their score. Cells (and thus their corresponding Element) with a low score (N/A to Medium) of AA are not autonomous elements, and cells (i.e. Elements) containing a high score (High to Very High) are considered

autonomous. We will examine how autonomous the generative elements are compared to the other elements in the work.

The Artistic Significance (AS) - lastly, the artistic significance of the generative elements will be determined. Similar to their autonomous ability, this is done by filtering the content of the /AS-coded cells on their score. Cells (and thus their corresponding Element) with a low score of AS (N/A to Medium) are considered not significant elements for the artwork as a whole, and cells (i.e. Elements) containing a high score (High to Very High) are considered significant for the artwork as a whole. Similar to autonomous ability, we will then shortly examine how artistically significant to the work as a whole the generative elements are compared to the other elements in the work.

In the next sub-chapters, we will proceed with the analyses of the selected artworks.

# 5.1. Mobile (c. 1932), Alexander Calder

Type: Sculpture

Medium: Metal, wood, wire and string

Dimensions: Unconfirmed:  $1500 \times 2000 \times 2000$  mm

Location: Tate Gallery Archive, United Kingdom Source: <u>https://www.tate.org.uk/art/artworks/</u> calder-mobile-l01686

#### Description

Mobile created by Calder. Tate description: "By suspending forms that move with the flow of air, Calder revolutionised sculpture. Marcel Duchamp dubbed these works 'mobiles'. Rather than a solid object of mass and weight, they continually redefine the space around them as they move. Calder's subtle balance of form and colour resulted in works that suggest an animated version of paintings by friends such as Joan Miró." (Tate, n.d.)

#### Why this artwork?

Calder's mobiles are delicate structures and good examples of Kinetic Art, art that involves movement or has an element of motion. "Artists making kinetic art may use motors to produce motion or may structure the work so that it is responsive to the natural movement of air currents." (MOMA, n.d). Because of the approach of taking external, unpredictable components (i.e. airflow) into account for the work, deliberately giving them an important role (e.g. initiating a process, or setting something - literally - in motion) and even carefully considering the properties of that external element (speed, force, etc.) in effect to the other components (in this case string, plates, spheres), arguably makes this work an example of generative art. One could see the mobile as a delicate system, that generates new compositions of the balancing elements based on certain rules (physics) when new input (airflow) is received. We think this work might be interesting to review from the perspective of our framework. Can we indeed name this example of Kinetic art "generative"? What elements are generative, and how autonomous and significant for the work are they really?

[Proceed to Matrix #1]\*

Conclusion analysis "Mobile" (Calder, ca. 1932)

*The generative* - the matrix shows that most generative processes take place on the level of the airflow, environment, and the audience. As the cells indicate, these are responsible for the most creation and emergence in the work. But as we can see in row '/R', these elements are interdependent on each other, meaning the most generative properties are located at the sum of their parts (6/ R) and are thus arguably a generative system as a whole.

**COLUMNS (Element categories)** 

- 1 = Artwork Element(s)
- 2 = Artist Element(s)
- 3 = Performer Element(s) 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

#### ROWS /E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

Matrix #1			Mobile (c. 1932),	Alexander Calder		
	<b>1. Artwork</b> (its subjects, media, systems, individual parts, etc.)	<b>2. Artist</b> (the maker of the work)	3. Performer	<b>4. Audience</b> (the ones experiencing/witnessing the work, or participating in the work)	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)
ELEMENTS:	1/E. Steel wire, metal panels, wooden spheres, string	2/E. Alexander Calder	N/A (there is no performer involved, so therefore this column is not taken into account for the analysis)	4/E. The audience walking around the work	5/E. The air flow in the room where 1 is exhibited	6. The parts of the mobile (1/E) move by the subtle changing airflow (5/E) caused by people (4/E) walking through the room (5/E) and past the mobile (1).
<b>ROLE(S)</b> of the elements in the artwork	1/R. To catch the wind, in order to move slightly	2/E. Composing the mobile, choosing composition and balance between the elements. Designing the "system" of mobile, people, movement.	N/A	4/R. Observe the work, and by standing and walking in front of it, create a subtle airflow that initiates the mobile to move.	5/R. To displace the attached elements of panels, balls, strings from each other, so the work changes composition and perspective continuously	6/R. The whole of mobile, audience, environment and their interaction forms the generative system, and it is there to form a closed, self maintaining loop.
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	1/AA. Medium. Depends on 5/E in order to move. But inhibits a wide variety of compositions that are possible, which the mobile can adapt to independently. However, depends on the artist for creating the right shapes and surfaces for catching the wind, design choices that will dictate the range of behaviour of the mobile.	2/AA. Medium: lot of agency in making creative choices for the composition of the mobile. However, is depending on the "physics" of 5/E in combination with 1/E, to eventually create a balance that is interesting to experience. Needs to experiment extensively to understand interaction of 1/E with 4/E and 5/E.	N/A	4/AA. Very high, can choose how to observe & pass by the mobile (direction, speed, side of the mobile etc.)	5/AA. High; a natural airflow specific to the environment will be present, which makes this element autonomous. However, for a larger part, 5/E is generated by the presence of 4/E.	6/AA. Very high; Once the mobile is hanging, the system is able to work independently and infinitely.
<b>ARTISTIC SIGNIFICANCE</b> of the element's role for the artwork	1/AS. High, for both the visual composition, as for functionally catching the wind	2/AS. High, the choices of 2 in designing the 1/E and testing how the the balance is formed are important for the eventual composition and movement of the mobile.	N/A	4/AS. High; significant to the level that they are 'required' for more airflow, and thus movement of the mobile. But not significant in the sense of composition of the mobile, since the range of motion and thus composition is preciously determined by the artist.	5/AS. Very high. The airflow generates movement of the mobile. The movement of the mobile is eventually what creates the complete work	6/AS. Very high. The interaction of all the elements with each other is very artistically significant for experiencing the full work.



Mobile (ca. 1932). © 2021 Calder Foundation, New York / DACS, London, via Tate Gallery (n.d.)

Autonomous Ability  $(AA)^*$  - The elements that proved most generative in this work, also inhibit the most autonomous ability. The matrix shows that the airflow (5/R), the audience (4/R), and the mobile itself (1/R) are the elements to which is given a level of control in the work, and have the most 'creative freedom' in generating output.

Artistic Significance (AS) - together, the elements named above are the key influencing elements that will affect how the mobile behaves. This makes them artistically significant for the artwork as a whole. However, although one might argue that the artist (2/E) relinquishes control to the system of the mobile (1/E), audience (4/E) and airflow (5/E), and is therefore not artistically significant for the work as a whole, we would emphasise that the artist' contribution mostly lies in creating the 'grammar' (i.e. the language of the work, with its set confinements and range of possibilities) of the work. Based on the results of the analysis, this work by Calder might prove as an example of Generative Art when we take its definition strictly. It also shows that tracing its autonomous ability and artistic significance is doable for 'nongenerative' works, and that most of those aspects lie at the level of what one could call a the "system", or better: the sum of its parts (6/E). We might conclude that therefore, generally works that belong to the Kinetic Art movement, could arguably also be reckoned as examples of "generative art".

**COLUMNS (Element categories)** 

- 1 = Artwork Element(s)
- 2 = Artist Element(s)
- 3 = Performer Element(s) 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

# 5.2. Fidenza Collection (2021), Tyler Hobbs

Type: Digital Image / Print Media: series of 999 algorithmically computer generated graphics Location: Art Blocks, Ethereum Blockchain Source: <u>https://www.artblocks.io/project/78</u>

#### Description

Fidenza is the name of an algorithm programmed by visual artist Tyler Hobbs. The basis of the programme is a *flow field algorithm* (i.e. algorithms creating a virtual grid-like structure on a canvas. At each point in the grid, an angle is 'stored'. Lines can be drawn over these points, which will then follow the corresponding angles), that allows for the creation of organic, unpredictable and nonoverlapping curves.

The configuration of the flow field can be adjusted via different parameters, such as turbulence, long or short curves, or sharpness of the angles. Each configuration creates a different effect. Next to that, Hobbs added extra variable parameters to the algorithm, such as shape of the lines (thick or thin), colour (14 hand-selected probabilistic colour palettes), varieties of scale (small to jumbo XL, uniform or varying), shape segments, stroke style, collision check modes (strict to relaxed), and margin (distance from the edge of the image), making the algorithm highly versatile for generating different iterations.

The script of the Fidenza algorithm is deployed to the Ethereum blockchain, which means that no-one can alter or delete the programme: it is permanent, immutable, and verifiable (Hobbs, 2021). It also entails that collectors can now "mint" an iteration of Fidenza through the blockchain (i.e. they purchase an iteration in advance with cryptocurrency. After that, the script will generate the iteration). What the new iteration Fidenza will look like, however, is unknown until the minting is completed. As Hobbs (2021) says: "Nobody, including the collector, the platform, or the artist, knows precisely what will be generated when the script is run, so the full range of outputs is a surprise to evervone."

Once a new Fidenza is minted, it is stored on the same blockchain as a Non-Fungable Token (NFT) that can be acquired by collectors. Hobbs a priori set the total amount for iterations to be created with the script to 999, which were all minted in June 2021. Today, a set of 999 unique Fidenza's (Fidenza#0 until Fidenza#998 - together called the Fidenza collection) exist on the Ethereum Blockchain: all digital images with different implementations of the said features (composition, shapes, colour, scales, etc.). The pieces are individually auctioned as NFTs via platforms like Art Blocks (Art Blocks, n.d.) and OpenSea (OpenSea, n.d.). Since its launch in 2021, Fidenza quickly grew into a popular generative art project on these marketplaces. Prices for a single Fidenza currently range from 74 ETH (229,546.52 USD) (OpenSea, January 9 2022) to 888 ETH (2,754,558,240.00 USD) (OpenSea, January 9 2021). The most expensive Fidenza to date was sold for 3.3 million USD in August 2021, for an amount of then 1,000 ETH (Hayward, 2021).

#### Why this artwork?

We think Fidenza would be interesting for analysis, since it is a typical example of what one today would call "generative art": it involves a computer, a programmed algorithm, and it produces complex geometric visuals. It would be interesting to see if the "generative" in this work really takes place where one would normally expect it (at the algorithm). Moreover, some discussions exist around this type of art, in which one argues that the artist has either *no* control at all over the output of the algorithm, or that the artist has *all* the control over the output of the algorithm (Bailey, 2018). In terms of where the autonomous ability lies in this work, this seems an interesting ambiguity. Therefore, we will analyse Fidenza with our framework to see if we can answer these questions.

[Proceed to Matrix #2]

Matrix #2					Fidenza Collection	(2021), Tyler Hobbs				
		<b>1. Ari</b> (its subjects, media, syste	t <b>work</b> ems, individual parts, etc.)		<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	<b>4. Audience</b> (the ones experiencing/ witnessing the work, or participating in the work)	<b>5. Envir</b> (external input from the e work is s	<b>onment</b> environment in which the situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)
ELEMENTS:	1a/E. The existing flow field algorithm and its parameters (turbulence, angle sharpness, etc.)	1b/E. The added features to the algorithm by 2 (i.e. varieties of scale, shape, colour, margin, etc.)	1c/E. 999 individual artworks, each an iterations of the output of the Fidenza script (1a+b). 1c are all digital images (JPEG's).	1d/E. The physical prints of 1c	2/E. Tyler Hobbs	3/E. The collectors on the NFT marketplaces minting new iterations (1c) of 1a+b	4/E. Visitors of the Fidenza online project pages of the marketplaces (and additionally people who can witness a printed version of an iteration.) And NFT collectors who purchase and own an iteration of 1c (and additionally 1d).	5a/E. The Ethereum NFT blockchain	5b/E. Onchain NFT Marketplaces, such as Art Blocks and OpenSea.	6/E. 2 creates 1b, based on 1a. Then 2 writes 1a+b to 5a+b. Then 3 mints 1c, which are stored at 5a and auctioned via 5b. After that, 4 can view or purchase 1c via 5b. 1c will never leave 5a.
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To form the base on which 2 can develop his custom algorithm further	1b/R. To provide the main parameters that can be altered/ randomised, in order to generate the instances of 1c	1c/R. To function as the visual output of a specific iteration of the algorithm.	1d/R. To function as the physical output of a specific iteration of the algorithm.	2/R. To choose and experiment with the possibilities of 1a. Alter 1a and add them with 1b. Test which range of parameters provide the most interesting outcomes, and adjust the algorithm to that. In short: create the blueprint of the work.	3/R. To mint (i.e. purchase) the iterations (1c) of 1a+b via 5a. To receive the freshly minted 1b as an NFT. And to keep 1c in their virtual vault, or offer it for auction to 4 via 5b.	<ul> <li>4/R. To view, place a bid, or purchase 1c via 5b, after which 4 obtains proof of ownership (not copyright) of 1c.</li> <li>Additionally, 4 can</li> <li>choose to purchase 1d, store 1c in his virtual</li> <li>vault, or eventually resell</li> <li>1c by offering it for auction again to other members of 4 via 5b.</li> </ul>	5a/R. To store 1a+b on its virtual chain. To "wrap" and store 1c as NFT's on its virtual chain. To calculate and perform every transaction done via 5b between 3 and 4.	5b/R. To house the online auctions of 1c. To function as the mediator platform between 2, 3 and 4. To curate collections like 1c for 3 and 4. To gain publicity for 1c and 2.	6/R. The system of 2, 1a+b, 3 and 5 creates an interesting method of generating art, namely creating a priori unpredictable pieces (1c) to all parties, that are generated via a set of algorithms (1a+b), yet still all are unique and artistically interesting in their organisation.
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	<ul> <li>1a/AA. Medium; once the script is running, it can autonomously operate and generate output.</li> <li>However, its contents are altered in such way by 2, that there is hardly question of creative freedom of choice for this part of the script.</li> </ul>	1b/AA. Medium; once the script runs, it can autonomously generate output. However, the creative choices that the script can independently make, are limited to a degree, since 2 has predetermined a range in which the choices are to be made.	1c/AA. N/A; 1c does not have explicit generative nor autonomous properties, and is depending on 1a+b and 2 for its actual visual outcome.	1d/AA. N/A; 1d does not have explicit generative nor autonomous properties, and is depending on 1a+b+c and 2 for its actual visual outcome.	2/AA. High - 2 is solely responsible for making the creative choices in 1a-b/E, that constitute the visual grammar of the work. However, but does not have a creative choice in which parameters effectively to change for 1c. Also, the last steps of creating 1c is 'outsourced' to 1a+b	3/AA. Medium; 3 has the agency to initiate the process of 1c generation (mintig), a vital step in 6. However, this is the only action 3 can take for generating 1 (3 is by design (by 2) not autonomously able to influence what parameters will permutate & how in 1a+b.)	4/AA. Medium: all members of 4 are autonomously able to perform their said role. Yet, just like 3, they have no control over what is actually generated by 1a+b.	5a/AA. High; 5a by design has the technical infrastructure to operate its roles autonomously.	5b/AA. Medium; it depends heavily on 5a for autonomous operation. However, it does have autonomous agency in curating generative art projects and in deciding which to feature on its platforms: no other party than 5b decides this.	6/AA. High; The system of 6 is able to operate independently and responsible for a lot of creative choices that make up the work.
<b>ARTISTIC</b> <b>SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Medium; important as the structural, universal starting principle for the fidenza algorithm (1b). But less artistically significant for the 'grammar' of the work as a whole.	1b/AS. Very high; the variations in the features produced by 1b are what make 1c unique and playful pieces. Although 1c are all constructed within the same constraints of the script (1a+b), and thus all have the same visual grammar (making it a coherent series), the core artistic concept of the work is about the still extensive amount of possible outcomes that 1a+b altogether are able to	1c/AS. High; it is the visual output of the algorithm (i.e. the 'end product'), and the element 3 and 4 view and purchase as "the artwork".	1d/AS. Medium; it is the visual output of the algorithm (the 'end product') in physical form, and the element 3 and 4 view and purchase as a form of "the artwork". Yet, although a nice addition to 1c, printing an NFT (an artwork that is designed for and exists in the digital realm), is not the main artistic concept of the artwork.	2/AS. Very high; the developed visual grammar and the constraints with which 1a+b can generate 1c are key to the work, making the role of 2 very artistically significant for the work as a whole.	3/AS. Low; other than initialising the generation of an instance of the work, 3 is not artistically significant for 1. Since it has no influence on the contents of the permutations in any way, and thus does not have the ability to decide what the contents of 1c eventually will be, it is not artistically imporant for 1.	4/AS. Low; because of their minimal role in generating 1, the role of 4 is not artistically significant for the artwork as a whole. (nb. other than that, perhaps their role is important for generating the hype around 1, created on 5a+b).	5a/AS. High; without 5b and its technical properties & infrastructure, 1 could not be generated and exist the way it does. Because that is an important part of the concept of the work, 5a's role is artistically significant for the work as a whole.	5b/AS. Medium; its role is important for generating visibility for the project, and for establishing the notion that 1c is a coherent, limited series of work (which adds to the idea/mystery of "what is creatively possible with tools like 1a+b"). But for generating the actual content of 1c, it is not from any importance.	6/AS. Very high; the role of 6 contributes to the <i>idea</i> of an algorithm and the blockchain technology being able to produce unpredicted, surprising art, which is an important element to this artwork as a whole.



Fidenza#313, sold for 1,000ETH (3.3 million USD). Image via OpenSea: <u>https://opensea.io/assets/</u> 0xa7d8d9ef8d8ce8992df33d8b8cf4aebabd5bd270/78000313



Fidenza#597. Image via OpenSea: https://opensea.io/assets/ 0xa7d8d9ef8d8ce8992df33d8b8cf4aebabd5bd270/78000597

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Fidenza's being auctioned at OpenSea. January 9, 2021

Conclusion analysis "Fidenza collection" (Hobbs, 2021)

The generative - The matrix reveals that the 'generative' in Fidenza, lies at the level of the script and its environment (the Ethereum blockchain and the on-chain NFT platforms like Art Blocks and OpenSea). The script, through the blockchain, generates a fixed amount of unpredictable works that subsequently only exist on that same blockchain. Besides that this adds to the notion of scarcity, rarity, and element of surprise of the artworks (which are very important elements for the work), it also shows that the innate structure of these environments are necessary for generating the art. Making this interplay of generative elements (script and environment) key to both the concept and form of this generative artwork.

Autonomous Ability (AA)\* - Although this work seems to involve a lot of generative autonomous elements, the matrix shows that the autonomous ability does not necessarily lie at the level of the individual elements, but more on the level of the sum of their parts (6/E). As a system, the elements are responsible for much more creative choices in the whole process, and carry a lot more autonomy than individually. Artistic Significance (AS) - More interesting is it to look at the AS in this work. Contrary to where the AA takes place, the AS seems to lie at a different level, namely mostly at the Artist element. This might be explained by the specific method of generating the artworks that Fidenza involves. This method entails that in advance, the outcomes of all permutations by the developed script are unknown to both the audience and the artist, and that there is no step of curation or intervention possible between what the script generates as output and what the audience receives. Moreover, creating on the Blockchain involves a scale of output that is significantly larger than other generative methods. The Fidenza algorithm namely generates 999 individual pieces, a batch size much larger than average batch sizes of algorithmically generated art. Combined with the fact that there is no cherrypicking of output possible, this puts a lot of pressure on the artist for ensuring that the algorithm still generates 999 versions of unique, interesting, and exciting outcomes.

These factors arguably require a "new" approach to making generative art (which Hobbs coined as "long-form" generative art (Hobbs, 2021)), in which the key to producing interesting generative art lies in the quality of the pre-programmed algorithm. This inevitably makes the role of the artist very significant to the work as a whole, as also becomes clear in the matrix. In the /AS row, we can see that in essence, the work is about the extensive process of designing, testing, tweaking, and iterating of the algorithm and its features, in order to come towards a script that produces high quality variations of artworks that inherently includes a signature artistic 'grammar'. A grammar that is not only interesting within each individual piece, but also coherent over the collection as a whole. Which thus makes the artist's role more artificially significant for the work than the role of the environment or the algorithm. This arguably makes this artwork an example of a generative work where the artistic significance and autonomous ability of roles lie at different levels.

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

- 1 = Artwork Element(s) 2 = Artist Element(s)
- 3 = Performer Element(s)
- 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

# 5.3. Continuous Project – Altered Daily (1970), Yvonne Rainer

Type: Performance (dance)

Location: performed at multiple exhibitions and venues. Amongst other at the Whitney Museum on March 31, April 1 and 2, 1970.

Duration: full evening

Source: <u>https://whitney.org/collection/works/</u> 47091

#### Description

Minimalist dance performance by Yvonne Rainer and dancers of the Judson Dance Theatre. The piece was designed to alter and accumulate material with every performance since its original presentation at the Pratt Institute in 1969. For execution of the piece, an array of elements was used, such as conceptual roles, affects, states & modes of performance. But also texts, musical & film accompaniments, and objects were used and most importantly: instructions with constraints and permissions for assembling these elements. Rainer attempted "to invent and teach new material during the performance itself" (McShine, 1970), which allowed the performers to learn and teach new material on the spot. The actual (i.e. not choreographed) behaviour, interactions, and discussions of the performers and their choreographed performance were all part of the work, by which the piece eventually blurred the lines between the concepts of rehearsal and performance. Previous to each performance, the group of participating dancers received written instructions by Rainer, which stated what outfits they could/could not wear, what stage properties they could use, what sub-piece they could perform, what role (i.e. learning or teaching role) was assigned to whom, and if they performed this role solo, in duets or in trios (Rainer, 1974). The output of each performance would form the input for the following performance, the exact form ultimately depending on the performers themselves (Roy, 2010).

#### Why this artwork?

In the existing art research or writings about art, this work by Rainer is not mentioned as a generative artwork. In the exhibitions where it was performed, it was mostly placed in the context of experimental and avant-garde art practice (such as the evenings in the Whitney Museum of Art) and brought into relation with the Fluxus movement, which at the time was prominent in the art scene.

In addition, for the exhibition "Information" (1970) at the MOMA, the performance was selected from a perspective to question a human-centred techno-logic (Anderson, 2018), but was not address as a generative piece. In our view, however, this performance does exhibits generative traits: the creation of the artwork namely, is done through executing the set of rules of play (i.e. instructions by Rainer). In other words: these form arguably the selfoperating system to which a level control is attributed to, like in other generative artworks. Therefore, we think it would be interesting to analyse this work according to our framework, and see if we can reveal what is exactly generative in this work, and where this generative takes place, and what its autonomous abilities and artistic significance is.

[Proceed to Matrix #3]

Matrix #3				Continuous F	Project - Altered Daily (1970), Y	vonne Rainer			
		<b>1. Ari</b> (its subjects, media, syste	work ems, individual parts, etc.)		<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	<b>4. Audience</b> (the ones experiencing the work4. Audience (the ones experiencing/ witnessing the work, or participating in the work))	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)
ELEMENTS:	1a/E. The scripted units of material assembled by 2, i.e. texts, video and music excerpts, objects, roles, modes of performance, choreographed behaviour, etc.	1b/E. The unscripted units of material: improvisations, associations & unlearned behaviour added by the performers themselves in situ.	1c/E. Instructions formulated by 2 (i.e. sets of constraints and permissions) on how to assemble all units of material.	1d/E. The instance of the previous performance (memories, learned material by the performers, etc.).	2/E. Yvonne Rainer	3/E. A group of approx. 7 dancers, often including artist (2) (n.b. changing assembly for every performance)	4/E. The people present in the room to either a) watch the performance, or b) walk by in transit to another room or place in the room.	5/E. The room or the hall in which the performance is performed	6/E. 3 follows the rules of 1c set by 2. While doing so, 3 creates & performs existing and new material (1a & 1b) in interaction w/ each other, influenced by 1d.
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To function as a set of predefined building blocks 3 can work with in order to create 1.	1b/R. To form unexpected, random, new elements in order to create 1. Done by 3, and are new and unexpected for both 2, 4, and other members of 3.	1c/R. Function as guidelines/ rules of play for 3.	1d/R. Functions as a base from which (some members of) 3 can develop 1. The 1 that is subsequently created, will in turn be the base (1d) for the following performance of the piece.	2/R. Creating the blueprint of the work: setting up the rules of play (1c) & assembling units of material (1a). And eventually being responsible for the outcome of 1.	3/R. Interpreting and executing 1c. Performing or improvising with 1a and 1d. Create and add 1b. In total: generate a new instance of the artwork.	4/R. Experience the performance, & (passively) inspire/influence the performers in their acting/ decision making	5/R. Forms the -quite literally- physical boundaries for 3 to perform 1a tm d. The properties of the room (acoustics, size, height, lighting, decoration, etc.) are the conditions in which 3 need to work out 1a tm d in.	6/R. To form a codependent system, that generates new material which then becomes part of the work on the spot. This, together with the sequential character of the performance (output = input) enhances the idea of an evolving performance, in which every instance is inherently part of every following performance (artwork) as well.
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	1a/AA. N/A: there is no autonomous ability required to perform this role. 1a is predefined by 2 into a fixed set. It depends on 1c (and thus also on 2 and 3) for further (mode of) application in the work.	1b/AA. Medium: depends on 1c and thus 2 and 3 for (mode of) application)), but is not predefined and thus open & flexible for random creation. Making it a more autonomous element than 1a.	1c/AA. High: once defined by 2, the guidelines are a stand- alone element that don't require more than itself for implementation.	1d/AA. N/A: there is no autonomous ability required to perform this role.	2/AA. Medium: autonomous in making choices of how to design 1a & 1c. But, not autonomous in directing the development & outcome of 1, as that agency almost completely lies at 3.	3/AA. High: however 3 is bound to a set of rules (1c), which is limiting their AA, they do have AA and creative freedom in deciding what new material they 'generate' that becomes part of the performance (1)	4/AA. Low: the range of possibilities for influencing 3 is diminished by 1a tm d & the agency in decision-making by 3 themselves.	5/AA. High: 2 & 3 cannot change the properties of 5, and will have to work with its fixed parameters, which ultimately will influence the exact outcome of the performance as well.	6/AA. High: together the system of 1a tm d, 3 and 5 forms a autonomously operating whole, which moreover is mostly independent from 2 or other external inputs for being able to "work".
<b>ARTISTIC SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Medium: it forms a substantial, concrete part in 1, but in itself is not the most important element for the work as a whole. What 3 does with it, and how 3 implements, alters, performs 1a, is more important.	1b/AS. High: its role is conceptually important for 1: the core idea of the work is to generate & introduce unchoreographed, actual behaviour and improvisations of 3, that together will be part of this instance, and likely the next, etc., etc.	1c/AS. High: the rules of play are the backbone of the piece, and form a generative structure along which 3 can make decisions for 1a and b.	1d/AS. Medium: however 1d influences the creation of the new instance (1), and is important for the concept of seriality in the artwork, it in itself is not as important for the artwork as a whole as 1b & c.	2/AS. Medium: as creator of the structure/blueprint that allows 1 to be generated, 2 is important. But, what the work is about, is the random generation & the emergence of a new instance (1) by 3 & the development of the artwork over time as a serial piece. Therefore, 2 can be considered less artistically significant.	3/AS. Very high: the choices of the performers, their interpretations of 1a & c, and their actual behaviour in 1b & d is what constitutes and generates the instances of 1, making them and their role very important for the work as a whole.	4/AS. Low: the influence and interaction of the audience is not much part of the work, and is not what the concept of the performance is about.	5/AS. Medium: the properties of 5 form given boundaries for 2 & 3, which will likely affect the exact form of the performance. However, these are not the most important or decisive factors for in how 1 will eventually will look like. 3, 2, and 1a tm d are more significant for that.	6/AS. Very high: the emergent properties of the system of 1a tm d, 3, and 5, and its relative 'independency' from the artist (2), are very important for that specific instance of the work and for the concept of the work as a generative piece.



















It is not necessary to read this program prior to performance.	Budimentary Notes Teward & Changing View of Performance
MBITNET MUSEUM OF AMERICAN ANY March 31, April 1, Mpril 2, 1970	Levels of Performance Reality:
CONTINUOUS PROJECT-ALTERED DAILY	B. Secondary: Performing comeons else's material in a style approximating the crisical or events is material in a style
BY YVCNNE SAINER	"genre".
Farfarmed by	<ol> <li>Tertiary: Performing nomeone else's material in a style completely different from, and/or ineppropriate to, the original.</li> </ol>
Becky Arnold, Donglas Durn, David Gordon, Barbara Lloyd, Steve Paxton, Twoane Rainer and others.	Elements used in Continuous Project (not all of the Following occur Guing any one performance)
Objects and "body adjurcts" by Deborah Hollingworth Films by Jack Arsaid (The Incredible Strikking Man) Michael Jack (Connector Behmansal) Fills Billock (Enc) Sound supervision by Cordon Hamma	<ol> <li>Rehearsal: Performance of previously learned material that is not in pollshed condition (i.e., has form insefficiently rehearsed), thereby merge- sitating verbalizations, repeate, arguments</li> </ol>
THE AUDIDACE IS INVITED TO GO TO ANY AF THE THREE PERFORMANCE AREAS AT ANY TIME. MOMPHUME, PARADREE ON SOM VAREA ACADOS THE RAILCHNANCE AREAS AT BUT PROCEED ANOLOGI THE PERFORMETOR ALCHES THE WALLS TO GET PARA ORE PLACE TO ANOTHER.	"(naving been testal itself ary be re-learned (naving been testal itself at a realiser date) or may be having a first ark arking and have in which case all the "kinks" may not have been worked out [cf. "working out").
Continuous Fucient-Alternational taily takes its name from a sculptural work by Abbert Mostle. It has altered and accumulation corr (gradually since its original presentation as a 30-minute scalaert with the scalaert at Prest institute in March 1969. It was there that I first attempted	<ol> <li>Pun-thrus Polished parformance of material. May involve verbalising because of pre-arranged mingmatr or actual response during performance. (See "Behavior").</li> </ol>
ensued was an coupling article fill during the performance limit. Whet our working-out and refining - to examin a what yoos on in the reheatmal - and a growing akopticism about the newsarity smally Dimension performance, find between these two phenomena. A curious by-prodicit of the second	<ol> <li>Morking Oat: Creation of new material is performance. It may result in intense response-bulkarions line of activity. It can resemble "Penhassal" and may involve "Seaching".</li> </ol>
beginning of a realisation on my part that various controls that they using to are becoming obsolcts: such as determining sequence of events	<ol> <li>Surprises: Naterial (objects, activity) introduced without previous knowledge of all the yer/ormers.</li> </ol>
The fact that my decisions have become increasingly infinenced by the table fact that my decisions have become increasingly infinenced by the responses of the individual members. Although it cannot be said that Continuous Projest is the result of group decision-making as a whole, it is important to point out that there are details throughout the work the membersue to list their should be predied by the throughout the work the membersue to list the should be predied by the throughout the work the membersue to list the should be predied by the throughout the work the membersue to list the should be predied by the throughout the work the membersue to list the should be predied by the throughout the work the membersue to list the should be the state of the the the the throughout the work the through the through the through the throughout the work the through the through the through the throughout the work the through the through the through the throughout the work the through the through the through the through the throughout the work the through the the through the through the through the the	<ol> <li>Marking: Performance of previously learned material in the absence of some of the conditions necessary for polisied performance, much as adequate span proper number of performers, proper expenditure of energy etc.</li> </ol>
Assertiveness other than my own, or to the manner is which temporares and to work together, i.e., transly exchanging opinions and associations about the work as it develops.	<ol> <li>Teaching: A performer teaches previously learned material to one or more performers who do not know it. of Choreographer invents new material.</li> </ol>
I gratefully acknowledge the assistance of the John Sman Roundation in the form of a felloweity, which during the past year has permitted as to work unbarrased by the fact that in normally do not aske	<ol> <li>Behavior:         <ul> <li>Actual: individual gesturel and vertual actually spontaneously occurring in performance of a predetomined situation. Can occur during any of the above or is "5".</li> </ul> </li> </ol>
e every et and 1 db.	b. Choreographed: bahavior that has been obser- ved, then learned, edited, cr stylired prior to performance.

Excerpt of the Flyer for the Continuous Project - Altered Daily performance at the Whitney Museum of American Art. Image via the exhibition catalogue of "Information" (1970) at the Museum of Modern Art (McShine, 1970).



Instructions to the performers (Rainer, 1974).



Pictures of the performance at the Whitney Museum of Art, 1970 (Rainer, 1974).

#### Conclusion analysis "Continuous Project -Altered Daily" (Rainer, 1970)

The generative\* - When analysing the individual parts in this work, we realised that there are more elements involved in establishing the artwork than previously expected. Next to the scripted material (1a/E), the instructions (1c/E), Rainer herself (2/ E), and the performers (3/E), which are probably the more obvious elements, the instance of the previous performance (1d/E), the audience (4/E)and the environment (5/E) are also worth mentioning as elements, as they form parts which 1a-c/E, 2/E and 3/E rely their actions on. As the cell in dictating the Sum of Parts (6/E) subsequently shows, this makes the work a more complex whole, and an intricate system in which each element influences the other. In short, the most generative properties lie at the levels of the unscripted material (1b/R), the instructions by Rainer (1c/R), Rainer herself (2/R), and the performers (3/R).

Autonomous ability (AA) - The role of the artist (2/R) seemingly gives the artist (2/E) a lot of autonomous ability, for 2/E decides 'the scores' (1c/E) which form the blueprint for the outcome of 1. We can thus think of Rainer's role (2/R) in this work as that of a musical composer: Rainer writes the 'scores' (1b/E) for every 'musician' (3/E), which then are executed by the musicians (3/E) creating the actual instance of the work. Therefore, we would expect that 2/AA would be high. Similarly, as 3/E is restricted by the formulation of 1c/E (decided upon by 2/E), we would expect that 3/AA would be low. The opposite however seems true: the analysis shows that 2/E is more depending on 3/E and their creative input to establish 1b/E and 1d/E, than 3/ E is depending on 1c/E to perform 3/R. In other words, the 'musicians' are responsible for the largest part of the creative decisions in this work, which mean they have significantly more creative agency than 'musicians' in traditional musical compositions. This makes 2/AA lower, and 3/AA higher.

Artistic Significance (AS) - Similarly, we would expect that 1c/AS and 2/AS were the highest in this work, as we expected that a large part of the creative decision making would lie at 1c/E and 2/ E. But also here the opposite seems true: the analysis shows that the contribution of 3/E is from more artistic importance to 1, than the contribution of 1c/E and thus 2/E. This makes 3/ AS (and subsequently 1b/AS and 1/dAS) higher than 2/AS and 1/aAS.

What we see in this analysis, is that a large artistic contribution to the work as a whole lies with the role of the performers. Although Rainer provides the structure for the work (the blueprint, so to say), the performers are still from key influence (if not from most influence) in deciding the outcome of the actual performance.

In this work, the performers are deliberately given an important role by Rainer, and lots of autonomous agency to perform that role. They are encouraged to come up with new material, are allowed to express or mould that in the way they desire, and can even teach or learn (i.e. show actual non-choreographed behaviour) "on stage" during the performance. What is amplifying this content generation, is the fact that the group of performers change in assembly for every performance. This increases the factor of randomisation and "outsourced control" within the artwork, aiding its generative character. In other words: the artwork this way keeps on evolving or "generating", instead of staying the same over performances and not creating new elements anymore (i.e. the work is in itself continuously "generating" instead of being "generated").

We think that this analysis shows that this work does contains generative and even emergent properties, since its elements altogether form an intricate system that is able to continuously create and instantiate new material for the artwork, which makes this work an interesting case for generative art.

**COLUMNS (Element categories)** 

- 1 = Artwork Element(s)
- 2 = Artist Element(s)
- 3 = Performer Element(s) 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

# 5.4. Structure de Quadrilatères (1985), Vera Molnár

Type: print

Media: computer generated graphic in ink on Calcomp plotter paper

Dimensions: 11 1/2 x 13 7/8 inches (29.2 x 35.2 cm)

Location: Senior & Shopmaker Gallery, New York City (US)

(Shopmaker, 2019)

#### Description

Graphic print by Vera Molnár. Molnár (schooled as a painter) is known for her geometrical computergenerated drawings, inspired by Russian constructivists, as well as Piet Mondrian and Paul Klee.

Molnár experimented with system-based art, and created hypothetical programmes (di Cutò, 2018) that ("Machine Imaginaires") contained mathematical rules determining the placement and colours of the lines (Yau, 2018). By changing the parameters of those rules in small increments, she produced endless variations of output. Initially, she calculated the permutations herself (sometimes using chance as a rule to direct the composition of colours and shapes in her work). But in the late 60's, she gained access to computers and plotters by which her imaginary program of algorithms could now be effectuated by a real machine: the computer itself. This specific drawing (1985) contains a grid of multiple black, irregular squares drawn on top of each other, with slights changes in placement and shape, creating a disordered grid that appears darker and heavier at some rows than others.

#### Why this artwork?

Molnár is generally considered as one of the leading pioneers of computer-generated art that had its influx in the 1960s. As many computer art artist at that time, she used a computer, plotter and a self-written programme to make abstract drawings. However, what makes Molnár's works different from the works of other generative art artist at that time, is the alternative approach she uses for making the drawings, which Molnár calls her "conversational method" (Molnár, 1975). This method entails that "instead of making a parameter change and then waiting for a drawing to be plotted (the plotting operation may require several minutes or several hours, depending upon the size and complexity of the picture), I make the parameter changes quickly while viewing the images on the CRT screen. I select only a few of the images shown on the screen for recording by the plotter." (Molnár, 1975 p. 187). Whilst this method of making computer generated images is now more common practice, in the 1960's and '70s it was not due to the lack of real-time visual output devices: only half-way the 1970's CRT computer monitors became widely available. For making generative art, this meant that iterating on a work was a much slower process, since there was no possibility to review the outcome of the programme before it was already fully printed. While most artist embraced this as a factor of serendipity in their work (amongst others Mohr, Nake), Molnár chose to use adopt the possibility of intermediate reviewing the output and adapting the programme accordingly. This made Molnár's method arguably a more shorter, nimble, and intuitive way of generating images with the computer. Effectively, this also means that Molnár uses an extra step of curation in the process of creating her art: she selects only the images that she sees fit for printing. We thus think this method can influence both the autonomous ability and the artistic significance of many elements in this work. Molnár's work traditionally is regarded as being "generative" in which a lot of autonomy is attributed to the computer. We think it would therefore be interesting to analyse Molnár's art through the lens of our framework. Perhaps we can check if the commonly ascribed autonomy by critics and researchers to the computer and algorithm in Molnár's work would holds up in our framework as well.

[Proceed to Matrix #4]

#### Conclusion STRUCTURE DE QUADRILATÈRES (Molnár, 1985)

For this work, we deliberately listed more elements under column 1, than for example in the analyses of artworks "Fidenza" and "Memories of Passersby I" which technically also involve a computer and monitor. However, in these artworks the computer and monitor play a significantly smaller role for creating the artwork than they do in Molnár's work. For Molnár, these elements were relatively new, and an integral part of her method. Also, in most research and documentation about Molnár's work, critics attribute a lot of autonomy is attributed to the computer. To therefore name the computer explicitly in the framework as a separate

Matrix #4					Structures	de Quadrilatères (1985), V	/era Molnar				
		(its subjects	<b>1. Artwork</b> s, media, systems, individua	ıl parts, etc.)		<b>2. Artist</b> (the maker of the work)	<b>3. Per</b> t (the one(s) performing	f <b>ormer</b> or executing the work)	<b>4. Audience</b> (the ones experiencing/ witnessing the work, or participating in the work)	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)
ELEMENTS:	1a/E: the imaginary image or idea of 1c/E by 2/E	1b/E. The programme containing the algorithm with parameters designed by 2/E	1c/E: the iterations of output of 1b/E, calculated by 3a/E.	1d/E. The computer monitor (CRT screen)	1e/E. The physical black & white print with lines and squares	2/E. Vera Molnar	3a/E. The computer	3b/E. The plotter	N/A (4 does not have an explicit role in creating 1, and is therefore not taken into account for analysis)	N/A (5 does not have an explicit role in creating 1, and is therefore not taken into account for analysis)	6/E. 2/E invents 1a/E, and aims to recreate this with 3a+b/E via 1b/E. 2/E iterates on 1b/E after seeing 1c/E via 1d/E. 2/E selects the final 1c/E, and let's 3a/E print 1e/E via 3b/E.
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To form 2/E's mental model of what 1d/ E could look like. To be the basis for 2/E design of 1b/E.	1b/R. To provide the rules and parameters that 2/E can alter in order to eventually achieve 1d/E. To instruct 3a/E what to calculate.	1c/R. To form the visual output of 3a/E's calculations of 1b/E.	1d/R. To function as a real time output device via which 2/E can view a digital representation of 1c/E.	1e/R. To function as the physical output of the final iteration of 1c/E.	2/R. To invent 1a/E. To design 1b/E. To iterate on the design of 1b/E after seeing 1c/E via 1d/E. To select the final version of 1c/E to be printed as 1e/ E.	3a/R. To execute 1b/E, and produce 1c/E.	3b/R. To print 1d/E	N/A	N/A	6/R. To create a system that facilitates a dialogue between 2/E and 3a/E, which ultimately results in generating 1.
AUTONOMOUS ABILITY of the element to perform its role	1a/AA. N/A (1a/E is a passive factor with which <i>is</i> created, rather than is creati <i>ng</i> )	1b/AA. High; is able to operate autonomously, and generate output that was not existing previously. However, depends on 2/E for its contents, and on 3a/E for its execution.	1c/AA. None; however changing in form with every iteration by 2/E, it does not have the ability to transform itself (depends on the content of 1b/E decided by 2/E)	1d/AA. None; it has no other option than to show 1c/E (in its exact form)	1e/AA. N/A (is a passive factor, that is created)	2/AA. Very High; holds a lot of creative freedom in many stages of generating 1; inventing 1a/E, altering 1b/E & selecting 1c/E for 1e/E. However, does make creative choices for altering 1b/E depending on what 3a/E creates (1c/ E) after executing 1b/E	3a/AA. Medium; can perform 1b/E independently, and has some creative choice in how 1c/E will look, as the script of 1b/E allows for a controlled level of randomisation. However, freedom of choice might be controlled or undone by 2/E.	3b/AA. None; cannot operate 3b/R without being controlled by 3a/E, and has no creative freedom in what to print.	N/A	N/A	6/AA. Medium; Once the infrastructure of 6/E is established, 6/R can flow independently. However, 2/E has such a decisive role in initiating, maintaining, and operating 6/R, that it diminishes the AA of 6/E as a whole.
<b>ARTISTIC</b> <b>SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Medium; however it is the initial idea that kickstarts the process of 6/E, and is the starting point for designing 1b/E, it is altered too much by 2/E in dialectic with 3a/E to be from high significance to 1 as a whole	1b/AS. Very high: it contains the 'grammar' that dictates how 3a/E should perform and thus what to create as 1c/E.	1c/AS. Medium; the process to get from iteration#1 to the final one is artistically important for the work. But, the individual iterations of 1e/E self are heavily curated by 2/E, resulting in most iterations being discarded, and thus not significant for the final version of 1e/E.	1d/AS. High; is very important for 2/E to provide immediate feedback on design decisions in 1b/E, and thus also for the iterative process of 6/E as a whole.	1e/AS. High; is the final, curated output of 1c/E (the 'end product') in physical form, and what is presented by 2/E as "the artwork".	2/AS. Very high; the decisions made in 2/R affect significantly what 1 results in. Moreover, the curation by 2/E that is involved in this method means a larger artistic significant role of 2/E in the artwork as a whole.	3a/AS. High; is a crucial tool for effectuating 2/E's 'ideas' (i.e. calculating the permutations of 1c/E designed by 2/E), and therefore also important for the method of 2/E in generating 1 as a whole.	3b/AS. Medium; is important for physically producing 1e/E. But less important than 3a/E for the iterative process of 6/ E.	N/A	N/A	6/AS. Very high; the interaction between 2/E, 1b/E, 3a/E & 1d/E dictates what 1c/E and thus 1e/E as final artwork looks like, making 6/R very artistically significant for the artwork as a whole.







STRUCTURE DE QUADRILATÈRES (SQUARE STRUCTURES), 1985. Computer generated graphic in ink on Calcomp plotter paper, 11 1/2 x 13 7/8 inches (29.2 x 35.2 cm). Image retrieved via Shopmaker (2019)

element, we allow ourselves to specifically analyse the role and interdependencies of this element in the work as such, with which we could check if the attribution of autonomy by critics is valid.

Similarly, the monitor is an important element in the 'conversational' method of Molnár for generating art: through this, Molnár can perform her dialogue with the machine and intervene in the steps between the programme producing output and the plotter printing the eventual work. We assumed this would impact the artistic significance of the role of Molnár. Therefore, we also took the monitor into account as a specific element in our framework, to more carefully analyse this, and eventually reveal if this assumption is true. We will now elaborate if we could corroborate this assumption.

*The generative*<sup>\*</sup> - as we can see in the matrix, the most generative properties are located at the elements of the programme Molnár wrote containing the algorithms with parameters (1b/E),

the computer as tool for executing this programme (3a/E), and Molnár herself (2/E). Of all elements, these are the active generative factors in this work, i.e. responsible for the most generation of new elements in the context of the work, as we can see in 1b/R, 2/R, and 3a/R. However, next to individually having generative properties, the matrix shows that these three elements in interaction which each other are responsible for even more creation. As 6/E and 6/R shows, these therefore form what we could call the 'generative system' of the work, that is able to generate more in this artwork than the sum of its parts.

Autonomous Ability (AA) - The matrix however shows that not all of the elements in this 'system' have the same level of autonomous ability. The creative freedom in generating new elements, namely, seems not equally divided over the system's parts. 1b/AA and 3a/R show a greater creative dependency (on 2/E), whilst 2/AA shows a high level of creative independency. This means

**COLUMNS (Element categories)** 

- 1 = Artwork Element(s)
- 2 = Artist Element(s)
- 3 = Performer Element(s) 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

# $\label{eq:expectation} \begin{array}{l} \text{ROWS} \\ /E = \text{the concerning element} \\ /R = \text{the role of the element in the artwork} \\ /AA = \text{the Autonomous Ability of the element} \\ /AS = \text{the Artistic Significance of the element} \end{array}$

that most creative freedom in choices, and thus autonomous ability, lies at the level of the artist. Which means that through the lens of our framework, the computer does not have the amount of autonomy that most other studies would claim.

Artistic Significance (AS) - From the matrix we can conclude that the high level of autonomous ability for 2/E, significantly impacts its creative contribution to the artwork as well. 2/AS compared to 1b/AS and 3a/AS shows that the role of 2/E is more important to the work than the role of 1b/E and 3a/E. Mostly because 2/E, through her design choices for 1b/E, decides on the artistic grammar of the work (how many squares, how much distortion, overlap or distance of the squares, how much order vs. disorder is present in the composition, etc.), which is of great artistic important of the work. But, as 2/AS shows too, also because of the specific ("conversational") method 2/E uses to generate 1 as a whole, 2/E's arctic significance is the highest compared to that of other elements. Because of the extra curational, iterative steps of selection, alteration, testing that the method includes, the artist is from key importance in determining what eventually will be the artwork itself. We do see however in 1d/AS, that 1d/E is an important element that contributes to this. Which shows that the computer monitor (1d/E) indeed is an artistically significant element for this work as a whole.

Over all, Molnár's method is often called a more instinctive approach "that enables greater receptiveness to the unpredictable" (di Cuto, 2018) that would prevent premeditation of the work. We think that our results show that one could also interpret Molnár's work as the opposite *because* of her conversational method: for how "unpredictable" is the outcome of the work truly, if the outcomes of the programme are heavily reviewed and curated in the process by the artist herself?

#### 5.5. Memories of Passersby I -Companion Version (2018), Mario Klingemann

#### Type: Installation

Media: Composition of multiple GANs. Custom handmade chestnut wood console that hosts the AI computer brain and additional hardware. Wood console: 70 x 70 x 40 cm. Two 65" screens ( 3840 x 2160 ) custom framed. Each framed screen: 152.2 x 89.2 x 7.1 cm.

Location: ONKAOS Gallery, Madrid (Spain).

(Artsy, n.d.)

Source: <u>https://www.artsy.net/artwork/mario-klingemann-memories-of-passersby-i-companion-version-1</u>

#### Description

"Memories of Passersby I" is an autonomous machine that uses a system of neural networks to generate a never-ending, never-repeating stream of artistic portraits of non existing people (Artsy, n.d.). More specific, a system of Generative Adversarial Networks (GANs), in which two sets of neural networks are trained simultaneously, namely a generative model G (i.e. "the generator", capturing the data distribution), and a discriminative model D (i.e. "the discriminator" that estimates the probability that a sample came from the training data rather than from the generator model) (Goodwill et al., 2014). Essentially, these two networks are pitted against each other: based on the training data (in case of Memories of Passersby I: a dataset of digital images of painted portraits by Western European Masters (Onkaos, 2018)), G creates its own representation of a portrait. This image is then 'presented' to its adversary D, which determines whether this sample is an image created by G (i.e. a fake portrait), or if this a copy of an image from the dataset (i.e. an original portrait).

In other words, G functions as team of art foragers and D as a team of art critics & police men (Goodwill et al., 2014). Through back propagation, the GANs are able to learn from their errors and improve their method, which eventually will result in the output data of G being closer to the original data of the training dataset (Goodwill, et al, 2014). What we see on the video panels of Memories of Passersby I, is this real-time learning: "the flow of images presented does not follow a predefined choreography but is the result of the AI interpreting its own output" (Artsy, n.d). Because of the feedback loop in the GANs, no image will be repeated in the installation, which means that Memories of Passersby I will keep on generating endless varieties of "artificial" and unique portraits.

#### Why this artwork?

As more artworks are made through GANs, the discussion on whether computational systems can be creative, and if so: on what level, increases too. Because of their architecture, GAN's are generally viewed as highly autonomous systems, that cannot only function as a medium to produce art with (like with any other algorithm) (passive, quantitative), but is also able to learn how to create art independently (i.e. without interference or curation by the artist - active, qualitative). At first glance, next to the notion of the system as an autonomous agent, this also seems to inherently make the system itself highly important for the creation of the artwork as a whole. In effect this would make GAN-artworks both highly autonomous, as artistic significant. We are therefore interested to see what analysis through the lens of our framework would result in: does it indeed show that all the autonomous ability and artistic significance take place at the level of the GAN? Can we dissect more aspects that play a role in this, and if so: on what level are they important to the work?

#### [Proceed to Matrix #5]

### Conclusion of analysis of Memories of Passersby I (Klingemann, 2018).

The generative\* - The results in the matrix show that there are many generative aspects in this work. Many generative process take place at the level of: the G model of the GAN (1a/E), the dynamic visualisations of the successful samples (1f/E), the artist (2/E). To lesser degree, the generative processes take place on the level of: the D model of the GAN (1b/E), the application (1c/ E). But foremost: the most generative processes take place at the level of the sum of all elements (6/E). This indicates that individually, all elements inhibit some sort of generative behaviour or properties, but that this is only kickstarted, facilitated or enhanced by the behaviour of another factor. In the matrix, we can see these interdependencies in the row "Roles" (/R) for al generative elements. E.g. the G model of the GANs relies on the dataset (1d/

E) for its training, and requires input from the D model for iterating on its method, and vice versa. The D-model makes decisions based on guideline instructions defined in the application (1e/E), designed by the artist (2/E). And the content of the generating visuals (1f/E) is defined by the choice of 1b/E when discriminating the sample data (1e/E) generated by the G model (1a/E). Together therefore, these elements form the generative system in this work. Remarkably, the matrix indicates that most of the elements in this system, are listed under column 1 (the artwork). This shows that the generative system in this work, is a system that is rather "closed", i.e. does not involve much input from other elements outside of the Artwork elements (such as Audience, or Environment). Moreover, the inherent feedback loop that is present in this system, facilitates that the system (6/E) can continuously iterate on itself and thus indefinitely create new output. Meaning that we can classify Memories of Passersby I as a work that is generating, rather than generated.

Autonomous Ability (AA) - how autonomous this system is compared to other elements within the work, we can see at the /AA coded cells in the matrix. These cells show that most AA is attributed to indeed the system (6/AA), and to one of its individual elements (G model GAN, 1a/E). However, the artist too scores a high AA, mainly due to its substantial amount of creative freedom in its role of designing the application (artist decides what guidelines for aesthetics are the rules for discrimination by the D model), incorporating the GAN in the application, deciding the physical features of the artwork, and moreover: collecting and curating the dataset on which the GAN is trained (2/R). Although the artist relinquishes some degree of control (2/AA) over the artwork by not being able to intervene in the outcome of the GAN (1f/E), these said creative choices are from such substantial scale, that this affects the AA of the generative system in the work.

- 1 = Artwork Element(s)
- 2 = Artist Element(s) 3 = Performer Element(s)
- 4 = Audience Element(s)
- 5 = Environmental Element(s)

\* LEGENDA MATRICES

#### ROWS /E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

<sup>6 =</sup> Sum of Parts

Matrix #5					Memories o	f Passersby I - Companie	on Version (2018), Mario	Klingemann				
			(its subjects,	<b>1. Artwork</b> , media, systems, individu	al parts, etc.)			<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	<b>4. Audience</b> (the ones experiencing/ witnessing the work, or participating in the	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of</b> (interactions, elements relate other, et
ELEMENTS:	1a/E. GAN - G model	1b/E. GAN - D model	1c/E. Application/ programme	1d/E. Training data (images of paintings)	1e/E. G samples (generated images by 1a/E)	1f/E. Animated visualisations of successful G samples	1g/E. Physical objects: two 4k screens, wooden case, chair	2/E. Mario Klingemann	3/E. The computer	4/E. The audience experiencing 1 via 1g/E in 5/E	5/E. The room 1 is exhibited in, and its properties (lighting, size, acoustics)	6/E. 2 choose designs 1c. trained or generates discriminate successfully pa is added to made experie for 4 via
<b>ROLE(S)</b> of the elements in the artwork	1a/R. Generates 1d/E, based on its training on 1c/. Adjusts its method depending on discrimination of 1d/E by 1b/E.	1b/R. Discriminate wether 1a/E presents a generated image (1e/E), or a copy of the original from 1c/E. Subsequently, passively decides which samples of 1e/E will be represented as 1f/E on 1g/E.	1c/R. To form the set of rules that instruct how 1a+b/E are implemented and process 1d/E, and generate & discriminate 1e/E.	1d/R. The dataset of digital images of paintings on which 1a/E is trained. Is collected, curated, and formatted by 2/E.	1e/R. Set of images (i.e. samples) generated by 1a/E, that contain images of 1d/E and images generated by 1a/E, based on 1d/E. Is virtually presented by 1a/E to 1b/E for discrimination.	1f/R. Visual representation of the 1d/E samples that successfully passed the discrimination by 1b/E. Showed as a continuously evolving, animated sequence (video) on screens of 1g/E.	1g/R. To function as both practical (house the hardware of 3/E, display 1f/E) and decorative elements that enhance the experience of 1 to 4/E.	2/R. To select and alter 1a+b/E. To design 1c/E. To collect, curate & format 1d/E. To design 1g/E.	3/R. To execute 1c/E.	4/R. To experience 1 via 1g/E in 5/E	5/R To establish the ambiance in which 1g is exhibited, that ultimately adds to the experience of 1 for 4.	6/R. To form operating maintaining s that is able to o own eleme
<b>AUTONOMOUS</b> <b>ABILITY</b> of the element to perform its role	1a/AA. High; is able to generate new elements independently. Also has the creative choice to decide how these elements look like. However, depends on input of 1b/R for adjusting its method	1b/AA. Medium; is able to operate independently. But relies on 1c/E and thus on 2/E for decision making	1c/AA. Medium; is able operate autonomously. However, depends on 2/E for its design, and thus also what its contents dictates	1d/AA. N/A (1d/E is a passive element, that does not contain explicit generative properties. Therefore, the AA of 1d/E is N/A)	1e/AA. N/A (1e/E is a passive element, that does not contain explicit generative properties. Therefore, the AA of 1e/E is N/A)	1f/AA. medium; is able to generate new visualisations continuously, but has no creative choices in which images from 1e/ E to use for animation, since this is decided by 1b/E.	1g/AA. N/A (1g/E is a passive element, that does not contain explicit generative properties. Therefore, the AA of 1g/E is N/A)	2/AA. High; 2/E is very autonomous and holds a lot of creative freedom in performing 2/R. However, 2/E relinquishes significant control over what samples are created (1e/E) and selected for 1f/E, to 1a+b/E.	3/AA. Low; 3/E can operate 3/R autonomously, but has little creative choice in this, as it follows instructions by 1c.	4/AA. Low, the experience of 1 is relatively orchestrated by 1g/E and 5/E designed by 2/E, 4/E does not have a lot of creative freedom to experience 1.	5/AA. Medium; however the properties of 5/E could influence how 4/E experiences 1, they are a priori decided upon and fixed by 2/E (darkened, empty, silence) to carry out 2/ E's vision of how to experience 1.	6/AA. Very hi system of the elements all to highly autono operating beo its architectu many creative are made "with the collective that form u system
<b>ARTISTIC</b> <b>SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Very high; what 1a/E generates is the spindle for further decisions and outcomes along the iterative process of 6/E. Therefore 1a/E is highly artistically significant for 1 as a whole	1b/AS. Very high; what 1b/E discriminates as false/real from 1e/E sets the bar for both 1a/E and 1b/E to learn and iterate on their method in the feedback loop. Also, choices made by 1b/E influence the artistic grammar of 1e/E, generated by 1a/ E, which will results in a specific visual style of 1f/E.	1c/AS. Medium; because 1c/R dictates how 1a+b/E should be implemented, it inevitably has some artistic influence on 1. However, 2/E can hardly foresee every result of the design choices made in 1c/E, which diminishes the AS of this element.	1d/AS. Medium; the visual properties (style of colour palette, contrast, composition, figurative representation) this type of images (17-19th century paintings by Western-European Masters) already inhibit, will inevitably influence the grammar of 1e/E. However, 1e/E will have its own distinct grammar that is artistically significant to 1 due to the architecture of the system as whole (6/E), which diminishes the AS of this element.	1e/AS. Medium; might contain samples that are selected for 1g/E. But might also contain samples that are discarded by 1b/E. Therefore from varying AS.	1f/AS. Very high; is the main component of 1 and that what 4/E experiences the most.	1g/AS. Low; are important for the full experience of 1, and can definitely enhance the experience of 1. But are not as important as the content of 1f/E for the work as a whole.	2/AS. Very high; the artist holds a lot of creative agency in many aspects/stages of the work. E.g. by curating 1d/E, the scope of visual grammar of 1g/E is largely set. Or by setting factors in 1c/E that form a guideline for 1b/E for discrimination, a certain aesthetics of 1e/E will likely be enforced. These are highly important choices for the outcome of 1, and therefore the AS of 2/E is considered high.	3/AS. Low; without the properties of the computer, this work could not be effectuated. This makes 3/E a technical requirement for 1, but its properties are not explicitly arsticially significant for 1 as a whole.	4/AS. None; 4/E does not have any relevant influence on how 1 as a whole looks, or is experienced, which makes its AS low.	5/AS. Medium; the properties of 5/E can certainly enhance the experience of 1. But since these are largely directed by 2/E, and not suppose to change over time, these are from lesser AS for 1 than other elements.	6/AS. Very his self-operation maintaining we elements that constitute a sy an important p concept of the the idea that a like this of autonomously and generate unpredicted of (and which has itself how to of an extra fact constitutes experience of the Therefore, a artistically sig part for 1 as a

### **parts** , how all te to each tc.)

ses 1a+b, c. 1a is on 1d, s 1e. 1btes 1e, if passed, 1e o 1f. 1f is ienceable a 1g.

m a selfg and system, create its nents.

high; the e relevant together is nomous in ecause of ture, and ve choices thin" or by e elements up the em.

high; the ating and g whole of at together system, is t part of the the work: t a system s can sly operate e creative, outcomes ias learned o do so) is ctor that is to the f the work. c, 6/E is ignificant a whole.



"Memories of Passersby I - Companion Version" (2018), by Mario Klingemann. Images retrieved via Artsy (n.d).





Artistic Significance (AS)\* - the effect of the artist's role (2/R) in the work is also visible in what is artistically significant in the work. Also here (/AS coded cells), we see that most AS lies at the level of the elements that together are the generative system (e.g. the G+D models (1a+b/AS), the animated visualisations (1f/AS), and the system itself (6/AS). But, also the role of the artist is clearly indicated as artistically significant (2/AS), mainly due to the determining impact of its creative choices on the grammar of the eventual work. This means that, despite the degree to which the generative system itself is able to autonomously operate and produce output and how important that is to the work, the impact of the role of the artist on the visual aesthetics, ambiance, and thus experience of the work as a whole is hard to trivialise in this case. As a result, contrary to how the creative potential of GANs is regarded in most discussions, our framework shows that the 'generative system' in GAN created art constitutes of more elements than just the GANs themselves. And that this system can neither be called fully autonomous, nor exclusively artistically significant for the work as a whole, but that instead the artist self appears to have much more autonomy and creative importance in generating works through GANs than one might argue.

# 5.6. Hot Pool (2010) - Driessens & Verstappen

#### Type: Installation

Media: Wood, lacquer, metal, heating elements, fan, candle wax, electronics

Size: 113 x 154 cm

Source: <u>https://digitalartarchive.siggraph.org/</u> artwork/erwin-driessens-maria-verstappen-hotpool/

#### Description

Installation by Driessens & Verstappen that contains a self-regulating internal environment. As they state: *"Hot Pool* is a diorama in which a landscape of wax continuously transforms under the influence of melting and solidification phenomena. The installation is an autonomous generative system wherein candle wax and heat are the shaping elements. The ongoing process is visible for the audience through a small window.

A black container is standing on six metal legs, and window opening is located at the front. Inside the container the basic facilities are installed: 20 kg of candle wax, 61 heating elements, fans, electronics and lighting. The heating elements are mounted underneath the bottom of the metal container. These elements are switched on and off individually by a special algorithm so that the candle wax melts locally and solidifies again after a while. Through expansion and shrinking during the melting and coagulation process an expressive landscape emerges that slowly changes in time." (ACM SIGGRAPH, n.d.)

#### Why this artwork?

We think this work by Driessens & Verstappen is a fairly simple, yet effective work that unmistakably contains generative elements. Its 'architecture' is clear and the dynamic processes that it contains are very transparent. Seemingly, where the AA and AS takes place in the work might be evident too, namely at the elements of the wax and the heat. We wonder if analysing this work through the lens of our framework would result in more insights about the generativity of this work, or a different understanding of where its AA and AS lies.

\* LEGENDA MATRICES

#### **COLUMNS (Element categories)** 1 = Artwork Element(s)

- 2 = Artist Element(s)
- 3 = Performer Element(s)
- 4 = Audience Element(s) 5 = Environmental Element(s)
- 6 = Sum of Parts

### Conclusion analysis Hot Pool (Driessens & Verstappen, 2010).

**The generative**<sup>\*</sup> — the matrix shows that there are many interdependencies amongst the elements in order to generate something. E.g. 1a-c/R show that they require input from one of the other elements before the can generate something. We have seen this phenomena in previous analyses of works as well (e.g. Molnár, Calder, Klingemann, etc.). We would like to propose naming these elements therefore "conditionally generative". 6/R confirms this, as it shows how the relations between the elements results in generative properties. Therefore, we can conclude that the most generative properties in this artwork take place on the level of *the interaction between elements*, and thus at the sum of its parts.

Autonomous Ability (AA) - The matrix shows that not one element has the most AA, but that the AA is 'distributed' over the sum of parts (6/AA). This is emphasised by the nature of the work. Namely its autopoietic nature: the dynamics between the heaters, the wax, and the closed box generates a self-maintaining process that is called autopoiesis (i.e. autopoietic systems are systems that maintain themselves by creating their own parts (Maturana, 1991)). Because of this nature, not one single element contains full autonomy but instead most autonomy exists at the sum of its parts. One could argue autopoietic systems are the epitome of autonomous systems, as they are able to operate independently and have an innate creative freedom in doing so. This work by Driessesn & Verstappen does exactly that: the whole process of melting and solidifying of the wax can continue and maintain itself perpetually, and with that it is able to generate different landscapes over and over again. This also means that the 'composition' of this landscape, i.e. the arrangement and state of molten and solid wax inside the diorama, will likely never be *completely* similar to a previous composition and is therefore non-repeatable.

Artistic Significance (AS) - Despite that certain landscapes in time are not *fundamentally* different from other landscapes in time (in the sense that each landscape still - and always - will include pools of liquid wax & islands of solid wax), the notion that there's an infinite and endless variation of landscapes 'possible' through this autopoietic process (and thus that one spectator will not see what the next spectator sees through the diorama) is key to the experience of the work, and likely a deliberate choice of the artists to select the elements of wax, heat and the form of a diorama as a confined space for these elements to interact in. This makes these elements very AS for the work as a whole, and the deliberate choice of the artists as well. This is the only aspect of the artists role (2/R) that is AS though (2/AS). In terms of AS, we namely see in the matrix that most AS is located at the collective of generative elements (6/E). Not only do the properties of the individual elements contribute to the work as a whole, for they make the process of phase/state transitioning possible which makes them already highly AS - the process they evoke is what the work is about. In other words, these elements are both practically important as conceptually. We therefore would like to argue that this makes Hot Pool (2010) a striking example of a highly "generative artwork".

#### **COLUMNS (Element categories)**

- 1 = Artwork Element(s)
- 2 = Artist Element(s)
- 3 = Performer Element(s) 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

Matrix #6		Hot Pool (2010), Driessens & Verstappen											
	(its subjec	<b>1. Artwork</b> ts, media, systems, individual	parts, etc.)	<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	4. Audience (the ones experiencing/ witnessing the work, or participating in the work)	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)					
ELEMENTS:	1a/E. the candle wax	1b/E. The heaters	1c/E. The box	2/E. Erwin Driessens & Maria Verstappen	N/A (there is no performer involved, so therefore this column is not taken into account for the analysis)	N/A (4. Does not have a significant role in affecting 1, and is therefore not taken into account for the analysis)	N/A (5. Does not have a significant role in affecting 1, and is therefore not taken into account for the analysis)	6/E. The autopoietic process of phase/state transitioning					
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To react on the changing temperature inside the box, showing the transitioning forms of its phase states	1b/R. To change the temperature inside the box (warming up > cooling down, and vice versa). To initiate the process of phase/state transitioning: let's the wax change its phase states	1c/R. To create & maintain the environment for the two main elements (wax + heat). Provide a "closed up" view of 1a/E, enhancing the landscape-like view & association.	2/R. Choosing the main elements to work with, and thus what dynamic generative process to highlight. Also, decides a priori when 1b/E should turn on/off, and builds/ programmes that technical infrastructure (not visible to 4)	N/A	N/A	N/A	6/R. To perpetually maintain & repeat itself, and subsequently continuously create changing 'landscapes', that are made up of different phase states of 1a/E.					
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	1a/AA. Medium: Has the innate ability/ chemical properties to "shape shift". Yet, depends on other factors (1b/E) for doing so.	1b/AA. Medium: Fairly autonomous in operation (initialises a process). But, depends on 2/E's instructions to 'know' when to do what (heat/cool).	1c/AA. N/A (1c/E is a passive element, and does not have autonomous properties itself)	2/AA. Medium: autonomous in making creative choices in how 6/E is created & when to initiate/terminate those. But, (deliberately) cannot influence or intervene in how the 1a/R reacts to 1b/R, and subsequently what 'landscape' results from that.	N/A	N/A	N/A	6/AA. Very high: in essence this process can maintain itself autonomously and perpetually. It also has the agency to evolve itself, without involvement of external factors.					
<b>ARTISTIC SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Very high: The dynamic "landscape" that 4 experiences is mainly constituted by the wax. So therefore, very significant for the artwork.	1b/AS. High; Indirectly very important for the artwork, due to reaction of the wax.	1c/AS. Very high: the box functions as the incubator for the dynamic process between the wax + heat (6/ E). Moreover, 1c/E is the object 4 sees first, and creates the diorama into the internal environment.	2/AS. Medium: Significant in terms of how the boxed environment looks and how the landscape view is enhanced by 1c/E's design. Their choice in when to initiate/terminate the heater function might influence how the 'landscape' eventually looks	N/A	N/A	N/A	6/AS. Very high: The autopoietic process of 6/E is the most important aspect of 1, and therefore central to the work as a whole.					





Hot Pool, Driessens & Verstappen (2010). The box of candle wax in combination with changing temperature (hot/cold) forms a self-maintaining eco-system, resulting in fluctuating landscapes of molten and solid candle wax. (ACM SIGGRAPH, n.d.)





Three stills from "Seven Experiments in Procedural Animation" (2018). Karl Sims (2018)



#### 5.7. Seven Experiments in Procedural Animation (2018), Karl Sims

Type: video

Media: software (fractal algorithms, procedural noise, and reaction-diffusion techniques), hardware (Linux workstation with Nvidia Titan Xp GPU). Animation: Karl Sims Music: Arlo Sims Duration: 1 hour (original version) Source: <u>https://karlsims.com/seven.html</u>

#### Description

Video artwork picturing procedural animations of objects created with different sets of algorithms. Sims: "The animated textures and patterns were created from custom computer code employing various fractal algorithms, procedural noise, and reaction-diffusion techniques. The moving images are purely defined by mathematics, but are meant to evoke a biological aesthetic by resembling sea creatures, neurons, or other microscopic structures that transform from one emergent pattern to another. A 5-minute version of this piece was exhibited at ARS Electronica in the Deep Space 8K Theater and the 2019 Animation Festival in Linz Austria. The original one-hour version was commissioned by Boston Cyberarts for the 35-foot video wall in the courtyard of The Exchange at 100 Federal Street in Boston."

(Sims, 2018a)

#### Why this artwork?

Fractals (term introduced by Mandelbrot (1975)), are a form of mathematical language to describe, relate, and manipulate shapes which involve recursive algorithms (Peitgen et al., 2011). Fractal sets are used in natural sciences and computing to model amongst others natural phenomena, such as coast lines, mountain ranges, trees, etc. They inhibit a relatively simple structure (set of rules), but are able to create highly complex shapes and patterns. They are self-similar, meaning they are independent from scale (Peitgen et al, 2011) and contain perpetual recursive patterns when zooming in or out. Because of these features, over the past decades fractals became popular with graphic designers and artists for creative expression. Works generated with fractal sets are called Fractal Art. Many works by Sims are examples of this type of art, as also this specific work. For "Seven Experiments in Procedural Animation", Sims applied and experimented with a selection of popular fractal sets, such as the Mandelbrot and Julia set, to create a series of complex images. Sims uses procedural animation, a type of computer animation which automates animation of images itself, allowing for a more rapid testing of parameters.

Since Fractal Art is often named as a subgenre of generative art (for it is art created with a system - i.e. the fractal sets with recursive algorithms- to which some degree of control is attributed to) we are curious to analyse an example of this type of art with our framework. How autonomously are these systems for generating output, and how much do they contribute to the artwork as a whole? Moreover, since procedural animation seems an important tool in creating this specific work, we wonder how this affects the AA and AS of both the system, as the artist.

[Proceed to Matrix #7]

#### Conclusion of analysis of "Seven Experiments in Procedural Animation" (Sims, 2018)

**The generative**<sup>\*</sup> - similar to the generative elements in Hot Pool (2010), the matrix shows that the most generative properties lie at 1a-c/R, 2/R and 6/R. For 2/R these are relatively unconditional, meaning 2 (the artist) can generate independently from other elements. However, in 1a-c/R we see that these generative properties are conditional: all three cells state that they require input from another cell, in order to generate something. These interdependencies are confirmed again in 6/E and 6/R, which show the relation between these elements and the "chain reaction" they together form. This means that, however these elements of 1a-c are (sets of algorithms, programme, and computer) are normally considered generative

\* LEGENDA MATRICES

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- 6 = Sum of Parts

ROWS /E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

Matrix #7		Seven Experiments in Procedural Animation (2018), Karl Sims											
		(its subj	<b>1. Artwork</b> ects, media, systems, individu	ual parts, etc.)		<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	<b>4. Audience</b> (the ones experiencing/ witnessing the work, or participating in the work)	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)			
ELEMENTS:	1a/E. the set of algorithms (fractal algorithms, procedural noise, and reaction-diffusion techniques)	1b/E. The code/programme	1c/E. The computer	1d/E. The procedural animation	1e/E. The video	2/E. Karl Sims	N/A	N/A	5/E. The hall/room in which 1 is screened	6/E. 2/E chooses 1a/E, writes 1b/E. 1a-c/E rely on each other for together generating 1d/E. Based on 1d/E, 2/E alters 1b/E iteratively. 2/E curates 1d/E, and creates 1e/E. In short: 1a-c/E & 2/E are together the 'system'.			
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To provide the mathematical formulas, with which permutations can be calculated by 1c/E, to eventually create interesting visual output (1d/E).	1b/R. Employing 1a/E in a custom way, designed by 2/E, to create 1d/E in combination with 1c/E.	1c/E. To execute 1b/E, and calculate the permutations of 1a/E. Produce 1d/E.	1d/E. Is the result of what 1a/ E + 1b/E in combination with 1c/E generated. An automatically animated visualisation by 1c/E of the outcomes of the permutations of 1a/E.	1e/E. Is the "final product". A selection of 1d/E by 2/E, with added sound design, edited by 2/E into one piece.	2/R. Selecting + copying + altering 1a/E. Writing 1b/E. Testing 1a/E & 1b/E, reviewing 1d/E. Altering 1b/E according to received 1d/E. Filtering & selecting what parts of 1d/E (sequences, sections, etc) to use for 1e/E. Choosing how to edit the selection of 1d/E, in order to create 1e/ E. Choose how to frame 1e/E (add sound design, post productional effects, duration, format, etc)	N/A	N/A	5/R. Provides the facilities for screening 1, both technical (display screen/ video wall & audio installation) as practical ("seating" for 4). Eventually: enhances the experience of 4 of 1.	6/R. To form a self-creating system that produces interesting output 1d/E by the iterative dialogue between its elements.			
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	1a/AA. Medium: Formulas needs to be written / created by something / someone. Relies on 1b/E for application and 1c/E for calculation. But once done, 1a/E can create output that was not there before and cannot be predicted by reviewing the separate elements (emergent properties), beyond the prediction of the 'creator' (2/E).	1b/AA. Medium: Requires 1a/E for content, and 1c/E for execution. But has inherent generative properties by design.	1c/AA. Medium; fairly autonomous in operation (executes processes). But, dependant on instructions for initialising this execution (1b/E). Has no creative freedom in making choices, only there to execute instructions.	1d/AA: N/A (is a passive element: is created rather than creates)	1f/E. N/A (is a passive element: is created rather than creates)	2/AA. High: 2/E holds a lot of creative freedom in decision making at every step of 2/R. 2/E only lacks AA in predicting the range of 1d/ E, which is hard to foresee when writing 1b/E due to the "butterfly effect"	N/A	N/A	5/AA. N/A (5/E is a passive element, and is there to be created with, not to create itself)	6/AA. Very high; due to the interdependencies between 1a-c/E and 2/E, the system is able to generate output autonomously.			
<b>ARTISTIC SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. Very high: the specific algorithms and their inherent structure are responsible for the particular output (1d/E), which in turn is central to the work. In essence, 1a/E is what 1 conceptually is about. Therefore 1a/R is very AS for 1 as a whole.	1b/AS. High; 1b/E is necessary for 1a/E to produce 1d/E. It is also the element in which 2/E's most effort lies. However, conceptually it is not as important for 1 as 1a/E is.	<ul> <li>1c/AS. Medium; AS in the sense that its computational properties are necessary for calculating the permutations of the 1a/, which is an important part of 1.</li> <li>However, the fact that 1c/E only 'executes' and does not have creative freedom for deciding 1d/E, 1c/R is less AS for 1 as a whole.</li> </ul>	1d/E. High: the output of the permutations of 1a/E that are made visible via 1d/E, are the basis for 1e/E and thus 1 as a whole.	1e/AS. Very high: 1e/E is what 4 experiences as 'the artwork', and is therefore very AS to 1 as a whole.	2/AS. Very high: 2/R shows that 2/E holds many roles for creating 1. Moreover, all roles hold all steps of 2/R are very important in the build up to create 1, E.g. what output of the permutations are chosen to be presented in the animation, and how these are processed in this, are important artistic	N/A	N/A	5/AS. Medium; the properties of 5/E (acoustics, darkness, size of video walls) are important for the framing of 1. However, conceptually 5/E is less important than 1a-c/E and 2/E for the artwork as a whole.	6/AS. High; the output (1d/ E) of the system is both a large part of 1e/f, as well as important to the concept of 1. However, due to the many extra post-production steps by 2/E for creating 1e/ E, the AS of 6/E is slightly reduced.			







elements, our analysis shows that the most generative behaviour lies at the sum of its parts. This indicates that this element (sum of 1a-c and possibly 2) is where the most emergent behaviour is located that is responsible for generating the intricate patterns seen in 1d/E.

Autonomous Ability (AA)\* - The "conditional" generativity that we see in the elements 1a-c, also seem to translate to the AA of 1a-c/E. Namely, as the results in the matrix show, 1a-c/AA hold medium autonomous ability, due to the fact that they are to some degree dependent on another element. On the contrary, the sum of their parts (6/AA) show a very high AA, for they together constitute in a self-operating system of sorts. Moreover, 6/AA seems to hold an even higher AA score than 2/AA. The most important argument for this, as the matrix shows, is that the artist can hardly foresee or predict what the outcomes of his code (1b/E) will be, due to the "butterfly effect" that is present in fractal algorithms: a small increment or adjustment in the code can result in large, unpredicted changes in the output. This behaviour of the algorithm adds a sense of surprise and "out of control-ness" (McCormack & Dorin, 2001) to the work, which arguably gives the sum of 1a-c (6/E) a higher autonomous ability, than it gives the artist (2/AA).

Artistic Significance (AS) - one would expect the same elements with high scoring AA, would also be the ones that are highly AS in the work, as that is what generative art arguably mostly is about (i.e. autonomous systems creating art). However, the analysis shows that the AS within this work is located at different elements. Namely at the algorithm (1a/AS), the video (1e/AS), the artist (2/AS) and the sum of parts (6/AS). That the video itself is important to the work goes without saying, therefore we discard that element in this conclusion. More interesting are the lower level of AS for the programme written by the artist (1b/ AS) and the computer (1d/AS): these cells show that these elements are more *practically* important, rather than conceptually. We think this is an interesting distinction in defining how important 'generative elements' can be to a work, in which

arguably elements that are conceptually important to the work are more AS than practically important elements to the work as a whole. Lastly, we expected that the element of the procedural animation (1d/AS) as a tool for creating this work would be high in AS. This is the case in terms of that its output is important for 2/E to edit the final video with (practically important), but it appeared less important for the idea of the work itself (i.e. less conceptually important). Contrary to that, the artist (2/AS) holds notable level of AS. As the matrix shows, the role of the artist is quite extensive for creating the work, which makes it arguably the most important element in the matrix. Moreover, one generally might think the procedural animations are the most important part in the final piece (1e/E), but the matrix shows that a large step in curating, editing, and framing is involved by the artist himself for making the work "the final work".

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- 4 = Audience Element(s)
- 5 =Environmental Element(s)
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\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

#### 5.8. In C (1964), Terry Riley

Type: musical composition Duration: undefined (usual length 45" to 1'45" (Riley, n.d.)) Instruments: any Source: <u>https://www.youtube.com/watch?</u> <u>v=tbTn79x-mrI</u>

#### Description

Minimalist musical composition by Riley, composed in 1964 and first recorded and released in 1968 (Carl, 2009). The piece is made of a set of principles and procedures: it consists of a single score of music consisting of 53 brief modules (or "patterns") composed by Riley, of varying length (the shortest being 1/8th beat long, the longest thirty beats) (Carl, 2009). The modules are to be played by any number of musicians, playing any instrument, in a fixed sequence (in ascending numerical order: first module #1, last module#53). One musician opens the piece, by playing a repeated 1/8th-note high C on a high pitched instrument (often piano) which is continued throughout the performance (a highly challenging role for the concerning musician). This functions as a metronome of sorts for the piece, dubbed "The Pulse" (Carl, 2009), giving the composition its name. All participating musicians receive instructions, also a priori defined by Riley, for playing the modules. Examples of instructions are: "Patterns are to be played consecutively, with each performer having the freedom to determine how many times he or she will repeat each pattern before moving to the next", and "Each pattern can be played in unison or canonically in any alignment with itself or its neighbouring patterns", or "The tempo is left to the discretion of the performers" (Carl, 2009). This results in a musical piece with polyrhythmic combinations that spontaneously arise among patterns played by the performers (Carl, 2009). Over the decades, "In C" has been (and still is) performed by numerous ensembles, all producing their own incarnation of the piece.

#### Why this artwork?

"In C" is often mentioned as one of the first examples of generative music, inspiring many other composers to engage with generative methods for musical composition, such as Steve Reich (Carl 2009). Key reasons why it is traditionally considered as a generative work, are



In C - Terry Riley [1968]. Album cover of the 1990 release, by CBS Records. Image retrieved via AllMusic (n.d.).

the amount of autonomy attributed to the performers, and subsequently the relinquishment of control by the artist in creating the piece. Riley is considered "...careful to allow the performer leeway in the choices made and to preserve his or her autonomy as an individual within the collective." (Carl, 2009). One might assume from this, that the performer therefore has a high amount of Autonomous Ability, and might also be Artistically Significant. We wonder if the generativity of this piece indeed can be allocated at the level of the performers, and would therefore like to analyse this work with our framework. Can we confirm this alleged autonomy of the performer after analysing this work through the lens of our concepts Autonomous Ability, and moreover: are the performers in this piece also artistically significant?

[Proceed to Matrix #8]

#### Conclusion "In C" (1964) by Terry Riley

The generative - as we can see in the matrix, this work has a relatively high density of generative elements. From the 6 elements only 1a + c/E can be considered passive, or not generative. This makes it a bit easier to define what the actual 'generative system' in this work is, namely the whole of 1b/E, 2/E and 3/E. Remarkable in this work as well, is that these elements in effect rely on each other, or on elements created by each other, in order to generate something (i.e. are

Matrix #8		In C (1964), Terry Riley											
	(its subje	<b>1. Artwork</b> cts, media, systems, individual p	arts, etc.)	<b>2. Artist</b> (the maker of the work)	<b>3. Performer</b> (the one(s) performing or executing the work)	<b>4. Audience</b> (the ones experiencing/ witnessing the work, or participating in the work)	<b>5. Environment</b> (external input from the environment in which the work is situated)	<b>6. Sum of parts</b> (interactions, how all elements relate to each other, etc.)					
ELEMENTS:	1a/E. The Score	1b/E. The instructions	1c/E. The musical performance	2/E. Terry Riley	3/E. The participating musicians	N/A (does not play a significant role in creating this piece)	N/A (does not play a significant role in creating this piece)	6/E. 2/E instructs 3/E via 1b/E how to apply 1a/E. 3/E interprets 1b/E, executes 1a/E and creates 1c/E					
<b>ROLE(S)</b> of the elements in the artwork	1a/R. To function as the set (predefined by 2/E) of musical components (53 modules) which 3/E need to play. Forms the 'blueprint' for 1c/E together with 1b/E.	1b/R. To instruct 3/E in how they can perform 1a/E. Predefined by 2/E. Forms the 'blueprint' for 1c/E together with 1a/E.	1c/R. The "final product", collectively created by 3/E. The experienceable part by 4. The instance of the blueprint (1a+b/E)	2/R. To design the blueprint (1a+b/E) for the work. Meaning: to compose 1a/E. To experiment with 1a/E i.c.w. 1b/E, in order to test for interesting compositions. To finalise 1b/E.	3/R. To interpret 1b/E and choose how to execute 1a/E accordingly. Execute 1a/E in order to create 1c/E.	N/A	N/A	6/R. To form a system that is able to generate unique instances of a composition, that cannot be predicted by a priori analysing the rules of play (1a+b/E).					
<b>AUTONOMOUS ABILITY</b> of the element to perform its role	1a/AA. N/A (1a/E is a passive element, so it's role is to be created with, instead of to create itself)	1b/AA. Medium; depends on 2/E for its content, on 1a/E for application and on 3/E for execution. But, in combination with those elements is able to generate 1c/E.	1c/AA. N/A (1c/E is a passive element, so it's role is to be created with, instead of to create itself)	2/AA. High; holds a lot of decision making in its role, and in that a lot of creative freedom. The only aspect in which 2/E has no AA, is in how 3/E interprets his designed rules (1b/E) and eventually how 1c/E will sound.	3/AA. Medium; has the AA to interpret 1b/R to their will, and subsequently decide how they create 1c/E with 1a/E. However, since the content of 1a/E is already predefined by 2/E, 3/E can only make creative choices for applying 1a/E. This diminishes the AA of 3/E.	N/A	N/A	6/AA. Very high; as a whole, this system generates instances of 1c/E independently from any other elements and inherently holds all the creative freedom to decide how exactly 1 will eventually be created.					
<b>ARTISTIC SIGNIFICANCE</b> of the element's role for the artwork	1a/AS. High; because of its function as a blueprint, it is an important element for the work, both practically and conceptually. Moreover, contrary to other elements, 1a/E contains all the musical components, which needless to say is key for 1 as a whole, and how it will sound.	1b/AS. High; the idea that 3/E has the freedom to interpret 1b/E to its liking, adds to the idea of the work being subject to chance. Therefore, 1b/E is highly AS for 1 as a whole.	1c/AS. High; needless to say important to 1 for it is the experienceable product. However, the idea of the system of 6/E being able to produce this unique outcome is almost more AS to the work than the output itself.	2/AS. Very high; 2/E is responsible for a large amount of creative composing and testing with rules prior to defining 1a+b. Meaning, 2/E is the only element contributing to the artistic 'grammar' of the work, making its AS to the work as a whole very high.	3/AS. High; the fact that the outcome of 1c/E is largely depending on 3/E, makes 3/ E's contribution to 1 as a whole highly AS. However, 3/E can only influence 1c/E within a certain range (i.e. the <i>application</i> of the melodic content, but cannot <i>create</i> the content themselves), which diminishes the AS of 3/E for 1 as a whole slightly.	N/A	N/A	6/AS. Very high; the system as a whole is both practically as conceptually very important to the work; the idea that a musical piece can be created through generative method/ system like this, is key to the work itself.					



'conditionally' generative). Meaning that the individual parts don't necessarily have the most generative properties, but the sum of their parts do. This is confirmed when we look at the cell of 6/E, in which these interdependencies are stated. Moreover, 6/R proves the generative, or even emergent, character of the system further, by stating that it is hard to predict the outcome of the performance, by just looking at the score and the instructions. This entails that there is a degree of complexity involved in this work, something that arguably is characteristic to generative artworks in general. Another remarkable 'generative' aspect about this work, but one that is not so evident in the matrix, is that over time this piece evolved as a work too. Because of its 'open-endedness', performers can (and are encouraged to) "reinvent" the piece over and over, which not only creates new instances of the piece, but also new interpretations of the 'blueprint' of the piece. Arguably, this might chance our perspective of the mode of this work, i.e. not being a "generated" piece, but a "generating" piece.

Autonomous Ability (AA)\* - as there are not many other elements than generative elements in this work, comparing the AA amongst elements might not be very valuable. What would be interesting to compare, is the expected autonomy versus the actual autonomy of the generative elements. Prior to analysis, we already mentioned that traditionally the performers in this work are considered highly autonomous. Our matrix however shows a slight discrepancy in this: 3/AA namely indicates that the performers score lower on the scale for AA, mainly due to the fact that their true creative freedom in decision making is actually fairly limited. The melodic content of the modules namely is created by 2, and on this content 3/E has no influence anymore. The performer only has some tools to be creative with 1a/E (timing, duration, repetition), but this is from less artistic significance to the work as a whole (or better: to the 'sound' of the work) than the content of 1a/E. This significantly lowers 3/E's actual creative freedom in decision making, and with that their AA. We see this predefined 'range' within an element can be creative as a form of 'controlled randomness', or limited, perhaps "scripted" autonomy. Instead of 3/E, most AA is namely located at the artist (2/E), as we see in 2/R: the amount of intricate puzzling and calculating the artist has done in creating the modules, in order to guarantee an interesting musical experience when performed by external performers, proves of a higher degree of AA in their role than 3/E has.

Artistic Significance (AS) - the fact that the actual freedom of choice of the performers (3/E) for generating 1c/E appears to be limited, also affects their creative contribution to the artwork as a whole. Since 3/E is not able to influence some very important parts of a musical composition, namely the melodic or rhythmic content of the piece, we can conclude that their AS is not as high as one might argue. In contrast, our analysis shows that most AS arguably lies in the hands of the artist himself, for carefully composing all the content of the 53 modules, testing conceptual rules for application and how they sound together, and with that experience in mind define and prescribe 1b/E to 3/E. This contribution, in our view, is from larger AS to the grammar and 'sound' of the piece, and eventually all the instances of the composition, than the contribution of the performers themselves.

**COLUMNS (Element categories)** 

- 1 = Artwork Element(s)
- 2 = Artist Element(s) 3 = Performer Element(s)
- 4 = Audience Element(s)
- 5 = Environmental Element(s)
- 6 = Sum of Parts

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

# 6. Comparing the outcomes of artwork analyses: findings

Now that we have these analyses, can we compare the generative elements, and their AA and AS between artworks? What do the results of the analyses through this framework show?

Finishing the analysis for every selected artwork allows for the next step in our research, namely comparing the qualities of each generative artwork with the qualities of other artworks. We do this by reviewing the conclusions of each artwork analysis and the matrices. Can we find notable similarities, discrepancies, in what 'the generative' in each work contains, at which elements it takes place, and to which degree this generative aspects has autonomous ability and artistic significance for the work as a whole?

#### Amount of distinguishable elements

Something first would like to point out, is the high amount of distinguishable elements in most artworks. This amount per work is much higher than we previously expected to distinguish. It seems that through carefully dissecting a generative work, more elements (passive or active) appear to be essential to the piece than might be evident at first sight. This is an interesting result, as it broadens the scope of what we can analyse with our framework, and moreover: broadens our conception of what could possibly be generative, autonomously or artistically significant within a generative artwork.

### Distributed generativity & autonomy: call for a broader notion of 'the system'.

Another thing that is evidently recurring within the results across analyses, is that in most cases the generative properties within an artwork are not confined to one individual element, but are distributed *across multiple* generative elements. This might sound obvious, since we are dealing with generative art which contains systems that per definition consist of multiple parts that interact with each other. But what we mean is that *more* elements than the ones involved in -what we traditionally would consider- 'the system' hold generative properties, that are essential for creating the work. For example, the elements under Environment in the works of Hobbs, or the Audience in the works of Calder and Rainer. And, as we will later elaborate on: in almost all artworks one of the most important generative element was the Artist self. Without the 'generative' characteristics of these elements, the work could not have been created or work like the way it works, but these traditionally are often not considered as 'the system' itself. The dependency of these traditional systems on these elements and vice versa is often clearly visible in the 6th column of the matrices, describing the relations, process and interactions of all parts within the work. Here we could list the dynamics happening amongst the elements, that subsequently revealed the 'broader' system that is at the core of the work. In most matrices, this column gives away what the true 'generative system' of the concerning work is, which mostly is the sum of parts of all the generative elements within the work (and not only the generative Artwork elements, under column 1). This is a frequent recurring result in our analyses, and we therefore would argue for a broader notion of what we generally understand as 'the generative system' when analysing generative art.

When comparing the autonomous ability of these generative elements across artworks, we see a similar phenomenon: individually these generative elements have a lower degree of AA, mostly due to their dependency on other elements before they can operate autonomously. But when reviewed as a whole, it appears that the sum of their parts hold a very high degree of AA. This occurred in many of the artworks that were analysed (Calder, Sims, Hobbs, Driessens & Verstappen, Riley), and to our view this aids the argument for an extended notion of what 'the system' in a work exactly is.

#### Deviated AA & AS\*

Another remarkable finding of our analyses is that the degrees of AA and AS often do not align within elements. Meaning: not all elements that score high (i.e. tagged High or Very High) in AA in an artwork, also scored high in AS for that work, or vice versa. E.g. Klingemann 1b/E and 1f/E, or Molnár 1d/E). This contradicts with what one might generally expect of autonomous systems: in most research about generative art there namely is a tendency to (implicitly) assume that when an autonomous element is used for creating the work, it per definition is also important for the work as a whole. As mentioned earlier in this study, we were wondering if this indeed would be the case when specifically looking at the works through the lens of AA and AS. After comparing the results of the analysis however, we can conclude that there is a slight discrepancy in this, and that the degrees of AA and AS can diverge across elements involved in the artwork.

Related to this deviated alignment of AA & AS in individual elements, however: the elements that from our analyses do show alignment in AA & AS (both high scores) across artworks, are the Artist (column 2), and/or the Sum of Parts (column 6) (e.g. Hobbs, Klingemann, Riley, Molnár). To us, this confirms the importance again of taking the broader notion of the 'system' into account when analysing generative art. But also that, apparently, the artist in most cases plays a surprisingly significant role in making the decisions in the work (AA) and that these decisions - compared to the decisions of other 'autonomous' elements in the work - are highly important or the artwork as a whole (AS). This mostly is expressed in the amounts of crafting/ developing, testing, and altering the artist need to do in order for the machine or system to create output. And after that, often many steps of selection, moderation, and curation of the output are done by the artist, before the work becomes the final work. These are all appear paramount decisions for the artwork and its experience, showing that there's still a large part of control located at the level of the artist.

The only example in which this was not the case however, was the work of Driessens & Verstappen. In this work, the artist's role was remarkably small on all levels (the generative, AA and AS). This might be due to the autopoietic characteristic of the system in this work, which by nature is entirely self-maintaining. It might be interesting for future analyses to take a closer look at more generative artworks with similar autopoietic features, to see if this occurs there as well.

#### Unconventional examples of generative art

As a last notable finding, we can conclude from our analyses that some 'traditional' generative artworks appear to contain less generative elements than non-traditional generative artworks. We see this for example in the matrices with the analysis of the works of Calder and Rainer. Compared to the ratio of passive (non-generative) and active (generative) elements in other works, these non-traditional generative artworks score higher in generative elements than their traditional counterparts. Moreover, the AA en AS of those generative elements in these works scores higher as well. On the other hand, some 'traditional' generative works, such as Molnár's, appears to be not as generative compared to other works. We think this is an interesting finding that appeared from doing the analyses.

2 = Artist Element(s)

\* LEGENDA MATRICES

#### ROWS

/E = the concerning element /R = the role of the element in the artwork /AA = the Autonomous Ability of the element /AS = the Artistic Significance of the element

**COLUMNS (Element categories)** 

<sup>1 =</sup> Artwork Element(s)

<sup>3 =</sup> Performer Element(s)

<sup>4 =</sup> Audience Element(s) 5 = Environmental Element(s)

<sup>6 =</sup> Sum of Parts

### 7. Discussion

What does this framework add to the field of generative art research? Does looking at generative art from this perspective provide us with other perceptions of those specific works, and subsequently, an other understanding of generative art? How do these outcomes relate to the frameworks we already know for analysing generative art? And how can we use this new perspective for further research?

#### 7.1. Relation to other frameworks

We developed this framework from the need for a more in-depth method for analysis of generative art, that allows us to look further than solely a denotation of the 'system' or its processes. Because in our view, the existing frameworks of Galanter, Boden & Edmonds, and Dorin et al, approach generative art from a rather descriptive point of view, which do result in very useful outcomes, especially for creating a singular vocabulary for researching generative art. However, these descriptive approaches do not facilitate a more critical analysis of the works in terms of how 'the generative' plays its role in the artwork. As we argued before, what most frameworks namely consider as generative elements in 'the systems', in practice just makes up for a small portion of the generative in an artwork, being the algorithm, fractal set, L-system, or whatsoever. Some hints towards this are made in some existing frameworks however. Boden & Edmonds for example do mention the impact of the environment on the artwork in their tool, and Dorin et al. already implemented "environmental interactions" as third component in their framework. We took this idea a step further in our framework, and explicitly pre-defined even more element categories (e.g. Artist, Performer, Audience) for analysis, to see what this would reveal about the role these elements play in the work (e.g. if these also could have generative properties and AA or AS). After seeing the results of this, we think we can confirm even more clearly that other 'external' elements do play a role in constituting 'the system' in an artwork (e.g. environmental input, but also the artist as well as performers) and that these are valuable to take into account too. Like mentioned in the previous section, we therefore would argue that the notion of 'system' needs to be expanded, into the larger whole of all involved generative elements, and most of all: the sum of their parts.

In the existing frameworks we do see some mentions about the sum of parts between entities (Dorin et al.) or individual parts (Galanter), but we think that in these frameworks not enough weight is assigned to the importance of this sum of parts for 'the generative' in the artwork. Therefore, we advocate for making 'the sum of parts' an explicit element category in analysing generative art.

We named this element "Sum of Parts", but perhaps we could consider the term Boden & Edmonds briefly mention in their framework, namely the "art system", as a more inclusive concept of what to take into account as the system when looking at generative art. We think this term suits quite well and would be an added value in describing this broader system in future generative art research.

In terms of AA and AS, in their frameworks Galanter and Dorin et al. tend to attribute a lot of autonomy, and implicitly also significance, to the 'systems' or machines in generative art. This certainly adds to the idea of 'creative machines', which unmistakably speaks to the imagination of all of us. However, because of this implicit attribution there is a tendency to neglect how much creative and handcrafted work by the artist self is still involved in generative art. The frameworks of Galanter and Dorin et al. lack the tools to critically analyse the role of the artist, which in our opinion severely sells short in providing a complete picture and understanding of these works. To prevent this, with our framework we aimed to facilitate analysis of the artist's role *explicitly*, not only to dive deeper into what actions of decisions the artist contributes to the work, but also to reveal how autonomous and artistically significant the "machines" involved in the work truly are. And as briefly highlighted in the previous section, multiple results in our analyses show that a lot of autonomy and artistic significance within the artworks indeed is located at the artists themselves. This reveals that even 'system generated work' contains a lot of effort and direction by the artist. We think that this insight contradicts the (implicit) attributions of the other frameworks and critics concerning how much 'control' is outsourced to the system. Perhaps this insight shows that we should nuance our general view on how much control the artist actually relinquishes to an autonomous system within generative art, and should adjust our conception of how autonomous those specific systems truly are.

#### 7.2. Notable insights

We will discuss some noteworthy insights that we came across when analysing the artworks through our framework.

Locus of generative gravity - when filled in, the matrices often made clear where the generative 'gravity' within the artwork is located in a glance: within the Artwork itself (at the left side of the matrix, i.e. under the Artwork element category, column 1), or outside of the Artwork (at the right side of the matrix, i.e. under the element categories of Artist (2), Performer (3), Audience (4), or Environment (5). We think this is a valuable added benefit of the framework in quickly forming a basic understanding of the particular work, and in comparing works with each other. What might be valuable in the future, is to come up with custom terms for these different loci of generative gravity, as we can imagine that explicitly naming these can help in making classifications of generative art systems and aid further analysis and understanding of these works.

Generated vs. Generating - Another insight from our analyses is that generative artworks exist in roughly two modes, and can therefore be classified under two headings. Namely, the works that are generated (i.e. works that are created with or through generative methods, but are not generative themselves) or works that are *generating* (i.e. works that are generative themselves). The first class are final products that are "finished", do not require any input anymore and are not evolving over time (e.g. the works of Molnár, Hobbs, and Sims). Works of the other class however, are not "finished", do require certain input in order to 'work' and are evolving over time, (e.g. the works of Rainer, Riley, Calder, Driessens & Verstappen, and Klingemann). Only the work of Klingemann might arguably be considered both, i.e. created through generative methods and a generative products itself. We think defining these modes is an important distinction to make when studying generative art. However, in most existing research, this division is generally neglected. This might leave valuable insights unseen, as we have seen with our framework this often implies differences in where the generativity is located, and also where the AA and AS in a work. Moreover: defining the modes can form an extra way of classifying and comparing generative artworks and their systems.

The "idea" of generativity - something that we came across when analysing the roles of the generative elements and subsequently the AS of that role, was that in some artworks the creative contribution of the generative elements to the artwork as a whole technically was not very artistically significant at all, especially not compared to the AS of generative elements in other artworks. Still, we could define these elements undoubtedly highly important for the work, mainly because of the idea of this element being able to generate something artistically. For example in the case of Molnár's work: the computer not necessarily played a creatively significant role in making the final print, as it just executes a programme without having any creative choice in what to output. Compared to this, the artist and the programme hold a higher AS for the work, than the computer itself. However, the idea of a machine like the computer being able to generating something artistically interesting is a *large part of this work* as well. Therefore, the idea of generativity (conceptual) might be more important for the AS of a work, than its actual output (practical). This might complicate answering the AS of an element for a work slightly, as this sometimes might requires some contextual knowledge of each work, as zeitgeist, innovation, artist intentions amongst others play a role in this. But we do think making a distinction in this can be very valuable for understanding the generativity of a certain work, and how that adds to the AS for the work as a whole.

Cross-disciplinary method - As we saw from our results, more works can be technically considered generative than one might previously expect, even from different art movements. For example Calder's Mobile (1932) or Rainer's Continuous Project - Altered Daily (1970), that stem from the artistic context of respectively Kinetic Art and Fluxus, and are traditionally not considered as generative artworks. Analysis of these works through our framework not only reveal that some elements have unpredicted generative aspects, but also show that these elements have a surprising high level of autonomous ability and artistic significance (e.g. the air flow in Calder's mobile, or the performers in Rainer's work). Often even more AA and AS than elements from works that are considered generative (and autonomous!). This makes an interesting case when considering generative art as a whole. It makes explicit that some characteristics of art movements, like for example Kinetic Art, Fluxus, have fundamental similarities with generative art, which might show

that we should accept an even broader conception of what Generative Art is. It also makes that Generative art arguably can be seen as a crossdisciplinary method for making art, through art movements and time.

Recurring "new" methods - Also, what we found in our research into the selected artworks was that many methods of making generative art seem to repeat themselves over history. For example, with the introduction of a new medium or technology (e.g. calculation devices, plotters, screens, neural networks, etc.), often new possibilities in creating generative art arise. What we see is that at those moments in time, Generative Art receives an influx (e.g. in the 1960s with procedural art, or in the last years with the NFT boom), and that one claims that the concerning new technology allows for "new" ways of making generative art. For example, "long-form" generative art, coined by Tyler Hobbs (2021), in which he claims that creating generative art through the blockchain technology and platforms like Art Blocks requires a "fundamental other approach than creating generative art before" (Hobbs, 2021), since the artist nor audience a priori know what the algorithm will eventually create. We find this remarkable, since it looks like this way of generating art bears many similarities with how generative art artists created art in the 1960-'70s, when they had no output device available other than a plotter. And thus also only knew what their programme would exactly output, once it was fully printed. In a way, technically this therefore also could count as "long-form" generative art. The only thing that makes Hobbs' method "new" or different from previous methods, is the aspect of scale that these on-chain NFT projects allow.

*In dialogue with the system -* one thing that became clear from our analyses, is that most artists engaging in generative methods, are not necessarily interested in letting a machine or system produce something, but more in creating something with the machine. Most artist use the generative method as a way to create a certain dialogue between them and the system. They give input, the system gives output. They tweak the parameters of the system or change their input, and the system responds to that again, etc. This is not only what makes the process of art-making interesting for the artist, but also for the audience and their conception of Generative Art as well. This dialogue adds a form chance, serendipity, unexpectedness and likely (controlled) "out-ofcontrol-ness" that makes Generative Art interesting to experience. This, together with our new notion of not-so AA systems, might shift the discourse around Generative Art from art created *by* the machine, to co-creating art *with* the machine.

Search for universal grammar - Another remarkable finding when searching for artworks and analysing these, is that a lot of the artistic grammar that we see in generative art, both in older works as well as in more contemporary generative art, is notably similar to the grammar (aesthetics, composition, rules of play) of e.g. the Russian Suprematist (Malevich, Lissitsky) or Abstract Expressionists (Kandinsky). The Fidenza series for example, has quite some similarities in colour palettes, line divisions, etc. as work from Malevich. Or the hypnotic, dreamlike aesthetic of GAN imagery like Klingemann's work, that bears similarities to Surrealist artists, like Max Ernst or Salvador Dalí. Although partially inherent to the technology, this distorted imagery is often picked up, enhanced, and actively sought after by generative artist in their work, like Klingemann does in Memories of Passerby I (Artsy, n.d).

We think this is a remarkable phenomenon. It is known that many generative artist are searching for a new aesthetic with their art, or are curating their work based on what aesthetics they think is superior to other output of their work. (Molnár, 1975, Onkaos, 2018). But apparently, the search and exploration of artist towards an appealing artistic grammar seems to be universal over time. It appears that rediscovering the language of the right balance, organisation, colour, composition, etc. is still collectively shared amongst artist, yet every decade through different methods, media and technology.





Suprematist painting (1915), Kazimir Malevich. Image retrieved via Stedelijk Museum.

Fidenza#100 (2021), Tyler Hobbs. The Fidenza works have a striking resemblance with the Suprematist 'language' of shapes, composition, and colour. Image retrieved via OpenSea: https://opensea.io/assets/ 0xa7d8d9ef8d8ce8992df33d8b8cf4aebabd5bd270/78000100



Epiphanie (Dream landscape) (1940), by Max Ernst. Image retrieved via Christie's (n.d).



Stills from Memories of Passersby I (2018), by Klingemann. The morphed faces bear similarities with the dream-like worlds in Max Ernst's Surrealist paintings. Image retrieved via Onkaos (2018).

# 7.3. Limitations of the framework & future research

Needless to say, this framework might not be conclusive in every aspect. The framework to an extend has fixed guidelines for how to interpret generative artworks, but in theory multiple readings or interpretations of roles, AA or AS are still possible, as well as multiple interpretations of element categories. We tried to obviate this as best as possible, by defining extensively and clearly what we consider aspects of a role, or AA or AS, and every element category, in order to make it as straight forward as possible how to dissect elements in an artwork, what to fill in the matrix, and where. However, we realise that always some ambiguity in interpretation of these questions might exist. Per person, but also per artwork, as we ourselves have experienced during the analyses as well. For example, in the analysis of Molnár's Structure de Quadrilatères or Klingemann's Memories of Passersby I: one can view certain hardware as Artwork elements, but also as executioners (i.e. Performers) of the work, since they -technically- just perform a task that was assigned to them. We were curious what this 'reading' of these works would reveal in analysis with our framework, which is why we put the computer and plotter as Performer elements in the matrix for these works. Another well-argumented placement, however, would have been just as valid for analysis. This flexibility in interpretation of elements in a work, and moreover: their role in that work, might diminish the conclusive effectiveness of the framework, as multiple readings are still possible. On the other hand however, this flexibility also leaves room for alternative ways of analysing artworks, which ultimately is what we aim with our framework.

We would however like to propose some guidelines that we experienced are valuable to keep in mind when interpreting an artwork. For example:

- in defining what possible elements are there it helps to ask oneself: what components are the experienceable parts for the audience, and what operates on the background/is invisible to the audience? What functions as input, what as 'the system' or transformator of that input, and what is the output of that transformation? What separate components does 'the system' consist of?
- In defining what elements take into account, it is beneficial to evaluate how important that part is for influencing the work as a whole. Not

important, or not able to influence? The element can be omitted in analysis, but do list them under the right category with a short explanation why.

- In defining under which category to list an element: what category traits does this element exhibit? Or: how is this element used in context of this work, and to what category traits does this compare to?

These are not definite or mandatory guidelines for interpretation, but we do advice to stay consistent in interpretation and keep all categorisation of elements the same over analysis. This namely aids the cross-comparison of the results amongst artworks, and eventually representable conclusions. As one can see from the analyses is this study, we did not succeed in keeping the interpretations fully consistent over all artworks, due to progressive insights in what one could dissect as elements within a work, but also due to experimentation with placement of these elements under different categories (e.g. in case of the examples of Molnár en Klingemann mentioned above). We are aware that these inconsistencies might have affected the results and thus conclusions of our analyses.

Due to this flexibility of interpretation, in combination with pre-defined categories, it is likely that not every artwork, or not every element can be 'captured' with this framework. This is also evident in some examples in this study: sometimes an element is not truly "autonomous", especially not in its role. For example when an element in an artwork is just there to "be", or "function as" something, it is hard to answer the question: "how autonomous can this element perform its role in the artwork?". E.g. Rainer's scripted units of material, in Continuous Project - Altered Daily (1970), which are more or less passive object with which is generated, by that do not generate something themselves. It feels therefore a bit odd to still take these elements into account when analysing their Autonomous Ability: they are not autonomous actors in the artwork, so how to answer this question when it seems not relevant? We solved this by including "Not Applicable" on the scale, but we realise that this might skew the results of the analysis. Therefore, we can imagine there might be a an alternative way of incorporating this, that is better for the analysis.

As mentioned before, this research contained a lot of iterations between doing the analysis and developing the framework. While performing one analysis and drawing conclusions from the results, insights on how to interpret elements in a work better, differently, or more extensively often already appeared. What we amongst others realised while going back and forth from designing the framework to testing it in analysis, is that:

- you can define elements, but you also need to define their role within the *context of that artwork* (here we added row /R)
- you cannot dissect all elements without also making their mutual interactions and interdependencies (i.e. sum of parts) a valid element in the framework (here we added column 6)
- You need some sort of scale to indicate on what range AA and AS in an artwork exist (addition of quantitative six-step scale)
- You need to make sure that that scale is not a gliding scale between analyses of multiple artworks. E.g. something that is from high AS in one artwork, can be from low AS compared to the AS of elements in another artwork. Because the ambition with this framework is to make cross analysis of artworks possible, that is something which requires a clear and solid understanding of the terms throughout analysis.
- Artworks from different disciplines apply element categories differently as well. The framework needs a solid structure for element categorisation that works for artworks from all disciplines (addition of the fixed element categories.

Concerning disciplines, we aimed for a representation of multiple art disciplines in our analyses. Work from dance/theatre, sculpture, installations, prints, video and music are represented in this study. However, due to the scope of the research, examples from literature, design and architecture were not included in the analyses. We are aware that this might not provide the full picture of what generative art includes. For future research we therefore suggest that more analyses with more artworks from more disciplines is done in order to make better comparisons and draw more inclusive conclusions from the framework.

Furthermore, to improve legibility of the analyses, we propose to create interactive code tags in the document to facilitate a smoother toggle between the in-text references of the cells, and the corresponding cells in the matrices. Also, we would suggest to think of a method or tool to make comparison of the matrices with each other easier and more clarifying. Done manually this namely is a fairly doable but already timeconsuming task with the results of only eight works, but will become significantly more arduous when more works and thus matrices are included in the cross-comparison.

### 8. Conclusion

As this research shows, the current most used definition of generative art<sup>\*</sup> is broadly defined and technically includes a vast and diverse range of artworks under the same heading. This, in our opinion, sells short to the incredible diversity and differences that exist within this group of artworks. Moreover the current existing frameworks for classifying and comparing generative art, don't go beyond a descriptive approach of the systems within these artworks, and also neglect two important aspects of what constitutes generative art: how autonomous these systems are, and what they contribute to the work as a whole. In this research, we have taken the definition of generative art quite literally, to test existing frameworks, but also our own. Because if that is what one defines as generative (i.e. something that contains autonomous systems to some degree for creating output), we might as well evaluate those autonomous abilities and artistic significance of the generative. We eventually proposed a theoretical framework with the aim to formulate an alternative perspective on generative art, that would honours its variety, while providing a tool for understanding generative art and its generative elements better, through the lens of Autonomous Ability and Artistic Significance. We think we can conclude that this framework allows for a very careful dissection of what the generative is, what its role is within the artwork, how autonomous it can perform that role, what it contributes to the artwork and how important that contribution is for the artwork as a whole. We saw that by being very explicit and meticulous in this, more insights on what exactly is generative in a work and on what level this generative takes place in a work come to the surface. This ultimately facilitates a better comparison between generative

<sup>\* &</sup>quot;Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art." (Galanter, 2003)

artworks, and results in a more clear overview of the differences and similarities between generative artworks.

We think this research illustrates some interesting insights, amongst others that a number of generative works that are normally considered "generative", surprisingly show a lesser amount of autonomous ability and artistically significant contribution to the artwork, than compared to other works that traditionally are not considered generative, or less generative. This illustrates that looking at generative art from this alternative viewpoint may reveal insights about generative art and its properties & characteristics that went previously unnoticed. This framework also highlights that generative art has many "faces": it spans many different forms of art, different types of artworks, and contains different things across various disciplines, times, and even over art movements. Therefore, we can conclude that there still is a lot unexplored and much to dive into when it comes to Generative Art.

We hope this frameworks proves to be a useful tool for this, especially in analysing and comparing Generative Art, that can help in eventually formulate a better understanding of this art form. We can imagine this tool being valuable for art critics, researchers, and curators. But possibly also for makers of generative art themselves, as the framework might reveal opportunities for including generative methods or elements at different categories, or in different modes.

### 9. References

ACM SIGGRAPH. (n.d.). Erwin Driessens, Maria Verstappen: Hot Pool. ACM SIGGRAPH ART SHOW ARCHIVES. Retrieved 17 January 2022, from https://digitalartarchive.siggraph.org/artwork/ erwin-driessens-maria-verstappen-hot-pool/

AllMusic. (n.d.). *Terry Riley: In C - Terry Riley* | *Releases*. Retrieved 17 January 2022, from https:// www.allmusic.com/album/terry-riley-in-cmw0001405495/releases

Anderson, S. (2018). Thinking Machines: Art and Design in the Computer Age, 1959–1989: The Museum of Modern Art New York City November 13, 2017–April 8, 2018. *Technology* |*Architecture* + *Design*, 2(2), 252–254. https://doi.org/ 10.1080/24751448.2018.1497380

Art Blocks. (n.d.). *Fidenza*. Art Blocks - Creativity in Generative Design. Retrieved 9 January 2022, from https://www.artblocks.io/project/78?page=4

ArtJam. (2021a, November 21). *The Generative Art Movement: Why Are These NFTs So Valuable?* Retrieved 19 December 2021, from https://blog.artjam.com/ generative-art-nft

ArtJam. (2021b, December 29). *Complete Guide On NFT Art*. Retrieved 14 January 2022, from https://blog.artjam.com/nft-art

Artsy. (n.d.). Mario Klingemann | Memories of Passersby I - Companion Version. Retrieved 16 January 2022, from https://www.artsy.net/artwork/marioklingemann-memories-of-passersby-i-companionversion-1

Bailey, J. (2018, October 30). *The AI Art at Christie's Is Not What You Think*. Artnome. Retrieved 19 December 2021, from https://www.artnome.com/ news/2018/10/13/the-ai-art-at-christies-is-notwhat-you-think Boden, M. A., & Edmonds, E. A. (2009). What is generative art? *Digital Creativity*, 20(1–2), 21–46. https://doi.org/10.1080/14626260902867915

Carl, R. (2009). *Terry Riley's In C*. Oxford University Press. https://doi.org/10.1093/acprof:oso/ 9780195325287.001.0001

Christie's. (n.d.). Max Ernst (1891–1976) -Epiphanie (Dream landscape). Retrieved 17 January 2022, from https://www.christies.com/en/ lot/lot-4050465

Cohn, G. (2018, October 25). *AI Art at Christie's Sells for \$432,500*. The New York Times. Retrieved 11 January 2022, from https://www.nytimes.com/ 2018/10/25/arts/design/ai-art-sold-christies.html

di Cutò, A. R. (2018, June 6). Vera Molnár: 'I have no regrets. My life is squares, triangles, lines'. Studio International. Retrieved 14 January 2022, from https://www.studiointernational.com/index.php/ vera-molnar-interview-computer-art-paris-mayorgallery

Dorin, A., McCabe, J., McCormack, J., Monro, G., & Whitelaw, M. (2012). A framework for understanding generative art. *Digital Creativity*, 23(3–4), 239–259. https://doi.org/ 10.1080/14626268.2012.709940

*Fidenza by Tyler Hobbs - Collection*. (n.d.). OpenSea. Retrieved 9 January 2022, from https://opensea.io/ collection/fidenza-by-tyler-hobbs

Galanter, P. (2003). What is Generative Art? Complexity Theory as a Context for Art Theory. *In GA2003 – 6th Generative Art Conference*. https:// citeseerx.ist.psu.edu/viewdoc/summary? doi=10.1.1.90.2634 Galanter, P. (2008). Complexism and the Role of Evolutionary Art. In J. J. Romero & P. Machado (Eds.), *The Art of Artificial Evolution* (Natural Computing Series ed., pp. 312–332). Springer Publishing. https://doi.org/ 10.1007/978-3-540-72877-1\_15

Galanter, P. (2016). Generative Art Theory. *A Companion to Digital Art*, 146–180. https://doi.org/ 10.1002/9781118475249.ch5

Galanter, P. (2019). Artificial Intelligence and Problems in Generative Art Theory. *Electronic Workshops in Computing*, 112–118. https://doi.org/ 10.14236/ewic/eva2019.22

Gardner, M. (1970). Mathematical Games. *Scientific American*, 223(4), 120–123. https://doi.org/ 10.1038/scientificamerican1070-120

Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., Courville, A., & Bengio, Y. (2014). Generative Adversarial Nets. *Advances in Neural Information Processing Systems*, 27. https://arxiv.org/abs/1406.2661

Hayward, A. (2021, August 26). Art Buyer Turned \$1,400 Into \$3.3 Million in Ethereum With This JPEG. Decrypt. Retrieved 9 January 2022, from https:// decrypt.co/79247/art-blocks-fidenza-nft-3-3million-ethereum

Hobbs, T. (2021, August 6). *The Rise of Long-Form Generative Art*. TYLER HOBBS. Retrieved 9 January 2022, from https://tylerxhobbs.com/essays/2021/ the-rise-of-long-form-generative-art

Klingemann, M. (2018). *Memories of Passersby I* -*Companion Version* [Installation]. ONKAOS, Madrid, Spain. https://onkaos.com/mario-klingemann/

Mandelbrot, B. B. (1975). Les objets fractals: Forme, hasard et dimension. Flammarion.

Maturana, H., & Varela, F. (1991). Autopoiesis and Cognition: The Realization of the Living (2 (1972) ed.). Springer.

McCormack, J., & Dorin, A. (2001, December). Art, Emergence, and the Computational Sublime. In Centre for Electronic Media Art (Ed.), Second Iteration. The Second International Conference on Generative Systems in the Electronic Arts (pp. 67–81). https://users.monash.edu/~jonmc/research/ Papers/art-2it.pdf

McShine, K. (1970). *Information* [Exhibition Catalogue]. The Museum Of Modern Art, New York City, United States. https://www.moma.org/ calendar/exhibitions/2686

Molnar, V. (1975). Toward Aesthetic Guidelines for Paintings with the Aid of a Computer. *Leonardo*, 8(3), 185–189. https://doi.org/10.2307/1573236

Moma. (n.d.). *Kinetic art* | *MoMA*. The Museum of Modern Art. Retrieved 17 January 2022, from https://www.moma.org/collection/terms/kinetic-art

Monro, G. (2009). Emergence and Generative Art. *Leonardo*, 42(5), 476–477. https://doi.org/10.1162/leon.2009.42.5.476

Onkaos. (2018, October 30). *Memories of Passersby I by Mario Klingemann* [Video]. Vimeo. https://vimeo.com/298000366

OpenSea. (n.d.). *Fidenza by Tyler Hobbs - Collection*. Retrieved 9 January 2022, from https://opensea.io/ collection/fidenza-by-tyler-hobbs

Peitgen, H. O., Saupe, D., Fisher, Y., McGuire, M., Voss, R. F., Barnsley, M. F., Devaney, R. L., & Mandelbrot, B. B. (2011). *The Science of Fractal Images* (H. O. Peitgen & D. Saupe, Eds.; Reprinted 1988 ed.). Springer Publishing. https://doi.org/ 10.1007/978-1-4612-3784-6

Rainer, Y. (1970). *Continuous Project-Altered Daily* [Performance]. Whitney Museum of American Art, New York City, United States. https://whitney.org/ collection/works/47091

Rainer, Y. (1974). *Work, 1961–1973* (First Edition). New York University Press.

Ridler, A. (n.d.). *Mosaic Virus*, 2019. ANNA RIDLER. Retrieved 8 January 2022, from https:// annaridler.com/mosaic-virus/

Riley, T. (n.d.). *List Of Works by Terry Riley*. Terry Riley. Retrieved 16 January 2022, from http://www.terryriley.net/works.htm

Roy, S. (2010, December 24). *Step-by-step guide to dance: Yvonne Rainer*. The Guardian. Retrieved 7 January 2022, from https://www.theguardian.com/stage/2010/dec/24/step-by-step-yvonne-rainer

Shopmaker, B. (2019). Vera Molnar: Paintings and Drawings 1949–1986 [Exhibition Catalogue]. Senior & Shopmaker Gallery, New York City, United States. https://en.calameo.com/books/ 0045073284a4d3aed2145

Sims, K. (2018a). Seven Experiments in Procedural Animation [Video]. Deep Space 8K Theater, ARS Electronica, Linz, Austria.

Sims, K. (2018b). Seven Experiments in Procedural Animation by Karl Sims. Karl Sims. Retrieved 17 January 2022, from https://karlsims.com/ seven.html

Stedelijk Museum Amsterdam. (n.d.). Suprematistisch schilderij (met zwart trapezium en rood vierkant) - Kazimir Malevich. Stedelijk Museum. Retrieved 17 January 2022, from https:// www.stedelijk.nl/en/collection/3130-kazimirmalevich-suprematistisch-schilderij-(met-zwarttrapezium-en-rood-vierkant)

Tate. (n.d.). '*Mobile', Alexander Calder, c.1932.* Retrieved 5 January 2022, from https:// www.tate.org.uk/art/artworks/calder-mobilel01686

The White Review. (2017, October 11). *Interview with Michael Hansmeyer*. Retrieved 14 January 2022, from https://www.thewhitereview.org/feature/ interview-with-michael-hansmeyer/

Vermont International Film Festival. (2014, October 8). *Sol LeWitt*. VTIFF. Retrieved 16 January 2022, from https://vtiff.org/events/sol-lewitt/

Vincent, J. (2018, October 25). *Christie's sells its first AI portrait for \$432,500*. The Verge. Retrieved 19 December 2021, from https://www.theverge.com/ 2018/10/25/18023266/ai-art-portrait-christiesobvious-sold

Yau, J. (2018, April 15). *A Trailblazer of Computer Drawing Gets Her Due*. Hyperallergic. Retrieved 14 January 2022, from https://hyperallergic.com/ 437834/vera-molnar-drawings-1949-1986-senior-and-shopmaker-gallery-2018/

Zentrum für Kunst und Medien Karlsruhe. (n.d.). *Matritzenmultiplikation Serie* 32 - *Frieder Nake*. ZKM. Retrieved 17 January 2022, from https://zkm.de/ de/werk/matritzenmultiplikation-serie-32