

FROM GENERATIVE TO PERFORMING



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Abstract

This article proposes generative art as a framework for creating complex multisensory and multimedia experiences, characteristic of performing arts. Generative art is all art that in whole or part is created by means of an autonomous system, i.e. a non-human system that independently determines features of an artwork that would otherwise require decisions made directly by the artist. The artist will usually take on the role of a framework designer, and the system evolves freely within that framework and its defined aesthetic boundaries. If the historic, non-computer driven predecessors of generative art—especially algorithmic art—much impacted the early visual geometric arts, and more recently even music and literature, it seems that at present this cross-medium potential has been forsaken and most generative art outcomes are visual. It is the goal of this article to propose a model for the creation of generative performances, derived from stochastic evolutionary Lindenmayer systems.

Keywords

Generative Art
Performing Arts
L-system
Theatre of Totality
Complex Systems

1. INTRODUCTION

The designation *generative* appears in 1965, with Georg Nees' exhibition in Stuttgart *Generative Computergraphik*, and again, the same year, together with Frieder Nake. There are a number of definitions of generative art (Galanter 2014; McCormack et al. 2014) that classify it according to media, methodologies or genres, such as systems art, interactive art, algorithmic art, OpArt, BioArt, evolutionary art, among others. The term generative implies an algorithmic structure that is followed for the creation of whatever output the artwork generates. It should be stressed that *generative* art is not a style or genre: it is a process through which aesthetic experiences are produced.

The algorithm is used to combine structure (order) with randomness (chaos), where each iteration becomes the seed for the next iteration, thus resulting in a seemingly infinite sequence of states or combinations, but all within a certain aesthetic boundary defined by the artist/programmer (Dorin 2013). Current generative art is mostly abstract (Galanter 2011), yet there are multiple approaches and studies that deal with the applicability of generative systems to particular areas or fields of study/creation, such as the original plant-growth model (a visual model applied to botany) and its derivatives in visual arts, including most well-known turtle graphics examples, music (Rodrigues et al. 2016; Dean 2017), and literature (Balpe 2005), and Galanter states that "contemporary technology-based generative art explores the same territory as complexity science and is at the apogee of the complexity curve".

However there doesn't seem to be an integrated approach that combines all areas into one integrated score that could make direct use of all of the above: literature, expressiveness, visual and musical elements. Because generative systems essentially produce sequences of code that can be interpreted as colours, spatial coordinates and motion vectors, pitch, modulation, tempo, rhythm, among others, there is no apparent reason why such systems cannot be used to generate interpretation (emotion, duration, aim, intent, etc.) or body-expression (movement, directionality, intensity, force, etc.).

Theatrical performances provide unique experiences. The individual interpretation and overall delivery are exclusive not just to the specific expression of the play but also to the audience. A subsequent performance will likely differ from the first. This is a strength that theatre and the performing arts hold over cinema, video, photography, painting or sculpting, where repeated viewings can reveal missed details, but the pieces are static and immutable. And this strength is shared with digital media art, through controlled randomness and interactivity. Performing arts imply different viewings and experiences. The relationship between the performer(s) and the audience is key to the experience and creates a deeper human bond. The idea of expanded or augmented performance is not new. The Bauhaus advocated an approach to theatre that aimed to integrate technology with performance and László Moholy-Nagy proposed the following:

Man as the most active phenomenon of life is indisputably one of the most effective elements of a dynamic stage production (Bühnengestaltung), and therefore he justifies on functional grounds the utilization of his totality of action, speech, and thought. (...) And if the stage didn't provide him full play for these potentialities, it would be imperative to create an adequate vehicle. But this utilization of man must be clearly differentiated from his

appearance heretofore in traditional theatre. While there he was only the interpreter of a literarily conceived individual or type, in the new Theater of Totality he will use the spiritual and physical means at his disposal productively and from his own initiative submit to the over-all action process. (...) The Theater of Totality with its multifarious complexities of light, space, plane, form, motion, sound, man—and with all the possibilities for varying and combining these elements—must be an organism. (Schlemmer, Moholy-Nagy and Molnár, 1961)

This multifunctional *organism*, with several different vectors of action and expression, shares some similarities with the Body without Organs (BwO): “The body without organs is an egg: it is crisscrossed with axes and thresholds, with latitudes and longitudes and geodesic lines, traversed by gradients marking the transitions and the becomings, the destinations of the subject developing along these particular vectors” (Deleuze and Guattari 1988). To materialize a BwO is to actively experiment with oneself, to draw out and activate the virtual potentials, through “becomings” with other BwOs. Moholy-Nagy’s claim focused on the transient and organic nature of the performing arts, where several (f)actors, human and environmental, assemble in configurations—“becomings”—that are never quite repeated, yet maintain a certain structure that allows us to recognize the piece being performed. As Davis explains:

The intuition is that the center of this spectrum from random to simplistically ordered structures in art is much richer than either of the extremes; all blank white canvases are more similar to one another than to any Impressionistic painting. Most art appears to fit into a band moderately between either complete order or total disorder. A simple explanation of this property of art is that the human mind is itself constrained to find appealing those visual and auditory event combinations that share properties of both symmetry and asymmetry, hierarchical complexity and subtle disorder, and that combinations of these loosely-defined properties tend to place interesting pieces in the center of this spectrum. The question remains, however, as to what formal abstractions can be proposed that can broadly generate art that follows these contours of moderate complexity, yet is flexible enough to allow the structural extremes. (Davis 1997)

In order to bring these two concepts together—generative art and the theatre of totality—a system is needed to generate all the relevant information, characteristic of a performance: light, space, form, motion, sound, music, emotion, action, speech, interaction. Let us refer to such a system as a *performance generator*.

2. TAXONOMY

The central concept of L-systems is that of rewriting, which is a technique for defining complex objects by successive segments of an initial object using a set of rewriting rules, like the classic von Koch’s snowflake curve example, later restated by Mandelbrot (1983). Koch and Mandelbrot’s models can produce infinite outcomes/refinements, but because they are repetitive, they soon become predictable, and thus are of limited interest.

2.1. Complexity

Generative systems can be expanded (and subsequently classified) according to their complexity, which can be a direct result of the use of randomness in the generator. They can vary between ordered systems, which are serial, repetitive, patterned; and chaotic systems, which are totally random, devoid of structure. Complex systems are those that are both ordered and chaotic, and are characterized by the appearance of patterns and elaborate, non-predictable yet recognizable structures. One important consideration about introducing randomness in a generative system: usually randomness is achieved by using pseudo-random number generators, but it can also be conceptually introduced as "*something that the artist does not control*", such as audience-dependent data (number of people, seating distribution, male/female percentage, etc.) or audience-generated data (noise, physical participation, tweeting during the performance, etc.). In this light, chaos-complexity is directly linked to audience interaction, which is another differentiation factor.

2.2. Sensitivity to Initial Conditions

These systems also vary in terms of their sensitivity to initial conditions, and can be either non-sensitive (also known as closed) or sensitive (open). Non-sensitive systems can only generate a finite number of elements, so that the final result has no significant dependency on the initial generation. This way, the system's structuring device—the exploration generator—defines the overall result. Sensitive systems, on the other hand, will eventually generate a potentially infinite number of elements: the system starts with an initial generation that strongly influences its evolution. Small changes in the initial generation bear significant changes in the final result.

2.3. A Careful Mix of Order and Chaos

The framework advocated in this article—the performance generator—uses complex systems. Most performing arts are based in a vocabulary that the audience can recognize and interpret, but constant or predictable repetition, obtainable through ordered systems, soon becomes monotonous and uninteresting. At one point the concept of complexity was overlapped by that of chaos and randomness, in other words, complexity was regarded as the opposite of order. But nowadays complexity is recognized as a balance of order and disorder (Galanter 2014). The key to producing an engaging artwork is to balance order and chaos, and one means to achieve that is through evolutionary stochastic L-systems. A performance structure (or score) can be generated, where the audience will be engaged in/by sub-structures (acts), and yet be surprised by unexpected changes and nuances (variations to the plot), all within well-defined aesthetic and cognitive boundaries—the style and content of the performance, the artwork itself.

3. DESIGN STAGES

Generative art systems can be characterized by three stages in their design: (1) structuring device definition, (2) amplification mechanisms definition and (3) event detection.

3.1. Structuring Device

The first stage corresponds to the design of the structuring device, through which the artist/creator sets the boundaries and aesthetics of the artwork. This is essentially a set of rules and procedures—an algorithm, a set of acquisition rules—the vocabulary that will be used in the system, and a set of potentiation or modulation mechanisms through which the vocabulary will be manipulated, changed or combined.

Usually L-systems are built from grammars, comprising symbolic axioms and rules. Each symbol can then be interpreted in any way, as turtle graphics instructions or musical note pitch and duration, among many others. But more complex directions are possible and desirable. Let us use the word vocabulary to designate the set of all possible symbol replacements we can consider using. When designing a structuring device for a performance, the choice of vocabulary is as important to its outcome as the rules that will manipulate that vocabulary. Consider this very simple example of an L-system grammar used to build (remix) a situational dialogue between two characters, Roland and Mr. Fineberg. Each constant (represented by + and -) is a character; each variable is an emotion (E), an action (A) and an interference (I):

Variables: E, A, I

Constants: +,-

Axiom: + E

Rules: (+ E → + A), (+ A → I - E), (- E → - A), (- A → I + E).

Vocabulary:

Characters: Roland (+), Mr. Fineberg (-)

Emotions: X cried; X shouted; X's brain reeled;

Actions: X knocked at the door; Only at the nineteenth knock did X raise his head; X said "Come in—that dashed woodpecker out there!"; X said "Please, sir, it's about my salary."

Interferences: Maybe he was endeavoring to be humorous; He was a married man himself; His chief characteristic was an intense ordinariness.

Let us assume that each time a variable comes up in a generation, a random element is chosen—and removed, to avoid repetition—from the respective vocabulary. We can then populate the vocabulary that relates to characters, emotions, actions and interferences.

Table 1
Successive generations

<i>Generation</i>	<i>String</i>	<i>Vocabulary instantiation</i>
0	+ E	Roland's brain reeled
1	+ A	Roland said "Please, sir, it's about my salary."
2	I - E	His chief characteristic was an intense ordinariness. Mr. Fineberg shouted.
3	- A	Mr. Fineberg said "Come in — that dashed woodpecker out there!"
4	I + E	Maybe he was endeavoring to be humorous. Roland cried.

Issue 1: The above sentences, presented as emotions, actions and interferences, are basic, and they could have been automatically generated from a set of verbs, adjectives and adverbs, or from textual analysis of existing texts—as was the case—thus enabling one of today’s most widely distributed activities: “remix, cut and paste”. It is not the goal or scope of this article to dwell in the field of computer generated literature, but the options abound, as the NaNoGenMo¹ initiative can attest, as well as one of its best known cases, Nick Montfort’s World Clock.²

¹ <http://arcade.stanford.edu/blogs/nanogenmo-da-da-20>

² <https://nickm.com/post/2013/11/world-clock/>

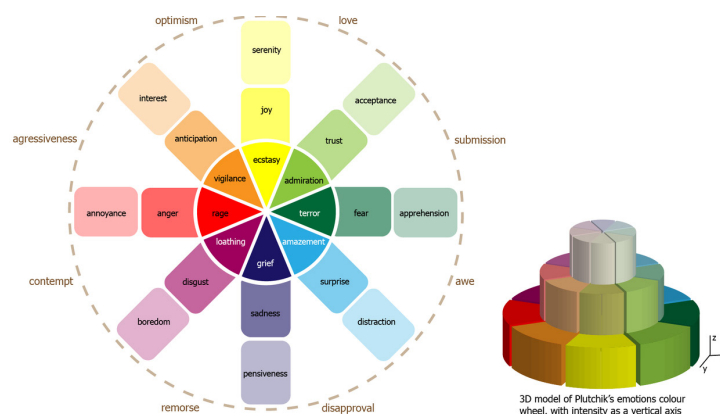
Issue 2: Even though the vocabulary is randomly instantiated, the structure is too repetitive and soon becomes monotonous; therefore stochastic systems are welcome in disrupting repetition and predictability.

Issue 3: Stage direction. Performing a dialogue needs timing, body and facial language and expression, pauses, physical interaction with objects or performers, among others directions. Therefore the structuring device will also have to consider these variables for each generation, even if allowing for stochastic variations, which will contribute to the required effect.

Going back to Moholy-Nagy’s seven variables of the Theatre of Totality (ToT)—*light, space, plane, form, motion, sound, man*—the structuring device should address all of them. The previous example used a vocabulary that would at most address man, yet Moholy-Nagy’s vision for *man* implied several more degrees of freedom than the classical theatrical interpretation of pre-written text. The generative art approach proposes that a coherent generative system—and its structuring device—can indeed tie all variables together, and where the choice of vocabulary is crucial in defining the type, style and nature of the performance. The ToT performance creator’s role is similar to that of the visual generative artist who designs an interactive artwork, defining its aesthetic boundaries, relating colour, spatial coordinates, movement and form.

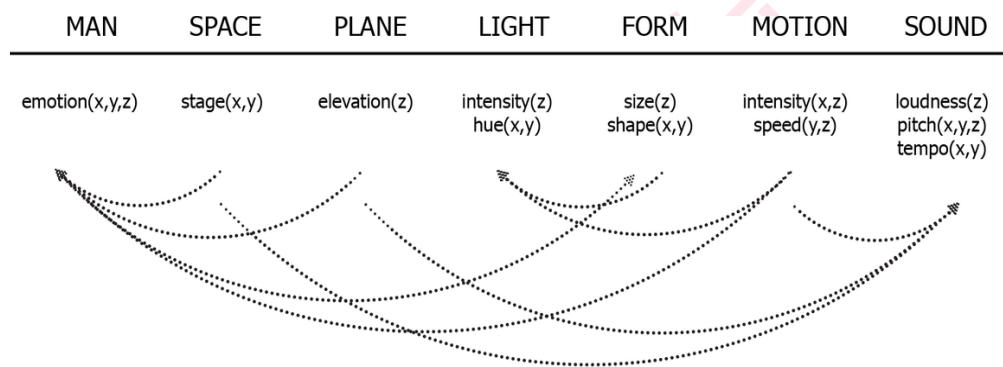
There are several studies regarding cross-modal correspondences in perception, and Spence’s comprehensive tutorial highlights some of them (Spence 2011). For example, high pitched sounds are usually related to small bright lights and to higher spatial positioning, whereas slow movement is associated to darker ambiences, long and low pitched sounds. More broadly, loudness is usually associated with brightness and size; pitch with elevation, size and spatial frequency; acoustic tempo/rhythm is usually associated with luminous and spatial frequency. If these relations suggest mappings between sound and spatial positioning, motion, position and form (at least as far as size is concerned), a connection to man is still missing. For that purpose let us use Plutchik’s work in *The Nature of Emotion* (Plutchik 2001).

Fig. 1 Plutchik’s emotion colour wheel. If the outer flaps are bent toward the centre, its shape resembles that of a cone, with intensity as its vertical axis. The top tier is smaller since intensity is at its lowest, therefore making all the respective emotions very close to one another.



Plutchik created a three-dimensional circumplex model of emotions—figure 1 best known through its planar projection as the *emotions wheel*. He assigned colours to emotions, with smooth transitions (slight changes in hue or saturation) between neighbouring emotions and harsh distinctions (significant changes in hue) between different and opposite emotions, making the wheel graphically more evident both in terms of intensity and similarity/opposition. Given any starting emotion, the following generation will be obtainable through its direct neighbours—or its direct opposition. For instance, using *annoyance* as an axiom, possible first generations would be *anger*, *interest* and *boredom*—or *apprehension*; if fear is generation n-1, generation n candidates are *apprehension*, *terror*, *trust* and *surprise*—or *anger*. There is emotional coherence in all these evolutions, which facilitates bringing plausible evolutionary story-telling characteristics into the performance.

Fig. 2
Mapping Plutchik's emotions three-dimensional space model (x,y,z) to the ToT variables, and cross-modal feedback.



This model allows for reverse mapping between emotions (*man*) and colour (*light*), as well as *space* and *plane* (derived from the emotion three-dimensional spatial positioning on Plutchik's model), thus completing the mapping onto all seven variables of the ToT, as shown in figure 2. The generative system will directly assign *man* with generated emotions and/or dialogues and directions, and all other performing agents will be connected by cross-modal correspondences, and/or feedback mechanisms.

3.2. Amplification Mechanisms

The second level is the amplification stage, where cognitive extensions are added to the system, correlations are made between different media types and collaborative practices may occur. Generative art is often recursive, and feedback mechanisms can be triggered by information gathered from the performance itself, and be used to influence the direction and evolution of the generative artwork. In this way, sound, image, movement, emotion, can be interpreted and manipulated in a dynamic performance. The seven ToT variables can then be addressed by mapping the outcomes of the *emotion* and *dialogue generators*, where the dialogue lines are engulfed in emotions. However, the reverse exercise seems just as appealing: take any existing written dialogue, break it down into smaller segments (parts, e.g.: beginning, middle, end), identify the emotions in every speech and tag them according to the colour wheel emotions and the part of the text in which they appear. When an emotion is generated, a non-repetitive dialogue sequence is also generated, as a function of the current part of the performance (same structure as before, e.g.: beginning, middle, end) allowing for stochastic variations within emotions and dialogues. The result will be a re-written, probably surreal version of the text, that has the same text/

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Original text here:
<http://www.gutenberg.org/files/8713/8713-h/8713-h.htm>

interactions and overall emotions, but in a (*slightly*) different order. The emotion sequence can be respected, even if allowing the system to insert controlled random detours into neighbouring emotions. Table 1 displays a partial variation on the first lines of *The Episode of the Landlady's Daughter*, part of *A Man of Means, A Series of Six Stories*, by Pelham Grenville Wodehouse and C. H. Bovill.³

Movement is the first human language, and goes beyond vocabulary and reason, that which cannot truly be expressed through words, and so another important element in the proposed performance framework is interpretive dance, which translates specific feelings and emotions, human conditions, situations, or fantasies into a combination of movement and dramatic expression. Russian ballerina, Anna Pavlova, when asked the meaning of one of the dances she performed, replied, "If I could have said it, I shouldn't have had to dance it" (Hava-Robbins 2002). It appears adequate to advocate interpretive dance as one of the main focuses of *man* and *motion*. Costume is another important amplification mechanism, and Oskar Schlemmer produced some of the richest avant-garde examples of the Bauhaus period (Fox 2015), which could easily be adapted into the 21st century, thus further connecting *man* and *form*.

Fig. 3

Mapping man to form— or vice-versa—where size varies according to plane height (elevation). Bauhaus costume by Oskar Schlemmer, *Das Triadische Ballett*, 1916

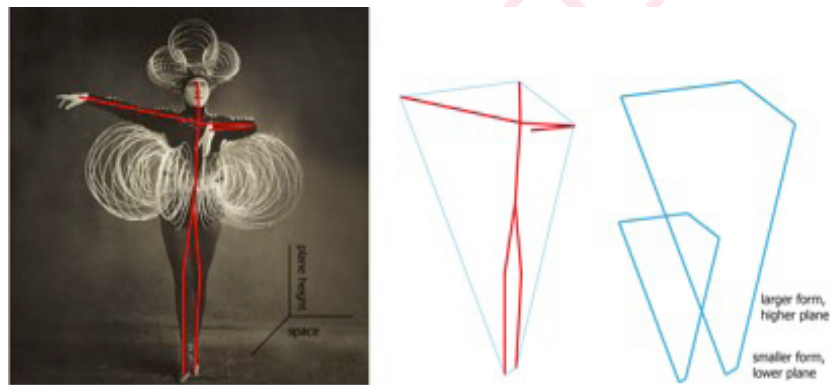


Fig. 4

A simplified vision of the stage/performance. The character on the left is using the *trust* space. The generative scenario behind him shows mainly lower plane activity and smaller forms, according to his spatial placement, whereas the character on the right is causing more disturbances (in colour, frequency and form) since he is standing, therefore using the higher planes, on the *anger* space.



The dialogue can be projected, as a replacement of the spoken form, or its reinforcement, thus becoming part of *light*, along with other expressive projections that use *form* (shape and size)—see figure 3—and *motion* (intensity and speed), leaving all aspects of body expression to *man*, and transforming the performance into a unique generative remix, whose true challenge is to extract and communicate the emotional and cognitive essence of the original work. This is a very different direction than that of artists/performers offering predetermined content to the audience, and through these mechanisms each performance can substantially differ from its predecessor. These mechanisms can also help era-

licate the problems mentioned in issue 2 of section 3.1, namely by creating silences, musical moments, body motion, lighting effects, etc. between different generations (i.e.: between emotion / dialogue sequences). A fully functional performance generator should consider the overall cross-modal evolution of the performance, with all its variables, rather than just the individual components.

3.3. Event detection

Finally, the third level is the event detection stage, where the artist has already made adjustments to the system, both in terms of structuring device and amplification mechanisms, and is now concerned in identifying the more interesting occurrences as the system runs. The artist can attain this stage through trial and error, and then identify unique generation sets as full-bodied artistic expressions of the initial concept and aesthetics, and assume them as a *performance score*. But it can also be attained as a real-time generated performance, by the artist, performers and audience, with as many degrees of unpredictability as the artist has decided to use randomness and interaction in the system.

4. ISSUES

4.1. Distributed authorship

A problematic issue can emerge with the use of a performance generator by a third party. Since the generator itself outlines the scope within which the performance takes place—and is assumed by its author as an artwork—and it can then be used to produce radically different concept performances, the performance authorship is clearly distributed. Furthermore, if the performance is obtained through a real-time system that takes into consideration both performers and audience data—like motion detection, noise (on and off-stage), real-time hashtag detection in shared media, audience held light emitting devices, etc.—both performers and audience are considered as part of the performance authorship (even though the act of purchasing a ticket or participation is often tied to a contract relinquishing co-authorship rights), thus potentially leading toward a distributive, democratic model, potentially defined as “an interplay of negotiated capacities of a number of actors, including the original system developer, producer, director / system parameterizer, performers and audience, to create the content, structures, form and affordances of the performance” (Jennings 2016), whose biggest risk is the *Kilo-Author* (Austin 2015).

4.2. Audience engagement and role

By interacting with the system, and becoming a co-author, the audience gains a new dynamic and empowering role, away from the (usual) passive consumption that takes place during a standard performance. In this context we can consider the existence of a creative audience, and this creativity as a form of social interaction, rather than the outcome of a social / cultural activity, as an emergent phenomenon of audiences-as-communities, reminiscent of Latour’s actor-network theory, involving individuals, groups, apparatus and systems. Not all audiences are willing to participate, and the motivation / ability / opportunity model has been used in their study (Wiggins 2004), so that mechanisms to change their

audience members from disinclined to participate, to being inclined to participate, to participating can also be implemented. Interactive audience engagement has not been studied in depth, but interesting findings have been made, relating mood and music (Speicher et al. 2016), audience as performer and composer (Walker and Bellet 2016), and physical audience engagement in the performance (Simon, Van Der Vlugt and Calvi 2016).

5. CONCLUSION AND FURTHER DEVELOPMENTS

Performances are becoming increasingly hybrid and technology permeates the stages. But the core of these complex systems is the content of the performance, not (just) the *mise-en-scène*. In recent years there is not only a notorious ethical redirection in performing arts, but also an overtaking of stages by hybrid bodies in hybrid motion, non-human, natural and artificial subjectivities, as the conscience of post-humanism sets in (Balona 2017). Improvisation has gained credibility in connection with task or game structures that depend on individual interpretation of rules in performance (Jowitt 2011) and Martha Graham described the dancer / performer as an *athlete of God*, with openness to the past, with memory of choreography and vocabulary, and the present, by means of creativity and reactivity (Carter and O'Shea 2010).

Interpretive dance and the Theatre of Totality can be brought together by means of a stochastic evolutionary L-system—the performance generator—that falls within Galanter's *complexism* theory (Galanter 2011). "Experimentation has replaced all interpretation... No longer are there acts to explain, dreams or phantasies to interpret... instead there are colours and sounds, becomings and intensities" (Deleuze and Guattari 1988). Expect the unexpected. The understanding of *performance as sensation*—as a force that disrupts perceptions and prejudices, to make perceptible the imperceptible forces - paves the way for experimenting with complex systems, such as the one advocated by the author.

If you have experimented with the many online L-systems turtle graphics applets,⁴ you will know that writing a successful L-system (i.e.: that produces appealing graphics) is not an easy task, let alone an evolutionary stochastic L-system whose outcome is a performance, as illustrated in figure 4. Nevertheless the potential for producing thoroughly entertaining, engaging and radically different events / performances, even the refinement process itself—as a series of interactive workshops, in order to reach a performance score—is the drive behind on-going developments, namely by determining which variables—emotions; actions; dialogues; spatial, scenic and sonic atmospheres—are key to make creators, participants and audience relinquish their control to determinism, chance and chaos and enjoy meaningful performative experiences.

⁴ Such as <http://www.kevs3d.co.uk/dev/l-systems/>

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