

generative art and rules-based art
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In previous papers I've described generative art as a broad and inclusive category that is as old as art itself. Generative art as such is uncoupled from any particular ideology, style, or school of art theory. It is simply a way of making art, and in that respect it is something of a blank slate.

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.ⁱ

While this definition has gained some currency, it's not as self-contained and transparent as perhaps it should be. For example, many readers take it to reinforce a common misconception; that generative art is essentially a sort of computer programming. This is mistaken, and the supporting text goes to some length to make the point that generative art long preceded computers. A "procedural invention," for example, can include a chemical reaction, the use of living plants, condensation and crystallization processes, melting substances, or any other physical process that can take place autonomously.

The key is that generative art happens when an artist chooses to cede some degree of control to an external system, and the artwork thus results from more than just the moment-to-moment intuitive decisions of the artist. Unfortunately, to date the notion of generative art has been marginalized. It is my hope that articles such as this one can help correct this situation. All will be better served if the long history of generative art is recognized as being tightly bound to the canon of mainstream art in galleries, museums, and the academy.

For example, generative art is threaded throughout 20th century art movements, but it is rarely called "generative art." There are movements and tendencies referred to as "systemic art" or "rules-based" art. These are often confusing convolved with movements such as minimalism and conceptual art.

Unfortunately the terms "generative art" and "rules-based art" are sometimes used interchangeably. In this article I hope to add clarity to the language, show that the terms are indeed usefully different, and illustrate this with some examples.

A full exploration of the historical relationships between rule-based art and generative art and the related art movements could fill a book or even a career. To limit the discussion I'm going to focus on two exhibits from the not-too-distant past. I'll offer a brief overview of each exhibit and some critical observations.

Finally I will enumerate a number of rule types, and indicate which constitute generative methods and which do not. I happily concede that this is a field in need of much work, and that I offer these somewhat speculative observations as an informed first effort.

logical conclusions

Subtitled “40 Years of Rules-Based Art,” this gallery show took place at PaceWildenstein in New York City from February 18 to March 26 in 2005. I was lucky enough to see this impressive exhibit in person, but I am limiting my comments to the evidence as presented in the corresponding catalog.

The show and catalog was obviously a labor of love on the part of gallerist/curator Marc Glimcher, along with co-curator and editor Bernice Rose, and writers Judy Knipe and Patricia Hughes. With the catalog’s essays for support, and a number of pieces on loan and not for sale, this exhibit had much more of a museum-like quality than one might expect at a commercial gallery.

In his opening essay Glimcher offers this definition of “rules-based art”:

For purposes of this investigation, rule-based art will be defined as art created utilizing one or more logic-based systems to direct the design and creation of the object. Their foundation may be mathematical, such as those based on geometric and number theories. Or, they may be founded in logic: for example solipsism and other tautological constructs. And finally, there are applications of game theory, in which the artist forces the art to conform to certain arbitrary (if personally meaningful) rules.ⁱⁱ

This definition points in some useful directions, and properly implies the overlap but not equivalence with generative art. Unfortunately, it is also problematic. The definition invokes technical sounding terms that are externally well defined. By comparison the works actually shown are either well outside of this definition, or sometimes within the definition in ways that are trivially reductionist. In other words, the definition as offered compared to the work shown is both over-inflated and yet not inclusive.

“Mathematical systems” are typically systems of axioms and deduced propositions. Such activities are not evident in the works cited, but there are pieces that are based on simple arithmetic.

While solipsism and tautological constructs are part of “logic,” they are deflated aspects devoid of the long chains of reason logical systems would usually connote.

The invocation of “game theory” is simply mistaken in that game theory as a discipline is the mathematical analysis of economic situations where multiple agents attempt to optimize a series of interactions to their own benefit. Some of the artistic processes exhibited are vaguely game like, but they are single player games devoid of any competitive or economic aspect. In other words, they may be games in the common sense, but they are not subject to game theory as such.

The situation, however, becomes much more confused as the catalog lists the operative rule for each work exhibited. The rules, compiled by Patricia Hughes, bare little correspondence to the definition offered by Glimcher. For better or worse the notion of what a rule is is so freely interpreted by Hughes that the term “rule” almost loses its meaning.

Here are examples from the front of the catalog.

ad rienhardt – [Abstract Painting, Blue](#)

The work is classic Rienhardt with 3 10" x 10" canvases joined vertically. Each square canvas is divided into 3 by 3 zones of blue paint that are barely discernable as being different shades.

The rule offered in the catalog is a quote from Ad Rienhardt's essay "Art as Art," which I will only partially re-quote.

...one formal device, one color-monochrome, one linear division in each direction, one symmetry, one texture, one free-hand brushing...No lines or imaginings, now shapes or composings or representings, no visions or sensations or impulses...nothing that is not of the essence.ⁱⁱⁱ

Certainly there is a correspondence between the given rule and the piece. But this is not a mathematical, logical, or "game theory" rule. It is more of a manifesto that constrains the activity of the artist within a narrow range. Visually the work does have a simple geometric aspect, but that is not the rule cited. The curators seem to be silently broadening term "rules-based" to qualify the painting as such. This happens in many places in the catalog and exhibit.

But even allowing the painting may be rules based, the painting serves as a good example of how not all rules-based art is generative. The rules as stated do not have sufficient specificity or autonomy to allow the artist to give up control to the rules, and allow them to take over and produce the art. In short, the rules cannot themselves generate anything specific. Some rules-based art may be generative, but some (e.g. this painting) is clearly not.

alfred jensen – [The Apex is Nothing](#)

Unlike the Rienhardt, this painting by Alfred Jensen not only fits within the previously quoted definition of rules-based art, it also qualifies as generative art, albeit of a very simple kind. The rule offered by Hughes references the use of Mayan base-20 numbers, and indeed these are literally painted within a partial grid. Translated into customary Arabic base-10 numbers the pattern revealed is shown here.

18				18		0				0
	16		16				2		2	
		14						4		
	12		12				6		6	
10				10		8				8
					18					
9				9		11				11
	7		7				13		13	
		5						15		
	3		3				17		17	
1				1		19				19

Not only does Jensen use arithmetic progressions, he lays them out in a playfully symmetric arrangement. The rules thus applied, Jensen transfers a part of the composition to an external autonomous system, and surrenders (in part) moment-to-moment intuitive judgment. This is the defining aspect of generative art.

(As a side note, the use of “18” in the centermost cell seems to fail if the intent is to link the four “X” shaped number sequences in a numerically significant way. “18” seems rather arbitrary).

It is frustrating, however, that the rule noted in the catalog is the following excerpt from the artist's notebook:

Take an object
Do something to it
Do something else to it
“ “ “ “ “

Take a canvas
Put a mark on it
Put another mark on it
“ “ “ “ “iv

During the heyday of pop, minimal, and conceptual art serial processes captured the imagination of many disparate artists and critics. In Mel Bochner's essay "The Serial Attitude" he rightly points out that "Serial order is a method, not a style." In the same article Bochner shows an example of how a two dimensional array of letters can be decomposed into multiple serial presentations.^v

Perhaps this is what Patricia Hughes, who cataloged the rules for each piece in the catalog, had in mind. She may also had in mind a kind of early performance art where the artist executes (a frequently absurd) script.

But this is not a piece about performance or one dimensional serialism. It is a piece about relationships in two dimensions, and it seems like the wrong rule was cited. In any case here, much like Jensen in the preceding piece, Johns has ceded control of one aspect of the piece to a generative process, and Grey Alphabets serves as an example of a work that is both rule-based and generative.

It should be noted that serialism, which this piece does not exhibit, is indeed also a simple generative system. And Bochner's observation could well be generalized to say "generative art is a method, not a style."

logical conclusions closing remarks

I realize that the above may seem to be awfully harsh, as I am seriously questioning way the curators have conceptualized the central element of their exhibit, the "rule." It would be tragic if my comments here steered those interested in generative art, or any kind of art, away from this catalog. It is clearly a "must read" for anyone with interests in the vicinity of generative or rules-based art. The identification of the topic in the art mainstream alone is a breakthrough. This is a collection of artwork as challenging and inspiring as one is likely to find anywhere. And the degree of thought and care put behind the exhibit is high, especially relative to the expectations of a gallery show.

And as you will see later in this article, I think Hughes is on to something in expanding Glimcher's more tightly scoped definition of rules-based art.

beyond geometry

Subtitled "Experiments in Form, 1940's-70's" this significant exhibit was shown at the Los Angeles County Museum of Art, and was conceived and organized by the Museum's curator and department head of modern and contemporary art, Lynn Zelevansky. The exhibit ran from June 13 to October 3, 2004. Unfortunately I was not able to see this exhibit in person, and know it only by the handsome catalog published by MIT Press.[4] There is also an impressive [website](#) with many of the same materials.

The real breakthrough achieved by this exhibit is best summarized by the forward, written by Andrea L. Rich, LACMA President:

Beyond Geometry: Experiments in Form, 1940's-70's looks at the history of post-World War II abstract art, examining the role of radically simplified form and systematic strategies in vanguard work from Central and Western Europe and North and South America. It is the first major museum exhibition to treat these issues art historically in an extensive international context. It is also the first to examine South American geometric art beyond a regional situation.

An essay rather than a survey, Beyond Geometry tracks parallels, intersections, and divergences in the evolutions of what, by the late 1960's, had become an expansive intercontinental discourse. At the same time, it questions the precedence often given to U.S. minimalism in previous accounts of the period.^{vi}

Where Logical Conclusions tends to maintain the late-modernist spirit of the work shown, Beyond Geometry tends towards postmodern deconstruction. The impulse to move to a broader multicultural view of minimalism and related movements is, in this regard, a great service. But at times the superimposition of a distanced ironic view eliminates the opportunity to take the artists system literally enough to drill down on them for further analysis. But there are many writers in the catalog, and it would be wrong to paint them with a single brush.

Zelevansky's opening essay focuses on the minimalist impulse to create literal objects; objects that are neither paintings nor sculptures (to paraphrase Judd), and are in a sense atomic ontological entities that start and end with themselves.

A number of generative artists are mentioned, but (as is typical) not identified as such. I found myself wishing the systems themselves were inspected with more care. For example, Zelevansky does little to differentiate between artists like Donald Judd who sent plans to fabricators, and artists like Elsworth Kelly who surrendered composition to random procedures.

The move from minimalism to conceptualism is not seen as a move from specific concrete objects for their own sake to specific concrete ideas for their own sake. Zelevansky contends that the use of systems was a strategy to point attention "upstream" from the object. But in doing so the art wasn't about conceptual systems, but rather the conceptual systems were merely a means to

create art about art. To be sure some conceptual art was art about art. But relative to the claims of many other conceptual artists, this view seems to be revisionist art history in the service of postmodernism.

Miklos Petemak offers an interesting essay on “art, research, and experiment” trying to illuminate the relationship between “scientific methods and systematic concepts.” But his understanding of science seems to be science as popularly described in the (postmodernism dominated) humanities. For example,

Alongside the proliferation of artistic forms, terminologies, and means of expression, we can discern similar phenomena occurring in the sciences. Paralleling the reflexive concretization of artistic processes and mediums are analogous developments, such as the issues raised by the critical philosophy of science, the theories of Thomas Kuhn regarding the structure of scientific revolutions and paradigm shifts, Michel Foucault’s archaeologies of knowledge, and Paul Feyerabend’s anarchist epistemology, delineated by the title of his best-known book, Against Method. There are numerous concrete instances of collaborations between the arts and the new scientific disciplines arising in the period under discussion, such as computer science and its far-reaching consequences, cybernetics, systems theory, communication, and information theory.

To be sure, contemporary artists are putting technologies to good use, and healthy collaborations abound between artists and scientists. But the notion that the direction of contemporary science is being plotted by postmodern writers such as Foucault and Feyerabend is simply out of touch. Most scientists tend to think that Kuhn is on to something with a fuzzy notion of paradigm shifts, but even Kuhn himself seems to vacillate when it comes to a hard notion of incommensurability.^{vii} And among the vast majority of those scientists who care to follow, views on method from Foucault and Feyerabend are either generously labeled as non-science, or less generously as nonsense.^{viii}

Brandon LaBelle’s short section on “Performing Geometry” is well worth mentioning as a nice summary of systems-based music to accompany the exhibits “Sound Room.” Recognition of related sound art in a visual art context is a trend to be encouraged.

The closing article by Ines Katzenstein somewhat helpful in giving background on some of the included work. But the overall tone was so overtly political, again in a cliché postmodern manner, that I was left asking at the end, “what does this have to do with geometry?”

But as with Logical Conclusions, there is much more to respect and recommend in Beyond Geometry than to complain about. It’s a treasure trove of mainstream (and not-so-mainstream) art that is either truly generative or resonant with the generative impulse.

Again, my interest is in moving generative art into the mainstream, and underscoring how interwoven generative art already is with traditional art. Both of these exhibits come tantalizingly close to making this argument, and yet the mainstream art world remains blind to generative art as the sweeping inclusive tendency it is.

rules-based art and generative art

Rules-Based art and Generative art are independent realms with an area of overlap. As previously noted a number of generative systems are not rule-based at all. These can include various forms of mechanical painting and drawing machines, chemical reactions, the use of living plants, condensation and crystallization processes, certain forms of kinetic sculpture, and so on.

In this section I'll list a number of art-rule types, and indicate whether or not they would constitute a generative system. Generally rule systems which are not generative lack the specificity and autonomy to create results "on their own."

It should be remembered that both rules-based art and generative art are fuzzy categories. Some works exist on the grey border of either or both. In addition, a given work of art may be dominated by the application of rules or the use of generative systems, or the generative or rules-based aspect of a piece may be slight.

As important as the question of whether a given work is rules-based or generative or both, is the question as to why an artist has chosen to work that way, and whether the use of rules or generative methods are indeed part of the content of the work, or merely a means to some other end.

In the following examples I've tried to limit illustrations to the pieces used in Logical Conclusions or Beyond Geometry. Interestingly, both exhibits share some of the same artists and even some of the same pieces.

The intended subtext here is that generative art is threaded throughout mainstream 20th century art, and indeed that a significant "generative art show" is contained within both Logical Conclusions and Beyond Geometry.

A number of examples are linked below. When an online image of the exact piece from the given exhibit was not available I've linked to similar pieces by the same artist. Over time some of these links may break. Thus is the ephemeral nature of web-based publications.

rule systems which are not generative

As noted earlier, some rule systems are not also generative systems. Generally rule systems which are not generative lack the specificity and autonomy to create results "on their own."

constraint rules

Constraint rules effectively limit and thus define the composition space of a piece. For example, "the artist will use a 4' by 3' canvas, and only cobalt blue and black paint." An artist might choose to use to use constraint rules to create controlled experiments (in the case of Albers), or to press an art-theory point (as with Manzoni), or to simply activate the creative process by reducing an infinity of options to a workable number (as with Zittel).

Josef Albers – (Logical Conclusions) [Variant V](#) linked here is very similar to the piece in show. For many years Albers constrained his painting to rectangular concentric areas to experiment with the interaction of color.

Piero Manzoni – (Logical Conclusions) [Achrome](#) here similar to piece of the same name in the exhibit from the same time period. Manzoni created a number of all white paintings where the variable allowed was the texture of the materials used.

Andrea Zittel – (Logical Conclusions) In an effort to activate her creative process Zittel decided to enforce the rule that “[all dresses should only be made from rectangles.](#)” This move resulted in an impressive body of work.

rules which present abstract scores for free interpretation

Abstract scores for free interpretation present systems of abstract symbols without a intended or predefined mapping into a multidimensional qualia space. The live performer invents a mapping from the abstract symbols into a property such as pitch, or color, or energy level, and then performs the score. Needless to say, some of these mappings will be more improvisational than others.

Earle Brown (Beyond Geometry) – A different piece from Earle Brown was presented in the Beyond Geometry Sound Room. The textbook example, and early high bar, of an abstract score for free interpretation is Earle Brown’s [December 1952](#). The players translate the abstract parameters of graphic forms into sound by a performing mappings of their own invention. For example, the horizontal dimension might be pitch, and the vertical dimension loudness.

inspirational rules

For some, the notion of “Inspirational rules” will appear to be an oxymoron. Others might prefer inspirational rules in the form of dada-esque koans, or (protect us) quotes from Sun Tzu. One of the better known examples from pop culture is a deck of cards with suggestive phrases written by Brian Eno called [Oblique Strategies](#). For those using a Macintosh a free version is available online.

Ad Rienhardt (Logical Conclusions) – As noted earlier Rienhardt’s [paintings](#) can be viewed as being inspired by his manifesto-like writings.

rules as frozen plans for installation or fabrication

Blueprints, or their information-equivalent, allow for zero degrees of freedom in terms of inventing mappings at the time of execution. As a practical matter fabricators and artisans will leave their own traces in the rendered media.

Nevertheless, because blueprints demand a predetermined fixed result they are usually not viewed as being generative.

Sol Lewitt – (Logical Conclusions) Many of Sol Lewitt's pieces are generative, but Modular Piece 7 is not one of them. (A similar, but different, piece is linked [here](#).) One might argue that Lewitt has harnessed symmetry-based generators in the pieces design, but at best the generative aspect is a borderline case.

To heighten the generative versus non-generative point, see the examples of LeWitt's combinatorial work that follow.

rules dictating thematic manual creation

Sometimes basic ideas or themes are referred to as “generative” in that they inspire a family of ideas or activities as variations and applications. These are, however, generally excluded from the notion of generative art because they depend on a human being acting as the generative system. Of course human beings are generative systems when viewed as objects. But taken as is, it leads to the conclusion that all art created by humans is generative art. At that point the term generative art loses utility and distinct meaning. Typically by generative art we mean art created with the assistance of non-human generative systems.

Ed Ruscha – (Logical Conclusions) [Various Small Fires and Milk](#) is an art book project where the operative rule is that only pictures of the thematic subject matter are used.

Bridget Riley (Beyond Geometry) – Similar to the exhibit's Polarity, and also done in 1964, [Current](#) exhibits an intuitive design which seems like it could be summarized by mathematical rules, but in fact was not generated by an external system.

rule as performance script or ritual

Conceptual art spawned, among other things, a sort of minimal performance art. Such work is rules-based in that it is the result of performance instructions. But since no control is ceded to an external system, such work can't be considered generative art.

Bruce Nauman (Beyond Geometry) – [Walk with Contrapposto](#)

Richard Serra (Logical Conclusions) – [Hand Catching Lead](#)

manual interpretation of non-autonomous rules

A number of miscellaneous rules-based artworks share only the notion that a generative idea can be explored in a series of manual variations.

On Kawara (Beyond Geometry & Logical Conclusions) – both exhibits show examples of On Kawara's [TODAY series](#). Each of these works must be completed in a single day, show the date in various colors and styles, and include a box lined with a newspaper of the day. As specific as these rules are, they cannot ultimately determine the piece autonomously, and thus this is rules-based art that is not generative art.

Robert Mangold (Logical Conclusions) – The pieces shown in the [link](#) are different from the work in the exhibit, but they illustrate the principle of using very few degrees of freedom in exploring variations of a compositional idea.

rule systems which are generative systems

There are a number of rule-based systems that could just as easily be called generative systems. A number of generative systems were used in works exhibited in Logical Conclusions and Beyond Geometry. This is part of the hypothesized generative art show within the show.

rules as algorithms

Tom Friedman (Logical Conclusions) - In this [untitled work](#) Friedman implements an image processing algorithm by executing a manual loop of activity. 36 S.O.S. boxes are measured, cut, incrementally offset, and then glued together, creating a single “blown up” image.

rules as recipes for autonomous processes

Ed Rusha (Beyond Geometry & Logical Conclusions) – In this famous fold-out art book, Ed Rusha eschews typical notions of composition and the decisive moment in photography, and instead implements the title of the piece by simply capturing [Every Building on the Sunset Strip](#) in his camera. Although the piece was manually implemented, it is generative in principle. The rule could have been handed off to a technician or a robot for execution.

rules as a well defined widely applicable process

Some processes are so widely understood, or so commonly observed, that they begin to become transparent and unnoticed. One of the virtues of generative art is that it can offer fresh presentations of such processes and bring them back to our attention.

James Siena (Logical Conclusions) – In [Enter the Faces](#) Siena explores fractals with a pop/folk sensibility.

combinatorial rules

Generative art includes systems that use a smaller set of elements to create a larger set of combinations.

Sol LeWitt (Logical Conclusions) – the following links ([I](#) [II](#)) show classic LeWitt wall drawing pieces that were not part of the Logical Conclusions exhibit. Here LeWitt (or more typically those following his instructions) systematically applies a small number of marks to create a large combinatorial exploration.

numerical sequences as rules

A number of minimal and conceptual artists have used numerical sequences such as arithmetic or geometric progressions, or the Fibonacci numbers, as a basis for pieces.

Mel Bochner (Beyond Geometry) – In [Continuous/Dis/Continuous](#) Bochner interleaves two number lines by alternating randomly between them.

line composition or drawing rules

Generative art includes line-oriented paintings or drawings that are determined by a set of rules or algorithms. Along with plotter art created by some of the earliest computer artists, the art mainstream includes impressive examples.

Francois Morellet (Beyond Geometry) – This [link](#) is similar to 22 Weaves shown as part of Beyond Geometry. The catalog also notes the controversy that occurred when Sol LeWitt created a series of very similar drawings more than a decade later.

Frank Stella (Beyond Geometry) – The Stella image from this [link](#) is very similar to the shown piece, Getty Tomb. The canvas stretcher itself becomes a generative element as it defines the distance between the iterated lines.

the rule of serial generation

Rediscovered by the minimalists in the 20th century, using a “loop” to repeat a graphic gesture, or an object, is a generative method as old as art itself.

Donald Judd (Beyond Geometry & Logical Conclusions) – The [linked work](#) is very similar to Beyond Geometry’s Untitled and also completed in 1969. A similar piece in red was shown in Logical Conclusions.

Andy Warhol (Logical Conclusions) – [Here](#) Warhol creates a basic tile system with a serial attitude.

tiling and other symmetric composition rules

Much of the oldest artwork on the planet consists of abstract patterns that exhibit symmetry and tiling patterns. Minimalists applied these basic generative techniques, in part, to remove attention from issues of composition.

Carl Andre (Beyond Geometry & Logical Conclusions) – The [linked piece](#) is very similar to the shown work 144 Pieces of Aluminum. A related piece was shown in Logical Conclusions.

chance operation rules

Often credited to the influence of John Cage, the use of chance operations in the creation of art grew in the 20th century.

Felix Gonzalez-Torres (Logical Conclusions) – In [Untitled \(Public Opinion\)](#) Gonzalez-Torres specifies that the installation be composed by chance by simply spilling candy in a corner of the room.

clustering rules that create composition

Layering taxonomic logic upon assemblage, some artists create pieces by ordering collections of found or commercial objects. To the extent that this ordering principle objectively clusters the objects creating unexpected correspondences and relationships, such work can be considered generative.

Bernd and Hilla Becher (Beyond Geometry & Logical Conclusions) – These links ([I](#) [II](#)) show work very similar to Typology of Water Towers and Cylindrical Gas Tanks shown in the exhibits. It is arguable whether this particular application of clustering is truly generative, turning primarily on the question of whether the clustering method is objective and thus external, or intuitive and subjective.

mapping from one domain to another

Transformation from one domain to another, such as temperature into color, or stock market data into sounds, is a popular technique in contemporary digital generative art. It is also found in generative art from the mainstream.

Mel Bochner (Logical Conclusions) – In this [piece](#) Bochner maps playful 2D number games on paper into 3D toy block structures.

Jan Dibbets (Beyond Geometry) –Shortest Day at My House in Amsterdam is linked [here](#) and is very similar to the work shown in Beyond Geometry, Shortest Day at the Guggenheim Museum New York. Since both were done in 1970 it's questionable whether they were both literally executed on the shortest (daylight) day of the year. In any case, along with the generative element of pictures being taken at timed intervals, time is mapped into space as the images are serially arranged in a grid.

Damien Hirst (Logical Conclusions) – The piece shown is similar to other paintings in his Controlled Substance series, including [Opium](#) linked here. Hirst uses a key that maps letters and numbers into color dots, and then spells the name of the substance in question with the corresponding color dots.

rules which create cycles and phase interactions

Time art can generate variations by having two or more cyclic behaviors with differing periods. As the cycles go in and out of phase a combinatorial effect is played out, and at any given instant different variations will be apparent.

Francois Morellet (Beyond Geometry) – The work shown, Neon 0' 90', Switching with 4 Interfering Rhythms, is a set of 12 neon tubes arranged at crossing right angles. Because the tubes turn on and off with varying cycles, variations of various shapes, such as "pluses," "T"s, and "L"s, are created. This [link](#) shows a larger switched neon installation by Morellet.

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ⁱ Galanter, P., *What is Generative Art? Complexity Theory as a Context for Art Theory*, in International Conference on Generative Art. 2003: Milan, Italy.

ⁱⁱ Rose, B., et al., *Logical Conclusions : 40 Years of Rule-Based Art*. 2005, New York City: PaceWildenstein. 185 p.

ⁱⁱⁱ Ibid.

^{iv} Ibid.

^v Alberro, A. and B. Stimson, *Conceptual Art : A Critical Anthology*. 1999, Cambridge, Mass.: MIT Press. lii, 569.

^{vi} Zelevansky, L., V.L. Hillings, and Los Angeles County Museum of Art., *Beyond Geometry : Experiments in Form, 1940s-70s*. 2004, Cambridge, Ma: MIT Press. 239 p.

^{vii} Kuhn, T.S., *The Structure of Scientific Revolutions*. 3rd ed. 1996, Chicago, IL: University of Chicago Press. xiv, 212 p.

^{viii} Sokal, A.D. and J. Bricmont, *Fashionable Nonsense : Postmodern Intellectuals' Abuse of Science*. 1998, New York: Picador USA. xiv, 300 p.