ARTIST'S ARTICLE

Generative Systems and the Cinematic Spaces of Film and Installation Art

Mike Leggett

ABSTRACT

The author's informal research in the 1970s explored iterative and generative systems using motion-picture film. His approach was practice-based and occurred in the context of artists studying the structure and materiality of the film experience. Based on historical and contemporary notes he accumulated about his film *Red+Green+Blue*, the author evaluates the generative art that emerged using this analogue-based medium in the light of recent discussion of digital and binary-based interactive installations.

This article sets out to reconsider my informal research from the 1970s exploring iterative and generative systems using analogue-based motion-picture film. My approach was practice-based and occurred in the context of artistic work on the structure and materiality of the film experience. In the cinematic space of various projection environments, the role of the audience as an active participant was critical to the process of making meaning.

In 1972 I commenced in the production of a series of 16-mm films thematically linked to landscape. One of these titles, *Red+Green+Blue* [1], I describe here in the context of historical and contemporary media practice. In making the film I applied mathematical rules to iterative principles, combining prepared graphical images with filmed landscape images. I noted emergent properties at that time but did not identify them as a generative system until later.

In light of the contemporary context of current generative art-making, practice-based research and interactive installations, in this paper I discuss the film and its making as a model for a proposed computer-based system.

GENERATIONS

The physiological/psychological illusion central to the film experience (inaccurately but popularly described as the *persistence of vision,* or, as Gombrich suggests, "the sluggishness of our perception" [2]) relies on the repetitive replacement of the image on a frame of film by the film projector at a rate that creates the appearance of continuous motion [3]. Repetition within the machinery and iteration of film material was identified from a very early stage of the development of the cinematic spectacle and constituted a central characteristic of the apparatus as a whole. The Edison kinetoscope appeared at the end of the 19th century, using loops of film material that could endlessly repeat a simple scene played out under the control of each viewer. Later, filmmakers and artists in the 1920s and 1930s, from Vertov to Man Ray, from Richter to Ruttman, used the duplicated, repeated image for expressionist effect or decoration. These experiments with temporal and iterative strategies set out to expand the material space of the cinematic experience. They were distinct from the classic cinema narrative being aesthetically established at the same time, which sought to consolidate the illusion and its attractions and prevent disruption within the narrative space [4].

Clauser [5] discusses filmmakers such as Eggling, Fischinger and the Whitney brothers, whose experiments with abstract form influenced and informed filmmakers in England, Europe and the U.S.A. during the late 1960s and early 1970s [6,7]. Their work encouraged the development of discourse around representation and the techno-aesthetic apparatus of cinema as social and cultural phenomena [8,9]. At the London Film-Makers Co-op (LFMC), a core of the films made from 1968 onward employed various iterative procedures. A workshop was established to provide access to laboratory facilities under the control of the artists—film became a plastic art instead of simply an industrial tradition.

"Structural/materialist" filmmakers in Britain, Europe and the U.S.A. set out to make available to the audience the whole "apparatus of representation," within the filmic phenomena of a screening. In an encounter with "film as phenomena," as film "abstracted," there existed an opening up of the spaces between its component parts. This was in contradistinction to the conventions of cinema, intent on concealing the many joins that held the illusion in place. The structural/materialist approach presupposed the audience engagement as moving far wider, exposing the conditional, revealing in the mind an awareness of process in the production of experience and in the function of its reception. The role of filmmakers in this formulation was described by Stoneman:

> This textual practice can also be said to offer a different articulation of the "maker" outside the work, affecting one of the elements central to the relationship of the text to the spectator. . . . This relates to the Constructivist notion of the "art worker" as the scientific experimenter, which counters idealist ideology of the artist as transcendent individual who occupies a position outside society and its historical process [10].

PRACTICE

Most of the artists associated with the LFMC had developed skills in other art practice, often through tertiary study, in painting, sculpture, photography and music most notably. Many had begun working with film while having access to no more than a film projector and raw (found) film. Cin-

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ema thus became redefinable, and the projection screen became any flat surface, the projected film becoming a play of light, presence and absence. The emerging practice of performance art ("happenings") very often involved multi-projection devices. Such approaches extended the possibilities of cinematic intervention and became known as "expanded cinema." Invention included iterative methods using loops of film, often running through several projectors simultaneously and building moving collages or sculptural installations, thus placing the "found footage" into a context for which it was not designed.

The acquisition by the LFMC of a 16mm Debrie-Matipo (DM) step-printer, used in the film industry for the duplication of projection prints, enabled the LFMC filmmakers to use iterative strategies developed from expanded cinema aesthetics to make continuous prints. Instead of being projected through the acetate into a screening space, the light affected the unexposed film stock held in contact with the image-bearing loop.

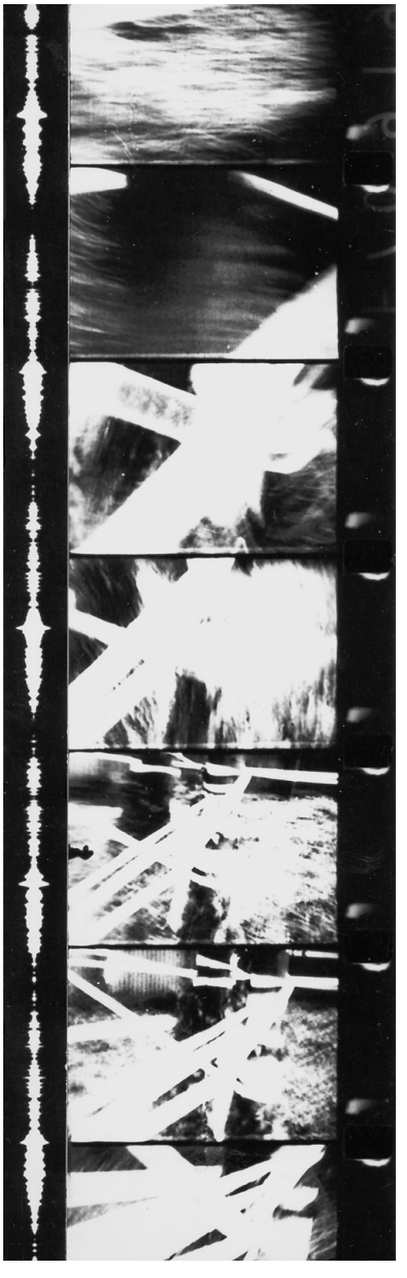
The iterative approach involved both picture and sound elements in several film and video artworks I produced during the 1970s and 1980s. My film *Shepherd's Bush* (1971) [11] employed an 8-second looped black-and-white image of rapidly pixelated movement across grass and through trees, rendered from white transparency to dark opaqueness, over a 12-minute duration. The soundtrack was made from a longer looped sound image and produced electronically on an EMS VCS-3 synthesizer, later transferred onto the film at the final print stage (Fig. 1).

Generative Film: *Red+Green+Blue*

Sections of my film *Sheepman & the Sheared Parts 1*—*7* [12] extensively employed iterative sequences in image and mask channels of the DM printer. Following on from my use of the looped image in *Shepherd's Bush,* I began sketches on paper for this project in 1972; the completed section *Red+Green+Blue* appeared in 1976. The following year, as part of a reassessment of work plans for writing and further production, I prepared a comprehensive set of notes reflecting on the whole process of production and the series of screenings that followed in Europe and the U.S.A. [13].

The concept for the film—within the scope of the *Sheepman & the Sheared* landscape-based series—was to articulate the physical and chemical properties in the motion-picture color-reversal process. My strategy was to combine the primary colors—red, green and blue—on the DM printer, by printing through a series of prepared looped graphic shapes of predetermined dimensions that would operate as the automated procedure. After processing, the duplication film stock would then display the complementary colors cyan, magenta and yellow (each a mixture of two primary colors) as a visible system in relation to the primary colors, together with white and black. The process would in effect synthesize the complementary colors, together with white as a combination of all three primary colors, within the processed emulsion layer of the duplication stock.

Fig. 1. Image strip from 16mm film *Shepherd's Bush* (soundtrack along left side of image). (© M.G. Leggett)



As the basis for a series of tests and experiments, I sketched an array of groupings for the graphical elements, initially based on four concentric circles with acetate color filters introduced into the printer's optical path. Following repeated screenings of the tests, my reflections centered on four observations:

- circles within the square reinforced the flat surface area of the screen space
- juxtaposition of circles within the time signature created apparent lateral (x- and y-plane) movement and receding/advancing vectored (z-plane) movement
- color within the circles further established the surface area of the screen space
- secondary, "three-dimensional" imagery became perceptible.

The conclusion of these experiments led to my plan to use three concentric circles linked in their indexical signification to the three primary colors. The secondary imagery I noted led me to determine that the primary colors, instead of originating from acetate filters arranged within the printer, should be generated by objects in the natural world. I used film footage of the three primary color pigments from naturally occurring sources —the sky, the grass and red berries—to introduce a poetic dimension to the abstract construction [14].

System

I employed a final series of tests using color loops, various graphical loop sizes and graphical durations to determine the elements of the analogue system [15]. The three loops contained the graphical progression, grouped in 12 frame units—or ½ second at a projection speed of 24 frames per second—separated by units of clear frames calculated for each loop. A constant mask altered the conventional ratio of the frame/screen from 4:3 to 3:3. This square contained three concentric circles of different diameters in the ratios 1:3, 2:3, 3:3 (Fig. 2) grouped in units of 12 frames.

The dimensions of the loops I used in the final version can be described arithmetically as the Lowest Common Multiple (LCM). The total length of each mask loop was in the ratio 9:10:11, producing a total running time of 8 min 25 sec to complete the cycle and return to the starting point (Table 1).

The color loops used in the tests were replaced with three 400-foot color rolls, each shot in a continuous "take" (film recording) of an object reflecting each primary color (represented by berry, grass and sky). I determined the duration as "about right" for assessment of the visual outcomes. It was not until this advanced stage of testing had been reached, when all components of the system including durational function were present, that complete prints could emerge from the process to enable full evaluation (Color Plate D No. 1).

Analysis of Final Print: Random or Pattern?

Color: I noted in several tests that color balance, while correct in parts of the 300-foot print, shifted out of balance elsewhere. I realized that the rolls of color original contained variables. In the case of the sky, occasional and partial cloud cover would alter the color saturation/density. In the pasture where the grass was being filmed, the light would angle differently when I panned the camera, zoomed in or changed the focus. I shot the red berries at high magnification with a very restricted depth of field; the image moved in and out of focus throughout the take and thus affected the integrity of the color filtering.

Movement: At certain moments, the system displayed a logical progression, with circles "advancing" from the "distance" to the "foreground," or vice versa. At other moments the progression appeared random. At certain points where phasing was such that circle images were following very close upon one another, these movements and counter movements, combinations of circles and particular colors, occurred very rapidly, causing some viewers to claim that afterimages remaining on the retina began to interplay with the dynamic information arriving from the screen.

Masks: It was impossible to retain strict registration between the separate originals tri-packed into the printer and the print stock over three successive exposures. The masks remained in sharp focus, in contrast to the slightly out-of-focus quality of the color rolls, because the mask rolls were in direct contact with the duplicating stock, while the image-bearing rolls were one thickness of film beyond and behind.

Loops: The use of loops could be informed by observation of the join marks, though this was not readily evident. The remains of a grease/chinograph-pencil sync point left a faint cross mark on one frame of one of the loops. It nonetheless provided to the attentive viewer a clue for the record of the system in operation.

The strategies I had put in place devolved, if not abdicated, a part of the image-making process, picture and sound to circumstances or conditions determined by the process. By experimenting with recursive strategies, *Sheepman & the Sheared,* like other work of the time, revealed for the reflective audience member the emergence of behaviors that exceeded the component parts of the process. Initial responses tended to disregard the notion of autonomy from aspects of the compositional process, possibly with the consideration that, taken overall, the film was a highly constructed artifact. It was only later, in 1979, that a reviewer used the term "generative system"; that was the first time I encountered the expression [16].

For the viewer who had come to a similar conclusion but had determined not to begin counting intervals as a means of understanding the system being applied, what engagement with the film remained? Following a screening, people would often remark upon the relationality between objects as images in the field of view of the camera: the image of a cloud suddenly obscuring the blue of the sky; the shock of a swath of grass suddenly coming into focus from within a field of green; the massive dimensions of the image of a red rosehip suddenly coming into focus at the point where a large circle of in-focus grass was superimposed. Attention was diverted across the flat surface of the screen by the appearance of objects occupying Euclidian space, defocusing into areas of pure color and instantly returning the gaze back to the flatness of the projection surface.

Use of the term *generative* in the context of artists' film of the time was novel. While an iterative approach to film composition was taken in many films made by myself and others [17] employing loops and other iterative forms, *Red+Green+Blue* was a rare excursion into generative systemics.

Table 1. Calculation of loop size in final version of *Red+Green+Blue*.

	Blue	Green	Red
Each loop in 12 frame units. LCM = 990	11 units	10 units	9 units
LCM/loop units = total loop cycles	90	99	110
Number of frames in loop	132	120	108
Total frames to return to start point	11880	11880	11880
Total footage (frames / 40)	297 ft		
Total duration (footage x 1.666)	8 min 25 sec		

Contemporary Evaluation of *Red+Green+Blue* as Generative Art

Henry Clauser, in his 1988 description of "a dynamic, generative computer art," described the making of acrylic paintings employing procedures guided/dictated by computation. A "structural system" was employed, and he used the term "epiphany" to describe "the creation of a form differing, often radically, from the main compositional format of the picture's elements . . . not a creation by the artist but rather the product of the generative process—a self-precipitating structure" [18].

Making the film *Red+Green+Blue* was in actuality a process of *recording* the operation of the generative system and its variables. Each pass on the printer was in effect a once-only state. Recording "the results" of the operation of the system caused the variables to become constants, each projection of the film simply reproducing them.

The painstaking process of making each print was not dissimilar to the work of a silkscreen or lithographic artist laying down successive colors. It delivered a similar outcome: a print that was ostensibly unique but could be produced as an edition. The film print of course deteriorates from its very first screening, picking up dirt and scratches and then, over a longer period of 10–50 years, fading. For this reason, of the three prints made of *Red+Green+Blue*, one was used as a duplicating original from which to make projection prints.

The variables, including those already noted, are:

1. Pro-filmic: panning, zooming, focus, color saturation and hue, exposure, visible incident.
2. Post-filmic: film processing, printer lamp, loop and color film "damage" (dirt and scratches).
3. Performance: screen surface; projector, lamp and optics; venue ambience; print dirt and scratch "damage"/fading.

For each subsequent print made from the system, while the pro-filmic (point 1 above) would remain constant, the post-filmic (point 2) would introduce another unique set of recorded variables. Perfor-

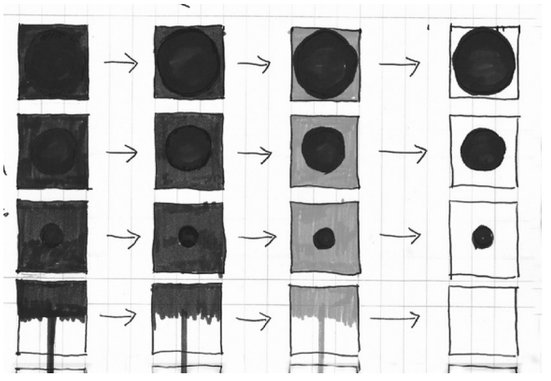


Fig. 2. Each square represents a 12-frame unit prepared into three loops of different length as represented in Table 1. Each graphic loop and its primary color are shown here combined and printed to the duplication stock (right of diagram), commencing at the same relative starting position for each color. (© M.G. Leggett)

mance as projection (point 3) thus remains the only constant variable in the system.

Variables as observed at a screening, or deduced as an ongoing reflection consequent to interaction with the screening process, assumed a level of audience autonomy. This was complementary to the autonomy afforded the filmmaker as the designer of the system [19].

Generative Directions

McCormack noted a key characteristic of generative systems: "The emergence of new properties that result from local interactions between individual components. These new properties are not specified in the genotype—they emerge from the generative process" [20].

Andy Webster, in *ROYGBIV,* set out rules involving duration and spectral colors collected with a digital video camera on several tapes during a series of cross-city walks. The subsequent horizontal three-screen projection installation contains images, unedited but subject to the generative system, that are related by color but appear and disappear in sweeps across the screens. Intentional and unintentional breaks in the system "become more interesting than the intended subtle transitions from one colour to the next. It is the interaction of these contingent phenomena with the strict production rules that generates the final novel structure" [21].

Reorganizing the generative components of *Red+Green+Blue* as a physical installation could alter the conditions for observation and interaction. The employment of three synchronized film projectors, projecting three color rolls of film with graphic masking bi-packed in the gate of each projector, aligned to illuminate the same screen, would reproduce the film process described in earlier sections. The sculpture of the installation, the screen, the projectors, the color rolls and the loops would present to the perambulating audience the component parts of the generative system and its variables.

Is visibility of the components, however, the key to the generative approach? Or does this device emphasize the teleological, the mechanisms of the apparatus, at the expense of the viewer's heuristic purpose?

Edmonds has observed: "In generative time-based art, the explicitly defined part of the work is the structural element including specifically the rules to be used in determining in which order and at which pace the image sequence should develop" [22].

This observation encompasses the functioning, material realization of a system and applies, as I have noted, in the analogue as well as the binary domain. Specifically, in *Red+Green+Blue* the algorithmic element applied is a procedural one, rather than the more complex procedures accessible using declarative or logic programming, as identified by Edmonds: "Whilst procedural programs describe a sequence of actions to be taken by the computer one after the other, declarative and logic programs describe what is required in terms of rules" [23]. In other words, the details are left to the computer system.

Could there be value in reproducing *Red+Green+Blue* in a computer-based form?

The materials being manipulated by this system would be so fundamentally different as to require the concept to be re-thought. Color display in the digital domain is not "made" through the mixing of light in its component primaries onto unprocessed duplication film. Light is expressed as pixel values and electrical energy rather than photons and transparency values. The ways in which the concept could be adapted or, probably more interestingly, developed, would entail working directly with the materials and processes of the computer. There are several initially promising approaches.

The Generative Interface and Installation

The concept of *Red+Green+Blue* rested clearly on the interaction of the material processes within the procedural system, but its genesis was laborious and time-consuming, the outcome simply a record of one particular printing session and the variables within the system. While the images and materials as phenomena relate to the articulation of color within the system, their ordering is beyond most viewers' comprehension.

Migration from analogue to digital would present the possibility of reducing the number of variables while increasing exponentially the generative possibilities. The rules of the system could become the focus of variation for the interacting subject to affect, as executing them could be made instant, making production of the variation, the range of generations, potentially endless. McCormack describes an interface for non-expert interaction with a gene-splicing system [24]. A wall-mounted screen for *Red+Green+Blue* would enable selection from on-screen options to construct the viewing and listening experience desired, for instance:

- the graphic appearance, scale and dimension, and numbers of bi- and tri-packed layers
- the colors to be used, having fixed values or the variations derived from image-based footage
- the durations, tempo or tempi to be used, possibly linked to a sound generator, so that syncopation becomes an additional possibility.

A projection installation would retain the principle of mixing light, while assimilating the generative components and system operation governed by code, to become a digital variation of *Red+Green+Blue* (Color Plate D No. 2).

As Brown and Sorensen have demonstrated, the program code could become a part of the visible or audible process [25]. This, however, would problematically move the work away from a "material presence" into the domain of the symbolic. Substantively, however, an installation based on an "expanded cinema" film configuration could substitute film projectors with three computer-controlled data projectors.

The system could become like a mu-

sical instrument, synesthetic, like Rimmington's fabled 19th-century conception of a color organ, polychromatically attractive and stimulating to the beholder in practiced hands, but abstracted, machine-like and random to the less attentive or informed. The system could access resources from a large media database, generating a volume of information "significantly greater than the genotype itself (often referred to as database amplification)" [26]. Perhaps the best location for such an interface would be within a network of linked web sites sharing the media resources necessary for the generative jamming to occur.

Pixel Editing, LED Installation and LCD

The separation of the RGB elements at the pixel scale is determined by the physical dimensions of each pixel. Individual RGB elements for screen display at working resolution are designed to elude detection by the naked eye. These picture elements become more visible on the large "public address" screens used at sports events and public occasions, being based on light-emitting diode (LED) technology, adopting the dimensions and the visibility of the sculptural. Expensive technology of this kind, although well beyond most budgets, does not faze artists such as Jim Campbell [27], who has built smaller, coarser-resolution screens controlled in the same way as the bigger screens by software that manipulates RGB diodes—one for all three colors. While these screens produce images that test the extremes of representation, their potential returns the viewer to the highly productive heuristic options implicit in such systems. Current "smart-pixel" technology research, which seeks to integrate electronic circuitry and optoelectronic devices in a common framework, could provide further opportunities for artists.

Such potential likewise exists in liquid crystal display (LCD) technology. Each subpixel on an LCD is independently controlled to allow RGB-filtered white light to be transmitted through the screen; thus it has a direct correlation with the additive color system used in the making of *Red+Green+Blue* and could also prove useful in the generative digital domain.

Conclusion

In the 1970s, the modern, the new and the popular set the research agendas. The many strands of debates about abstract cinema then as now include the relationship between cinema and film, the rock "light show," the esoteric artist's film, music and art, and continues to be remarked on 35 years later, for instance by Mark Amerika:

> These early "film as phenomena" experiments demanded a different set of expectations from the filmgoer. . . . And yet, with the lack of historical perspective that pervades most VJ culture, and as more and more young artists find it all too easy to perform in alternative spaces . . . you would think that VJ culture came to us totally out of the blue [28].

Recent critical discussions concerned with "abstraction and complexity" and "formalism and culturalism" have continued the discourses of late Modernism in response to much of this work. As Mitchell Whitelaw has observed: "Generative art is in a unique and powerful position . . . [to] experiment with the emergent outcomes of particular ontologies, modes of being and relation" [29]. In proposing the term "critical generativity," Whitelaw focuses on abstract generative works of the kind made with Casey Reas and Ben Fry's Process software tool. This and others like it are systems that deliver "live" outputs to a screen [30], as distinct from artifacts—film material—projected with little variation to the screen.

This paper has described some practice-based research from the 1970s, a period when I and others explored iterative and generative systems using motion-picture film. The strategies adopted by the artists devolved without abdicating a part of the image-making process to circumstances or conditions determined by the process. *Red+Green+Blue,* by experimenting with iterative and recursive approaches, revealed the emergence of properties in the system and reflective behaviors in the audience (as well as in myself, the filmmaker) that exceeded the component parts of the filmic phenomena.

Generative systems working within complex networks and extensive databases, given the resources for research and the deployment of experimental models and installations, will develop a digital cinema practice. Utilizing processes not socially associated with the institution of cinema and its cinematic narrative forms will accelerate the emergence of new social interactions, manifestations and phenomena.

Acknowledgments

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