Dynamic Visual Formation

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Abstract

Computational media bring new complexities to the visual realm and the creation of visual forms. With the objective of examining theoretically and experimentally the creative process of image-making in the computer environment, a "system of dynamic visual formation" is proposed. The central argument is that images are no longer fixed, unique and eternal. Rather, what is created in computational media is a variable spatio-temporal module. Spatial and temporal properties of the system are defined. Ultimately, the investigation searches for the most elemental constituents of dynamic visual formation moving towards a theory of dynamic visual language.

> Art does not reproduce the visible but makes visible.
> Paul Klee, *The Thinking Eye*

It is common sense that every new visual environment, every new medium, requires a different approach to the creation of visual elements. The forces at play are different for each case and thus demand new ways of conceiving in the visual realm. What is new in the creative process of image-making in computational media? Does Visual Language—and the basic elements as traditionally taught—suffice for the creation of visual forms in interactive media? And if not, what would the basic elements be? What and how can we to teach visual language both for and in a dynamic environment?

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Visual language

Point, line and plane (and volume for 3D environments) are considered the basic elements of visual language—and of Geometry—and have been discussed in most books on visual language since the Bauhaus courses in the '20s. Among the sources used are Kandinsky's *Point and Line to Plane*, Klee's *The Thinking Eye* and Dondis' *A Primer of Visual Literacy*. However, the distinction between point, line and plane is no longer necessary or even valid in a dynamic environment, where the spatial structure is a process which changes in time. In other words, each point, line and plane is now one of many states of a "dynamic visual formation."

Traditionally, a visual element is described by seven basic attributes: shape, scale, orientation, position, tone, color and texture. The relations among the attributes create inner and outer qualities of elements, which provoke meaning-making. In the static visual world the seven attributes suffice for the creation of spatial structures and even the indication or inducement of spatial and temporal relations. Works of art by Kandinsky, Klee, Vasarely and Soto are examples. However, in a dynamic environment the attributes as such are not enough. The dimension of time must be incorporated in such a way that space and time can no longer be isolated.

Dynamic media

Computational media are of a different nature and require a different approach to the creation of visual elements. Essential to the creation of visual elements in the computer environment is previous knowledge of certain fundamentals:

- "traditional" visual language used in the creation of static spatial structures;
- "temporal" visual language used in the creation of spatio-temporal structures (such as in films);
- perception of visual forms whether static or temporal.

But these fundamentals are not enough. There is a need for new modes of visual sensitivity and conceptualization, as well as new modes of perception and creation of visual forms. With the objective of examining theoretically and experimentally the creative process of image-making in the computer environment, a "system of dynamic visual formation" is proposed. The main argument is that images are no longer fixed, unique and eternal. Rather, what is created in computational media is a variable spatio-temporal module.

The principle governing the proposed system is that the paradigm of the creative process of image-making has changed. This shift has its origin in the 1920s. Four concepts are central to it:

- spatial and temporal relationships within works of art;
- transformable qualities of works of art;
- participation of the viewer;
- relationships with other arts and with scientific fields of knowledge.

Although listed in isolated form, the concepts are interconnected and in many cases interdependent. Works of art which, for example, incorporate motion (optical or actual) already involve the concept of change and thus transformation. Similarly, many works inciting psychological movement require the active participation of the viewer in order for the perception of motion to be felt.

The concepts emerged in the art scene in Europe and Russia in the beginning of the 20th century and were largely explored in the '50s and '60s, when the term "kinetic art" was then coined and accepted by the artistic community (Popper, 1968, 95). It is also relevant to point out that those works undermined the traditional division of painting and sculpture.

Also taken into account are the five principles of New Media Language proposed by Lev Manovich (2001): numerical representation, modularity, automation, variability and cultural transcoding.

Like the inquiries on visual form carried out by Kandinsky and Klee in the beginning of the 20th century this investigation searches for the most elemental constituents of "dynamic visual formation."

It is relevant to point out that, since this is new territory, there was a need to create new vocabulary that would name and describe the proposed system and its constituents.

The system of dynamic visual formation

In order to explain the proposed system it is first necessary to consider the difference between "visual form" and "visual formation."

A visual form is a stable spatial structure. It is a time-independent spatial whole. Because there is no change with time, it is described only by spatial parameters.

Visual formation engages the spatiality of visual form with a temporal dimension. It is time-dependent in that it changes in time, such that later parts are dependent on earlier ones in the continuous process of formation. Its dimensions of time and space cannot be isolated.

What is proposed is a "dynamic visual formation." The term "dynamic" indicates the possibility of modifying the process already changing in time. In this sense, it is not a fixed process. Rather it is a dynamic, an ever changing spatio-temporal whole: it is always in the course of becoming, of forming and trans-forming.

The fundamentals of the system of dynamic visual formation comprise the study of two processes *(figure 1)*:

1) The system of "inter-actions": the exchange of spatial and temporal information by two agents—an "active subject" and a programmed system.

2) The dynamic visual formation: the properties of visual attributes and the basic element—"rhythmic unit."

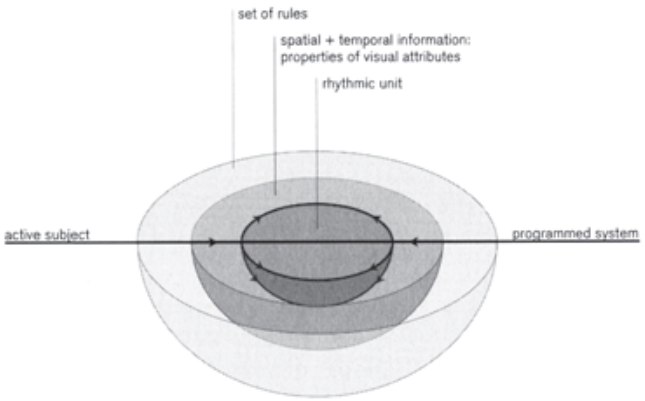

Figure 1. Diagram of the System of Dynamic Visual Formation.

System of inter-actions

A dynamic visual formation is created and re-created in the process of exchanging information between two agents.

Two conditions are necessary for the exchange of information. The first condition is the existence of two independent and active agents, one of which is a programmed system, and the other an active subject. By active subject I mean a person who is intellectually and physically engaged in the process of exchanging information. The subject is not an observer, but the creator of his or her own visual experience. One agent requires the existence of the other. The second condition is the mutual interdependence of the actions of the two agents. The exchange of information fulfilling the conditions will be called "inter-actions."

A person (e.g., artist, designer, programmer), or a group of people, develops a program that circumscribes the possibilities for inter-actions by means of which visual formations can emerge. The program that constitutes the system of inter-actions–defines "what," "how" and "how much" spatial and temporal information to exchange in the process of dynamic visual formation. It is limited by a set of rules organized in three categories:

1) Rules of Formation: The Content

The rules of formation define what information is given a priori and what information to exchange in the creative process.

2) Rules of Action: The Methods

The rules of action define how information is exchanged, including the active mechanisms of exchange (the ways of inter-acting), where they are active, and how to activate them for each pair of inter-actions defined by the rules of formation.

3) Rules of Influence: The Quantities

The rules of influence define how much information is exchanged. These quantities specify the extent of spatial and temporal information for each pair of inter-actions covered by the rules of action.

Dynamic visual formation

The process of dynamic visual formation is described by two interdependent components. One is the most elemental constituent in the process of dynamic visual formation: the properties of visual attributes of the basic element. And the second is the basic element: the variable spatio-temporal module called "rhythmic unit."

The properties of visual attributes

The properties of visual attributes are what constitutes the information being exchanged in the system of inter-actions, in other words, what creates the basic element.

What is proposed is a set of properties for each of the seven basic attributes (shape, scale, orientation, position, tone, color and texture). Properties are variables that function as independent data settings. It is by means of inter-actions that data values are set. Data values are numerical. Properties are subjected to the rules of usage: "what," "how" and "how much" information to exchange in the process.

The properties are grouped in three separate but interdependent categories: spatial, temporal and kinetic. Changes of value of one property affect the value of other property or properties in the two other categories (see examples below). The properties proposed are (detailed descriptions below):

- **spatial:** origin;
- **temporal:** starting point and duration;
- **kinetic:** velocity, amplitude and reference point.

Although we are dealing with the same attributes as traditionally in visual language, because now they have properties in spatial and temporal dimensions, each attribute creates a "rhythm" which defines the role it plays in the basic element.

Since the system attempts to search and, at the same time, to explore the most elemental constituents of dynamic visual formation, the "loop" is used as its organizing principle. In this sense, the attribute's rhythm is a loop, a compound of a cycle and an interval *(figure 2)*. The Cycle is a periodic recurrence of the relationship among all properties of the three categories of the attribute. And the Interval is the period of time between the recurrence of the attribute's cycle: it is the amount of time set for the cycle to initiate again from its Starting Point. For example, if the value for interval is zero what is experienced is a continuous repetition of the cycle, where the Starting Point looses in significance. The rhythm of the attribute is equal to the cycle. If the value is 1 second, the perception of the rhythm is that of a cycle which repeats every second. In other words, there is a rest, a pause of 1 second at the Starting Point of the cycle *(figure 3)*.

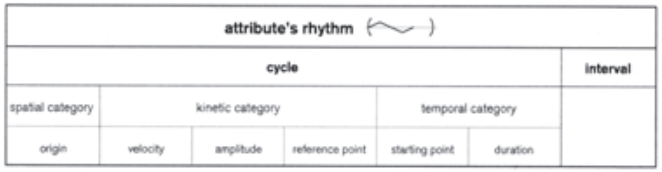

Figure 2. Configuration of an attribute's rhythm

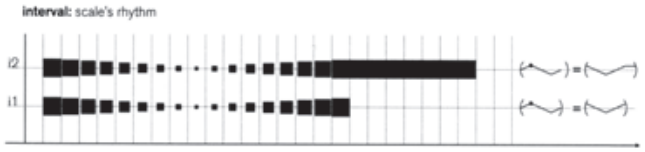

Figure 3. Diagrammatic representation of two scale rhythms with different values for interval: i1=0 and i2=x.

Spatial property: origin

The spatial property of Origin is related to the dimensions of space. It describes the spatial qualities of attributes. Thus, Origin is defined by the same parameters which are used to define the seven attributes in the static world of visual representation. For example, the attribute of position is described by values in the "x" and "y" coordinates (2D environment).

Origin is a variable and it defines the spatial quality at zero point in time of the cycle of that attribute. Not only can its value be changed by means of inter-actions, but most importantly, the value is only one state of many in the formation and trans-formation process of the rhythm. In other words, unlike in a static visual element, spatial parameters are no longer fixed *(figure 4)*.

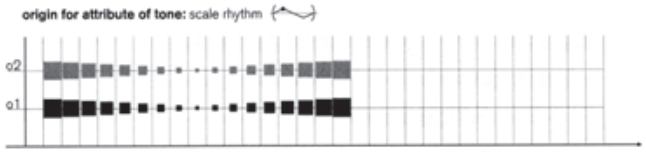

Figure 4. Diagrammatic representation of two scale rhythms with different values for Tone origin: o1 = 100% and o2 = 50%. The values for all other attributes (scale, shape, etc.) are the same.

Temporal Properties: Starting Point and Duration

Temporal properties are related to the dimension of time. They define the temporal qualities of attributes. Two temporal properties are proposed: Starting Point and Duration.

Starting Point is a variable and defines the moment in time for the cycle to initiate. In other words, it defines the zero point in time of the cycle. There are many possible points in the cycle which can be set as the Starting Point, of which four are defined in the system *(figure 5)*. It is relevant to point out that the cycle does not differ by changing the value of Starting Point. This is an example of inter-actions which affect the formation process without modifying its structural whole. In other words, it is the perception of the rhythm which is affected. However, if the interval is larger than zero, changes of values alter both the perception and the visual quality of the entire rhythm, where the Starting Point plays a major role *(figure 6)*.

Duration is a variable that describes the period of time for the completion of the cycle.

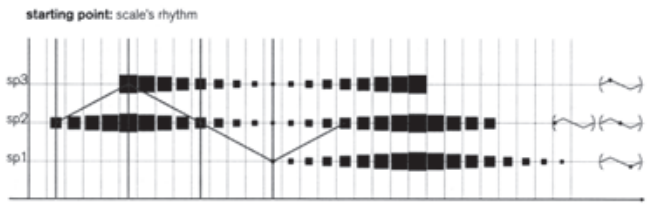

Figure 5. Diagrammatic representation of three scale rhythms showing the four values for Starting Point defined in the system.

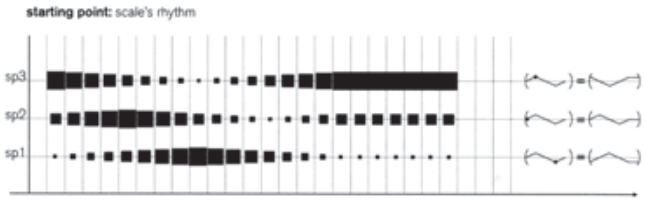

Figure 6. Diagrammatic representation of three scale rhythms with intervals larger than zero and different values for Starting Point.

Kinetic properties: Velocity, Amplitude and Reference Point

Kinetic properties define the spatio-temporal dependent qualities of attributes. In other words, the properties in which the dimensions of space and time are inseparable. Three properties are proposed: Velocity, Amplitude and Reference Point.

Velocity is the speed and direction of the process of change of an attribute. It is a variable that defines the rate at which the attribute's formation occurs *(figure 7)*. Because the motion is cyclical it always happens in opposite directions. The starting direction depends on the value of Starting Point (temporal property; also see *figure 5)*.

Amplitude is a variable that defines the extent of the process of change of an attribute. Depending on the value of Starting Point (temporal property), the value for Amplitude might set a maximum value or a minimum value or both *(figure 8)*.

Reference Point is the point in the spatial structure in relation to which the motion refers. It is a variable that defines the anchor for the attribute's motion. Any point in the spatial structure can be set to be the Reference Point. In the present system five points are assigned, which are related to Shape Origin (spatial property) set to a square: four corners and the center *(figure 9)*. For example, if the value is set to the upper left corner for the attribute of orientation, the square will rotate around that corner.

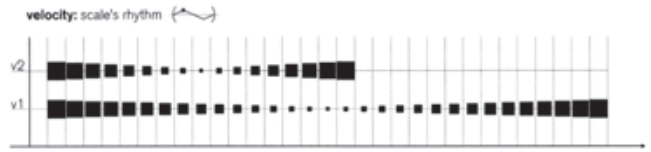

Figure 7. Diagrammatic representation of two scale rhythms with different values for Velocity: v1 < v2

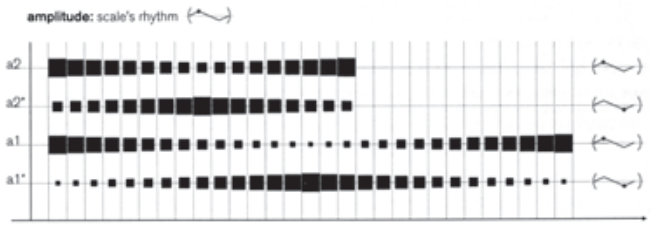

Figure 8. Diagrammatic representation of two scale rhythms with different values for Amplitude. a1 and a2 determine minimum values; a1* and a2* maximum values.

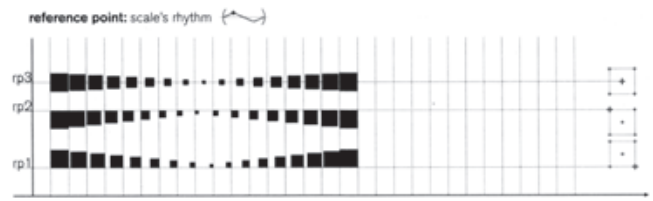

Figure 9. Diagrammatic representation of three scale rhythms with different values for Reference Point.

The basic element—"rhythmic unit"

What is proposed as the basic element is a "rhythmic unit." The rhythmic unit is a variable spatio-temporal module. As described earlier, it is created and recreated by means of a system of inter-actions. The rhythmic unit is characterized by a rhythm (again a "loop") which is the visual formation process. The rhythm is a compound of a **rhythmic cycle** and an **interval.**

The rhythm of the rhythmic unit is complex. Unlike a static visual element, inner and outer qualities of a dynamic visual formation are created in a dual system of relationships *(figure10)*. The first is the internal relationship among the spatial, temporal and kinetic properties of each attribute, which makes each attribute's rhythm. The second, apparently similar to the static form, is the relation among all attributes, which now is more complex since each attribute already has internal relationships.

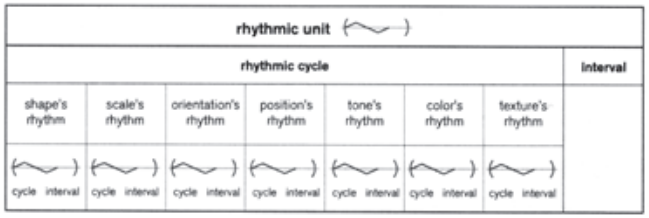

Figure 10. Configuration of the Rhythmic Unit.

Rhythmic Cycle is a whole made of the relationship among all attributes' rhythms: it is a periodic recurrence of the relationship among the cycle and interval of all attributes. It is relevant to point out that the rhythmic cycle is not an "and-summative" whole. Rather a "gestalt," a total structure, a system of relationships in which variables are integrated and coordinated. All attributes are equally important constituents of the whole. They all contribute to the formation of the rhythmic structure, where each individual property has a role. Any change of values of an attribute's property (by means of inter-actions) effects the structure of the whole which is the rhythmic unit's rhythm. The same way that any change in the whole rhythmic structure effects the individual parts, the attributes' rhythms.

The Starting Point of the rhythmic cycle is the **Point of Equilibrium:** the relationship among all Starting Points of all attributes' cycles. It is a variable and it defines the zero point in time of the rhythmic cycle.

Interval is the period of time between the recurrence of the rhythmic cycles. It is the amount of time set for the process of visual formation to start again from its Point of Equilibrium. The interval is a variable and the value can be set by means of inter-actions.

Experiments

Can the elemental constituents of the proposed system allow for the creation of dynamic visual formations in computational media? Can complexity be created out of the exchange of the most elemental spatial and temporal information? How does the creation and re-creation of dynamic visual formations happen in practice?

A series of experiments were created as exploratory environments of the system of dynamic visual formation in the context of rhythmic visual patterns originated by the ever changing relationships among rhythmic units. Ultimately, experiments with the system were used as catalysts for the creative process of visual formation in the computer environment. The experiments are constrained by a rigorous use of the most elemental formal and algorithmical parameters. It is relevant to remark that the constraints are a point of departure and not of arrival.

Spatial qualities are those of elemental 2D geometric forms, in the same way that the algorithms used in the exchange of information are the most basic ones. No colors other than black and white are used. The binary system of positive-negative or negative-positive is explored. However, the attribute of tone plays a major role and allows for gray scale rhythmic combinations.

All rhythmic patterns are modular and serial structures: a rhythmic unit is used as a variable spatio-temporal module that is repeated and organized in a rigid regular grid. All experiments are serial in two respects. One is the way in which units are organized in the structure of the pattern. And the other is the creation of serial rhythmic patterns in the process of inter-actions, when the oneness of units and regularity of the patterns are disrupted and obliterated by qualitative and serial variants and trans-formations.

The same rigor was applied for the choice of input and output devices used in the experiments. Again, they are the most elemental ones: the mouse and the monitor screen. The challenge was to explore the constraints imposed by their very nature and capabilities.

Experiments can be experienced in the url: http://www.atsweb.neu.edu/dva/m.meirelles/dvf/

Analysis of experiments

> I ask myself: what are all the things I perceive for which I have no concepts? Or conversely: what are all the things I don't perceive because I have no concepts for them?
> Karl Gerstner, *The Spirit of Colors*

One of the central issues explored in the experiments is the perception of motion vis-a-vis the conception of dynamic visual formation, more specifically in relation to the perception and creation of rhythmic visual patterns.

The perception of motion is dependent on a system of references where the distinction between "thing" and "framework" is essential. Koffka explains that in a totally homogeneous field a moving point would not be perceived in motion due to lack of frameworks of reference. In this condition, the point "would be exposed to the *same* stresses everywhere, all positions being dynamically indistinguishable from each other" (Koffka, 1935, 281, italics in original).

The influence of object and field factors plays a major role in the perceptual (aka phenomenal) experience of motion as well as of time. For example, experimentation has showed that "under equal stimulus conditions large objects move (phenomenally) more slowly than small ones" and that "the apparent velocity is the smaller, the greater the field" (Koffka, 1935, 290, 294).

Because "dynamic visual formations" are processes changing in time which are modified by means of inter-actions, so are the relationships among them. Both are time-dependent occurrences. The relationships among rhythmic units create spatial and temporal tensions which are influenced by two interdependent factors. One is the nature of visual formations: the role of the attributes' properties in forming and trans-forming rhythms. And the other is the system of references: the distinction between "object" and "framework." In rhythmic visual patterns—as can be seen in the experiments—the system of references is plural. In these cases, a rhythmic unit is relative not only to the space where it happens (field), but to the other concurrent rhythmic units, also working as frames of references.

Thus, two influential factors play a major role in the perception and conception of rhythmic patterns: the nature of the rhythm and the system of references. The scrutiny of rhythmic patterns is centered in the examination of the limits of these factors. On one hand, their influence in creating uniform and homogeneous patterns, and on the other, the complexities and ambiguities that arise in the entire pattern.

The role of the nature of rhythms in the creation of patterns can be explored in the experiment *3 patterns*. The experiment compares three patterns, each constructed of a singule rhythmic unit repeated 49 times in a regular grid. Differences among the patterns are created by the nature of the units' rhythms. In other words, the attribute playing a major role in forming the rhythm is different in each case: rhythmic unit "a:" tone; rhythmic unit "b:" orientation; rhythmic unit "c:" scale.

The concept of "synchrony" is used as a means to explore differences among the patterns. The term "synchrony" is used to express a coincidental rhythmic occurrence. One or more rhythmic units are in synchrony when their rhythms happen exactly at the same time and with exactly the same values for the properties. The different levels of synchrony point to the differences in perception and creation of the patterns caused by the influence of the nature of the rhythm and that of the system of references.

For example, in the case of all units "a" in synchrony (all units with coincidental values for the attribute of tone) the whole pattern is perceived as one singular uniform unit, to the extent that individual rhythms are obliterated. This is not the case for the other two patterns, where the individuality of the units are maintained, even though the patterns are quite uniform *(figure 11)*.

On the other extreme, that of almost no synchrony among units, in the case of the rhythmic unit "b" (orientation), the pattern is less complex than the other two, where the contrasts of scale and tone are more evident and thus create stronger spatial and temporal tensions among the formations *(figure 12)*.

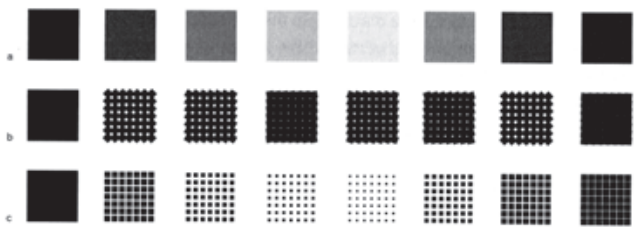

Figure 11. Sequence of images captured from the experiment *3 patterns* showing all units in each pattern in synchrony

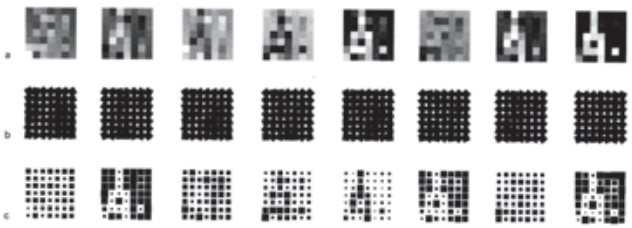

Figure 12. Sequence of images captured from the experiment *3 patterns* showing asynchronous units in each pattern

Similar analysis could be made for units with complex rhythms—where more than one attribute plays a major role in forming the unit's rhythm. In the experiment *dve1*, the original pattern is constructed of a rhythmic unit repeated four times in a regular grid. Because the value of origin for the attribute of scale can be changed, patterns might have up to 64 units. The number of units depends on the values set in the process of inter-actions. Independent of the number (from 4 to 64) the units are always organized in a regular grid.

When rhythms are complex, the concept of synchrony can be explored in diverse ways. One is to have all units with coincidental rhythm for a given attribute, for example only the tonal values being exactly the same. In this case, although there is uniformity in the tonal motion the scale motion is still asynchronous, which keeps some level of complexity in the entire pattern *(figure 13)*.

The other is to synchronize both rhythms of scale and tone attributes. Although this option creates a more homogeneous pattern, there is still some diversity due to the values of origin for the attribute of scale being different. This happens because the spatial property of origin influences the temporal property of duration *(figure 14)*.

Figure 13. Sequence of images captured from the experiment *dve1* showing units in synchrony for Tone rhythm, and differences in the Scale rhythms.

Figure 14. Sequence of images captured from the experiment *dve1* showing units in synchrony for both Tone and Scale rhythms, and differences in values for the spatial origin of Scale.

Further complexities and ambiguities caused by the nature of rhythms and the system of references can be examined in the experiment *dve2*. The experiment is constructed out of the same rhythmic unit repeated 25 times and organized in a regular grid. The unit's rhythm is complex: a compound of the rhythms for the attributes of shape (in "x" and "y" coordinates) and of position (in "x" and "y" coordinates).

When the experiment is first opened two attributes play a major role in forming the unit's rhythm: "x" shape and "x" position. The pattern has very strong vertical tensions and the impression is of five elongated rectilinear units changing width in relation to its left side–which is an illusion, not a true fact, since the value for reference point is set to the center point. The rhythm in relation to the "x" position is almost not perceived.

By using the mechanism of mouse over, the units (restoring the values for the zero point in time of its cycle) become "independent" (and no longer perceived as one long unit). Now ambiguities are more complex in that not only the nature of the rhythm (as before), but also the frames of reference influence the uncertainties in the entire pattern. It is my perception that the units appear from time to time to "join forces" with other units and become "one horizontal longer unit" and then to "separate" again and restore its own independence. My personal impression is that it is quite difficult to identify individual units in the entire pattern unless the value for tone is less than 100%. In this sense, the oneness of units is obscured and at times obliterated by the nature of the rhythm and the uncertainties in the frames of reference. The regularity of the grid is not completely lost due to the strong horizontal tensions created by the relationships among units, even though the pattern is now complex and multiform *(figure 15)*.

If a third attribute contributes to forming the whole rhythm, the uncertainties are enlarged. For example, by setting values for amplitude and velocity of "y" position. In this way, the regularity of the grid is completely lost. The perception of individual units is now very distinct, to the extent that each unit seems to perform a different rhythm that appears to be spatially and temporally independent from all the other concurrent rhythms *(figure 16)*.

Figure 15. Sequence of images captured from the experiment *dve2* showing the process of inter-actions with a series of units and the creation of new horizontal stresses among units.

Figure 16. Sequence of images captured from the experiment *dve2* showing the process of inter-actions with a series of units and the obliteration of the perception of the original grid.

Because of the number of variables in this experiment, there are a series of possibilities in the creation of rhythmic patterns by means of inter-actions. Each value that is changed creates new spatial and temporal relationships and tensions among the units. The formation and trans-formation processes disrupt the regularity of the pattern to the extent that new dimensions are discovered. It is an invitation to dynamic visual explorations.

Conclusions

A "system of dynamic visual formation" was proposed with the objective of examining theoretically and experimentally the creative process of image-making in the computer environment. Ultimately, the investigation searched for the most elemental constituents of dynamic visual formation.

The central question to the entire research was whether the proposed system—the basic element and its properties—suffice for the creation of visual formations in computational media. In other words, if the conceptual framework sustaining the system would address and allow for any imaginable visual output. Even though this might seem ambitious, I believe there is a need for such a quest, if we are willing to teach how to create visual forms for and in the computer environment.

I don't think I have answered the question yet. There is a need for further exploration and experimentation with the system in order to determine what is essential and what needs to be incorporated. In this respect, the series of experiments—of which three were analyzed here—are still incipient and so far explore only rhythmic visual patterns.

On the other hand, it is possible to argue that the experimentation with the system already suggests a few essential points towards a theory of dynamic visual formation:
1) The creative process of image-making in computational media is not an individual's isolated activity. Rather, it is a collaborative and participatory endeavor, where at least three agents are necessary: the creator of the program (who defines the system of inter-actions); an active subject and a programmed system (whose inter-actions create dynamic visual formations).
2) In the computer environment a visual element is a variable spatio-temporal module always in the course of becoming, of forming and trans-forming.
3) The most elemental formal and algorithmical parameters create complex and even unpredictable rhythmic visual patterns. The exchange of basic spatial and temporal information in the process of visual formation produces spatio-temporal complexity.
4) Two interdependent factors play a major role in the perception and the creation of rhythmic patterns: the nature of a dynamic visual formation's rhythm, and the system of references.

Those issues in fact point to directions for further research. There are two major areas of future research. The first concerns the system of inter-actions: the exchange of spatial and temporal information between the agents. It includes the nature of algorithms and of input and output devices. The experiments were constrained by elemental algorithms and used the most basic input and output devices. It is quite obvious that those two areas can be easily implemented with more complex algorithms or with other existing input and output devices. The direction, however, does not seem to depend on purely technological decisions. Rather what should be considered is the conceptual gains effected by the decisions. For example, the search for a more "gesture-based" system of inter-actions could determine the choice of input devices. Is it possible to integrate degrees of freedom that artists are used to in everyday practice? To what extent would this affect the creative process of visual formation? What kinesthetic properties should be considered in the creative process?

The second area for further research concerns the quality of spatial and temporal information used in the system of dynamic visual formation. This is the area presently being carried out: the system presented here is under implementation by including the attributes of color and texture in a series of new experiments. The purpose is to further explore the correlation of properties for different attributes and to study their roles in the creation and re-creation of rhythmic visual patterns.

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Optimal Line Length in Reading – A Literature Review

Namahn and Randolph G. Bias