Symmetry: Culture and Science

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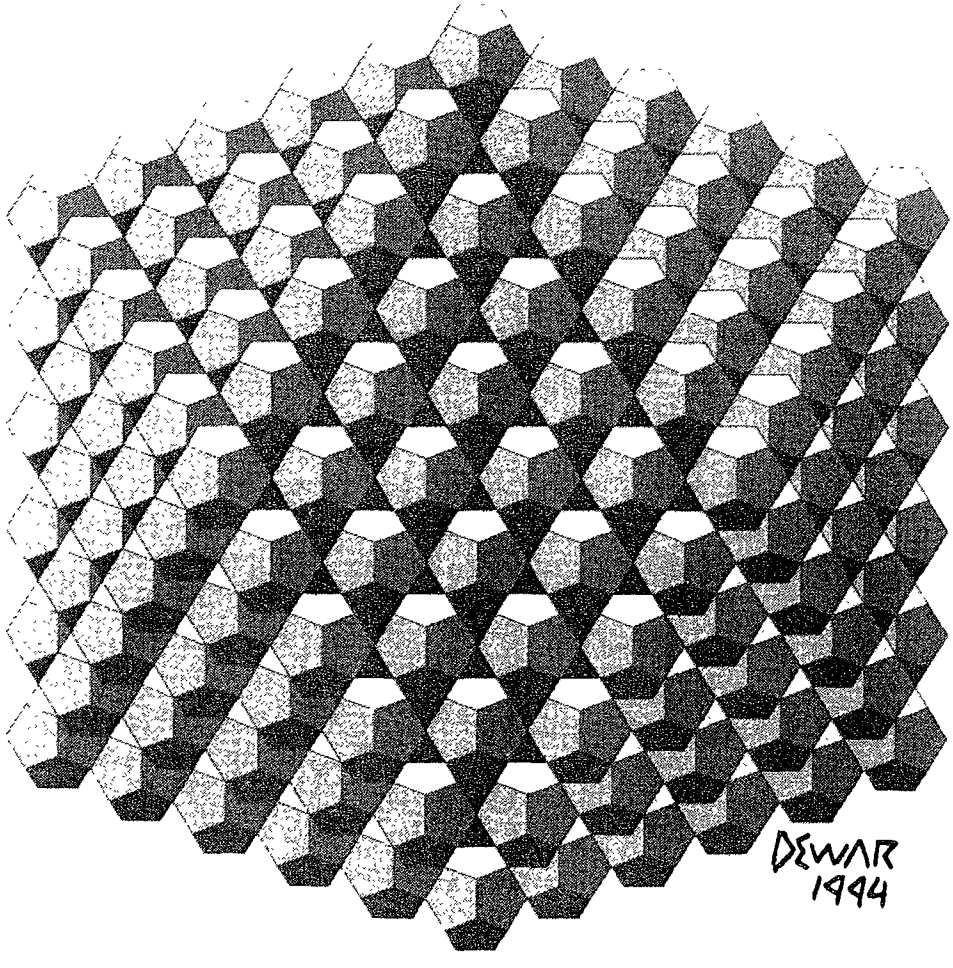

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IN THE WAKE OF CHAOS

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Thoughts about the fractalated curriculum as an integration of art, math, and science.

For the past two years I have been working with themes from chaos theory by the use of classic icons of chaos in my own creative work which is done both on and off of the computer. This past summer I was given a small grant from the University of Maryland to develop fractals and lessons based on chaos and complexity theory for use in art education. I have prepared several shows of my own art work that will demonstrate those conceptions as well as a curriculum guide for use in k-12 art education. My first idea for In the Wake of Chaos was stated while I was a resident fellow at the Virginia Center for the Arts in Sweet Briar in the summer of 1993. I will continue this exploration of selected themes and icons from chaos at the Tyrone Guthrie Center in Ireland in July of 1995 as a resident artist fellow of the center.

THE CHAOS CURRICULUM

The general purpose of this curriculum development project was to explore conceptual links between science and art. The goal was to produce art by an examination of the motivations and aesthetic positions of the many academic field that have become involved in chaos and in the development of complexity theory.

Theoretical science seeks to generalize from measurements, the motivation in art is to particularize; the art work functions as an integrated whole. Artists involved in the uses of technology usually approach the chaos/fractals idea as sources of tools and inspiration. The logical structures behind those tools and inspirations, may not be relevant to their overall all artistic purpose and aesthetic intents.

The tools (fractal geometry) can provide psychological models of aesthetic perception. Research from the following areas or fields will be employed as the knowledge base for this educational, curricular, as well as artistic effort.

1. CHAOS (COMPLEXITY) THEORY

As a branch of system theory, it would be hard to argue against the universality of these concepts across all disciplines. Systemic thinking is in large part the way of knowing to adapt a phrase from Jerome Bruner (1961). Nonlinear systems are viewed within our program as a natural subset of that concept. We have the ability to explain these concepts, as metaphors or systemic constructs, to student with non-mathematical background. As a mathematical construct, we have an additional richness of theory.

It would be wrong to use the implications of the fractal dimension(measure of complexity) in a data free context. Fractal dimensions only exist as a apart of the mathematical construct. However, one would not be incorrect in using some of the attributes of fractals, such as statistical self-similarity and complex boundaries in describing human organizations and thus calling the organizations fractal either in a systemic or a metaphorical sense of the term.

It would seem to this writer at least that in the arts the metaphorical sense is a valid use of the term fractal as will as a fruitful way to explore the limits of nature from the aesthetic point of view.

Is human memory fractal? (as metaphor). Many believe that the human memory is fractal, that it consists of cluster within clusters within clusters and a semi formal argument can be made for this case based on the necessity for the memory network to be aligned with an hierarchial control; with higher and higher nodes corresponding to higher and higher levels or clusters. This conception of the fractal is used as a guide for thought and not as a means of measurement.

David Walter in a recent posting on the internet has observed as follows:

"The discussion about chaos and fractals is interesting. I'm coming to the view that chaos and fractals are two words covering the same areas- the study of non-linear systems by iterating equations, iterated functions, ifs codes.
I am inclined to agree that chaos is usually used in conjunction with dynamics and fractals in conjunction with pictures, perhaps fractals are the pictures of chaos."

Fractals are the language of chaos and chaos is the language of the fractal. both chaos and fractals are created using iterative equations and it seems that chaos occurs when an iterative equation yields iterates which cannot be predicated, ie which are random. In these cases the curve of iterate values vs. iteration number is random. A key notion for chaos appears to be sensitivity of the values of the iterates to small changes in any value of the equation such as the initial conditions.

2. FRACTAL GEOMETRY
the Language of chaos

Perhaps one link between science and art, when the goal is to produce art; is to examine the motivations and the aesthetic positions of the two fields. Theoretical science seeks to generalize from measurements; laboratory work seeks specific results, using deduction but often also with an inductive goal. The motivation in art is too often to particularize; the art work as an integrated whole and the specific problems of that piece or image may never occur in concert again. Normative systems for solutions, such as in tonal harmony (in music) or watercolor landscapes conventions, are not necessarily typical examples. Artists usually seem to approach the chaos/fractal idea as sources of tools and inspirations, so that the logical structures behind their tools or images is neither clear nor from their intentions really relevant. A question does arise as to whether or not these tools mimic artistic processes and although they occasionally may seem to do so; in general they probably do not. This should not preclude us from using the metaphors in the description of the creative and the artistic process.

One needs to distinguish those cases where the tools do provide psychological models of the aesthetic perception and the creative enterprise from those cases where the results happen to be interesting such as in fractal geometry as opposed to fractal music.

There would be seem to be two different views as how we might use chaos theory.

1. One can use chaos theory in a mathematical way, meaning that one will actually look for attractors in empirical data.

2.One can use chaos ideas as metaphor, meaning a piece of language to make things clear from anther point of view, where the mathematical rigor can be forgotten. In this way, the new words can show characteristic of human system, or in artistic encounters that one may not have noted before.

The problem of prediction is a different point that can be treated by both cases. A difficult point remains in that whatever of the two modes of inquiry that one employs, one can be confused with the other. The metaphor is probably made up of other metaphors that can distort the new one. Language lays a large constrain on the way e look at the world.

3. THE NATURE OF SYMMETRIES
The Visual Form of chaos

I will feature some images of my work that were done with several computer software programs which are: chaos, fractal vision, fractals for the mac

One of the basic tools in many computer graphic programs are in the use of symmetries which are achieved through the mirror functions on the computer. I have used one icon of chaos , the mandelbrot set to, show how one can explore the symmetries found in that image by means of the zoom functions on the computer.

It is in this way that an artist can make use of the patterns and the hidden surprises which are basic to many of the so-called icons of chaos. We can zoom in on these details and then one can place them into tradition computer paint programs such as superpaint for the mac and manipulate them like any other graphic image.

I have been using a program called fractals for the mac and this allows one to save the fractal images generated from the basic equations and to import them into the paint packages. They can then be altered and printed on even rather simple printers like the new series of Hewitt Packard color ink jet machines.

4. THE GOLDEN SECTION DYNAMIC SYMMETRY
The Classical Dimension of Chaos

One of the historical antecedents from art history for the use of symmetry and chaos is the work of Jay Hambidge. Hambidge prepared a very detailed analyses of classical art from the standpoint of his theories of dynamic symmetry. Hambidge (1968) analyzed various objects from classical art that had been based on the golden section and the basic ratios for complexity and order that have been based on euclidian geometry.

Recently I have calculated what is know as the fractal dimensions for many of the classic icons found and generated by the equations of chaos theory and I have found that the more pleasing images in terms of aesthetics are those which have a fractal dimension at or near the value of phi,1.61418. Those images which are below this value are too ordered and rather dull from the artistic point of view and those above that value are too disordered and confused. The fractal dimension calculates a value between 1.0000 and 1.9999

5. THE HUMAN DIMENSION OF CHAOS

For questions regarding the usefulness of chaos theory in management usefulness in organization analysis. It seems that change varies from rigidity- stability-turbulence-chaos; the end state of chaos being least predictable, although one might say that it is contained within the rules of a larger bounding system. Management can utilize these concept, but they are applied differently when we get to a condition of chaos. Rigidity (closed system) stability (attractors) and turbulence (traditional modes of change) are all within the scope of management prediction and control. Chaos it seems , can transcend the typical rules and instead of predicting and controlling we might need to participate more fully in the change process itself and be alert to opportunities that we would miss if we were only focused on a planned future.

Prediction and understanding can be considered to be decouple by chaos theory, the underlying model can be well understood but the ability to predict may be limited as seen in many of the attractors models in much of the chaos literature.

The key is that we need to get rid of the concept of absolutes which is the old newtonian scientific mode, in fact Newton may have done us a disservice with the calculus, for example, equations in the closed, integrable form may give nice curves but show strange behaviors in the open form which must be solved by addition, this is the work of Smales at Los Alamos and others working in the early stage of the general development of chaos theory.

What if god is actually an dynamic system and the ultimate is living in a dynamic evolving world as opposed to saying that the system appears dynamic because we don't understand enough about it to find an absolute model?

Borrowing from the Mandelbrot's expression: fractal geometry, let us consider the fractals as extensions of the Euclidian objects (straight line, circle etc.)..

Then an definition that would encompass both fractal and euclidian could be different from the definitions of Barnsley. I want to ask if it is possible to extend the basic Euclidian without letting every compact subset into the consideration? When you think about it, t is the limit of an iterated function, then t follows this new definition but it may not necessarily be a fractal.

6. DRAWING WITH THE WHOLE BRAIN

Insight into the basic nature of the brain has a great implication for how one teaches drawing. Some of the basic principle from this general area of research which we have incorporated into our drawing programs are as follows.

1. All the actions of the brain are implemented by
neuron activity and by neural connections.

2. there is no way to transfer patterns of neuron activity and connections from one place to another.

3. Hence in the brain there cannot be transfer of concepts for any other cognitive elements from one place to another. This point is important because it rules out a central executive of any kind, short term memory, buffers, and retrieval. This means most of the current models of cognition are incorrect in the sense that they do not reflect what happens in the brain.

4. In terms of drawing this seems to mean that there are memories located in all parts of the body and especially in the fingers and in the hands and hence our drawing activities related to the general chaos curriculum focus on the important of the kinaesthetic cue in the drawing act.

5. We know that the output of a neuron does not contain information of the source of its input.

6. Goertzel's view that the dynamics of active cell assemblies are characterized by strange attractors is certainly a starting point for the investigation of brain dynamics.

Many of the methods that we have used in the teaching of drawing related to the fractalated curriculum were based on the early work of J. Liberty Tadd(1902) who explored the use of both hands, eyes opened and closed and the uses of the non dominant hand in the drawing activity as a way to increase and to may use of both sides of the brain. In addition to this early work, we have incorporated new ideas about tactile intelligence and tHE location of memories at or near the initial points of sensory input top frame a theory of drawing that seems to be well related to general chaos or complexity theories.

AIMS AND SCOPE

There are many disciplinary periodicals and symposia in various fields of art, science, and technology, but broad interdisciplinary forums for the connections between distant fields are very rare. Consequently, the interdisciplinary papers are dispersed in very different journals and proceedings. This fact makes the cooperation of the authors difficult, and even affects the ability to locate their papers.

In our 'split culture', there is an obvious need for interdisciplinary journals that have the basic goal of building bridges ('symmetries') between various fields of the arts and sciences. Because of the variety of topics available, the concrete, but general, concept of symmetry was selected as the focus of the journal, since it has roots in both science and art.

SYMMETRY: CULTURE AND SCIENCE is the quarterly of the *INTERNATIONAL SOCIETY FOR THE INTERDISCIPLINARY STUDY OF SYMMETRY* (abbreviation: *ISIS-Symmetry*, shorter name: *Symmetry Society*). ISIS-Symmetry was founded during the symposium *Symmetry of Structure* (*First Interdisciplinary Symmetry Congress and Exhibition*), Budapest, August 13-19, 1989. The focus of ISIS-Symmetry is not only on the concept of symmetry, but also its associates (asymmetry, dissymmetry, antisymmetry, etc.) and related concepts (proportion, rhythm, invariance, etc.) in an interdisciplinary and intercultural context. We may refer to this broad approach to the concept as *symmetrology*. The suffix *-logy* can be associated not only with knowledge of concrete fields (cf., biology, geology, philology, psychology, sociology, etc.) and discourse or treatise (cf., methodology, chronology, etc.), but also with the Greek terminology of proportion (cf., *logos*, *analogia*, and their Latin translations *ratio*, *proportio*).

The basic goals of the *Society* are
(1) to bring together artists and scientists, educators and students devoted to, or interested in, the research and understanding of the concept and application of symmetry (asymmetry, dissymmetry);
(2) to provide regular information to the general public about events in symmetrology;
(3) to ensure a regular forum (including the organization of symposia, congresses, and the publication of a periodical) for all those interested in symmetrology.

The Society organizes the triennial *Interdisciplinary Symmetry Congress and Exhibition* (starting with the symposium of 1989) and other workshops, meetings, and exhibitions. The forums of the Society are *informal* ones, which do not substitute for the disciplinary conferences, only supplement them with a broader perspective.

The Quarterly - a non-commercial scholarly journal, as well as the forum of ISIS-Symmetry - publishes original papers on symmetry and related questions which present new results or new connections between known results. The papers are addressed to a broad non-specialist public, without becoming too general, and have an interdisciplinary character in one of the following senses:
(1) they describe concrete interdisciplinary 'bridges' between different fields of art, science, and technology using the concept of symmetry,
(2) they survey the importance of symmetry in a concrete field with an emphasis on possible 'bridges' to other fields.

The Quarterly also has a special interest in historic and educational questions, as well as in symmetry-related recreations, games, and computer programs.

The regular sections of the Quarterly:
- **Symmetry: Culture & Science** (papers classified as humanities, but also connected with scientific questions)
- **Symmetry: Science & Culture** (papers classified as science, but also connected with the humanities)
- **Symmetry in Education** (articles on the theory and practice of education, reports on interdisciplinary projects)
- **SFS: Symmetric Forum of the Society** (calendar of events, announcements of ISIS-Symmetry, news from members, announcements of projects and publications)
- **Symmetro-graphy** (biblio/disco/software/ludo/historio-graphies, reviews of books and papers, notes on anniversaries)

Additional non-regular sections:
- **Symmetrospective: A Historic View** (survey articles, recollections, reprints or English translations of basic papers)
- **Symmetry: A Special Focus on ...** (round table discussions or survey articles with comments on topics of special interest)
- **Symmetric Gallery** (works of art)
- **Mosaic of Symmetry** (short papers within a discipline, but appealing to broader interest)
- **Research Problems on Symmetry** (brief descriptions of open problems)
- **Recreational Symmetry** (problems, puzzles, games, computer programs, descriptions of scientific toys; for example, tilings, polyhedra, and origami)
- **Reflections: Letters to the Editors** (comments on papers, letters of general interest)

Both the lack of seasonal references and the centrosymmetric spine design emphasize the international character of the Society; to accept one or another convention would be a 'symmetry violation'. In the first part of the abbreviation *ISIS-Symmetry* all the letters are capitalized, while the centrosymmetric image iSIS! on the spine is flanked by 'Symmetry' from both directions. This convention emphasizes that ISIS-Symmetry and its quarterly have no direct connection with other organizations or journals which also use the word *Isis* or *ISIS*. There are more than twenty identical acronyms and more than ten such periodicals, many of which have already ceased to exist, representing various fields, including the history of science, mythology, natural philosophy, and oriental studies. ISIS-Symmetry has, however, some interest in the symmetry-related questions of many of these fields.

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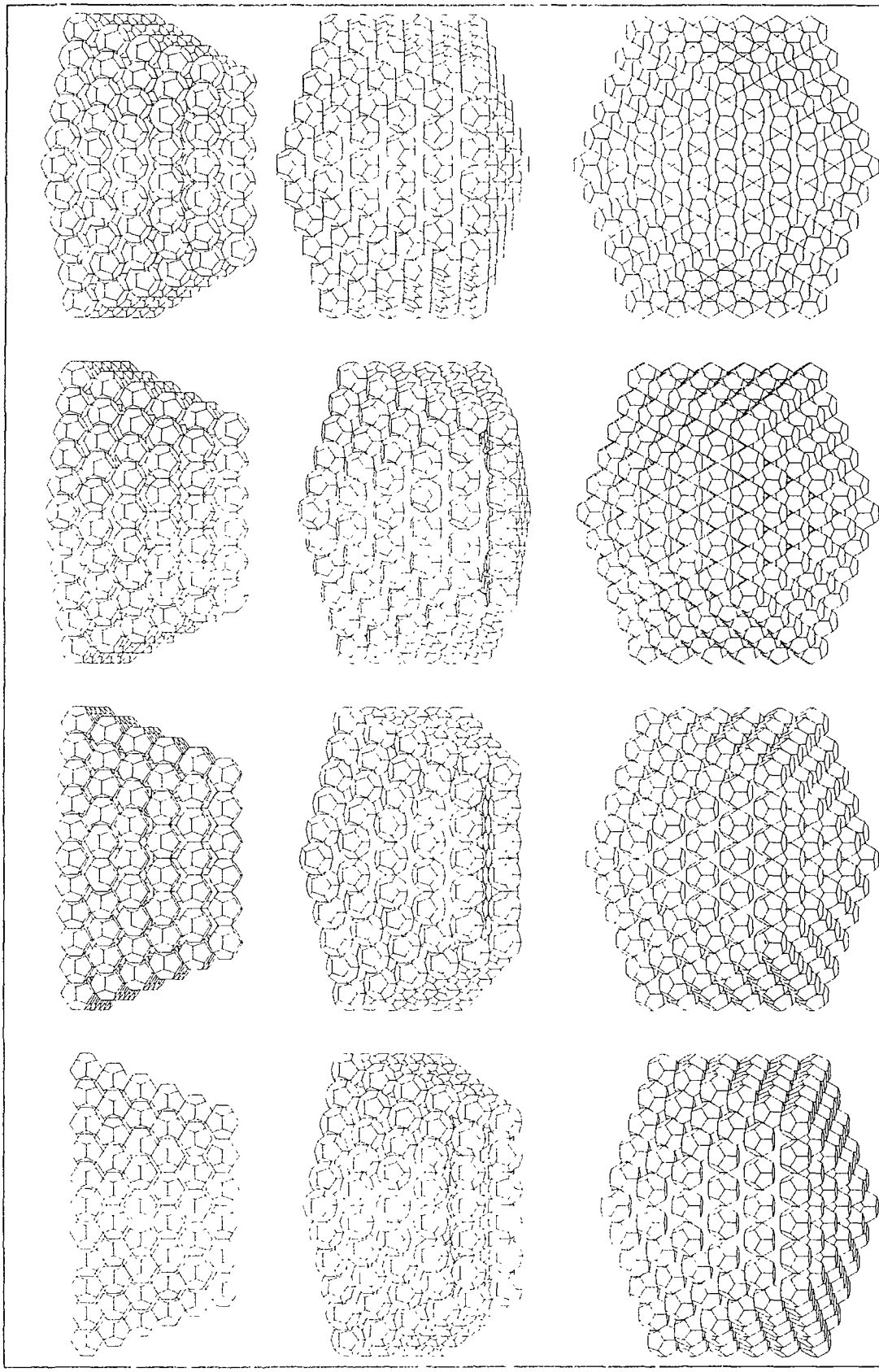
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