yochaos

www.yochaos.com
By

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ABSTRACT

In this thesis titled Yochaos, I have examined the question, What impact has chaos theory on digital art? My chosen subject matter implies research into the fields of science, philosophy and art, as a part of contemporary culture. While it seems like a stretch of the imagination to link chaos theory with contemporary art, I hope to demonstrate that both are profoundly rooted in our post-modern existence. My objectives were to prove that chaos theory has had and continues to have a great impact onto the way we perceive the world.

The methodology I have used when doing my research consisted of singling out scientists that have contributed to the establishment of the chaos theory and artists, whose work is related to it. Principal sources of information have been James Gleick's book on Chaos, John Brigg's Fractals – the patterns of chaos and Introductions to Chaos and Fractal Geometry. In order to find artists that are relevant to the subject matter I have conducted wide research in the Internet and in galleries. In addition, I've collected material relating to chaotic patterns in nature. In the website that accompanies this essay (www.yochaos.com) I have introduced chaos theory and related digital art and vice versa.

INTRODUCTION

The aim of this essay does not lie in drawing scientific conclusions from the chaos theory, but in employing the philosophical ramifications of such study to allow a unique perspective on the electronic media. While it seems like a stretch of the imagination to link chaos theory with contemporary art, I believe that both are profoundly rooted in the advance of science and reflect upon our post-modern existence. Conceivably, the most important comparison between chaos theory and digital arts is a shift in focus. Quite simply, both provide a modern method of perceiving the world around us.

The structure I have chosen to exemplify my points of research and subsequent findings is as follows: Firstly, I give a brief overview on how the chaos theory has developed throughout history in order to recognize its place in the 21st century. That is followed by an examination of chaos as a window into the whole. By explaining the butterfly effect, pattern recognition and fractal geometry I give further insights into the chosen subject matter. I then demonstrate how those scientific discoveries have had implications on the aesthetics in art. By examining fractal artists, such as Jackson Pollock and John Maeda, I reveal the mutual projections between science and art. This leads me to computer art, specifically digital art, in relation to chaos.

It is assumed that digital arts derive their energy and fascination from the relationship between artist and machine. Attempts to automate art are increasingly successful as developments take place in artificial intelligence, artificial creativity and artificial life.

Leonard Shlain's dialectic analysis of 'Art & Physics' is based on the belief that (r)evolutionary art and visionary physics (science) attempt to speak about matters that do not yet have words (Parallel Visions in Space, 1991). That is why people outside those fields find it difficult to understand their languages. Because they both speak of what may come, however, it is incumbent upon us to learn to understand them. This in turn requires the resolution of the question: What is the impact of chaos theory on digital art?

A BRIEF HISTORY OF THE THEORY OF CHAOS

The classical universe entertains a ‘vacuum' in which there is nothing (Edward Tryon 1973). Physicists have accepted the existence of a (potentially infinite) `zero point' background, which we don't notice because it's everywhere.

Euclid’s (325BC-265BC) most famous work is his treatise on mathematics ‘The Elements’. The book was a compilation of knowledge that became the centre of mathematical teaching for 2000 years.
Euclid has established a guide called 'common notions'. These are not specific geometrical properties but rather general assumptions, which allow mathematics to proceed as a deductive science. Things, which are equal to the same thing, are equal to each other (G R Morrow, 1992).

Newton’s (1642-1727) perceived the universe as a linear, closed set of events governed by cause and effect and the conservation of matter and energy. Matter was considered to be composed of a finite number of indivisible particles. Energy was thought to be a characteristic of matter. He was of the opinion that if we only had enough facts, we could predict any event with absolute certainty.
Newton did find inconsistencies in his calculations, but these were attributed to divine intervention and seen as proof of the deity’s activities. (See figure 1).

Fig 1

In Newton’s days the universe was seen as a very large, complicated clock, which,

when observed at an atomic scale, consisted of a very large number of billiard tables (M. Blair Ligon 2001)

In an article featuring in the Scientific American (January 1992), Martin Gutzwiller, drew attention to a paper that Albert Einstein (1879-1955) wrote in 1917, and which was completely ignored for 40 years. In that paper Einstein raised a question that physicists have only, recently begun asking themselves: What would classical chaos, which lurks everywhere in our work, do to quantum mechanics, the theory describing the atomic and subatomic worlds?

The effects of classical chaos, of course, have long been observed. Johannes Kepler (1571-1630) knew about the motion of the moon around the earth. At the end of the 19th century the American astronomer William Hill demonstrated that the irregularity is the result entirely of the gravitational pull of the sun.

So thereafter, the great French mathematician-astronomer-physicist Henri Poincaré (1854-1912) realised, most dynamic systems show no discernible regularity or repetitive pattern. The behaviour of even a simple system can depend so sensitively on its initial conditions that the final outcome is uncertain.

In the 1940's, computers and statistical mechanics proved predicting most events theoretically impossible by the sheer number and variables. The universe was then considered ummeasurable, but still entirely linear and mechanical. It was also believed that the effect of small events was just so much unavoidable noise. Infinitesimal events were absorbed by the greater scheme of things and the universe-as-machine, ticked on.

The first chaos theorists evolved in the 1960s and operated with intuitive and interdisciplinary methodologies. Early models were ignored or derided as amateurish by career mathematicians, for their lack of formal mathematical proofs. It was only with the availability of computers to formulate those proofs that chaos theory became an important factor in many fields.

Chaos- a window into the whole

Over the last decades, physicists, biologist, astronomers and economists have created a new way of understanding the growth of complexity in nature. This new science, called 'Chaos', offers a way of seeing order and pattern where formerly only the random, the erratic, the unpredictable, the 'chaotic', had been observed. Chaos is a dynamic phenomenon. It occurs when something changes. Basically, there are two types of changes; regular ones studied by classical physics and dynamics.

The science of chaos has been influenced by almost every discipline and subject, tying together unrelated kinds of patterns. These patterns, also called fractals, are represented in nature by biological systems, from the turbulence of weather to the complicated rhythms of the human heart, from the design of snowflakes to the desert sands, as is portrayed in my accompanying web site. During my research I have been accumulating examples from nature, which represent those patterns in order to demonstrate the point within the artefact.

Although highly mathematical in its origins, chaos nonetheless is a science of our everyday world, addressing seemingly naïve questions, such as: how clouds form, how smoke rises or how water flows in a river. Where does really chaos come from? Three major recent developments have made chaos a popular word.

1. Breathtaking computing power that enables researchers to perform hundreds of millions of complicated calculations in matters of seconds.
2. The rise in computing power has been accompanied by a growing scientific interest in irregular phenomena such as; random changes in weather, the spread of epidemics, the metabolism of cells, the changing population of insects and birds, the rise and fall of civilizations or the propagation of impulses along our nerves.
3. Chaos theory was born when these developments were combined with the emergence of a new style of geometrical mathematics. (Sadar, 2002)

The phenomenon of chaos is an astounding and controversial discovery that most scientists would have dismissed as fantasy just a couple of decades ago. However, Leibnitz in the 17th century and Jules-Henri Poincaré had already appreciated some of its conceptual elements in the 19th century. Ancient Chinese thought recognised that chaos and order are related. In Chinese creation stories, a ray of pure light, Yin, emerges out of chaos and builds the sky. Ying and Yang, (See figure 2) the female and the male principles, act to create the universe. But even after they have come out from chaos, Ying and Yang still retain the qualities of chaos. Too much of either reverts the system back to chaos.

Fig 2

In Chinese myth, the dragon represents the principle of order, yang, which emerges from chaos.

The ancient Greeks, seem to have accepted that chaos precedes order, specifically, that order comes from disorder, and most forces in real life are nonlinear. Hesiod, a Greek of the 8th century B.C, wrote the 'Theogony', a cosmological poem which states that "first of all Chaos came to be" and then the Earth and everything stable (The online Medieval and classical library, 1995).

The reason why chaotic behaviour has not been studied until now is because scientists reduced difficult nonlinear problems to simpler linear ones in order to analyse them. Newton's thought about the universe and also Galileo's work with gravity provides us with a good example. Galileo (1564-1642) disregarded small nonlinearities in order to get near results.

The Butterfly Effect

In the 1960's, new concepts arose from attempts to computer models and predict the weather. Forecasters found that any change in a weather model, no matter how small, eventually caused a drastic change in the outcome of the weather prediction. This became known as the 'butterfly effect', in part because of the graphic representation of these effects (See figure 3), but also because of an analogy made by meteorologists and computer scientist.

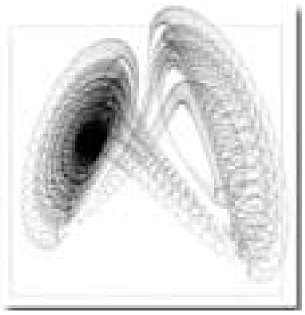

Fig 3

Graphical representation of Lorenz attractor's.

The butterfly effect, first described by Lorenz at the December 1972 meeting of the American Association for the Advancement of Science in Washington, D.C., vividly illustrates the essential idea of chaos theory. In a 1963 paper for the New York Academy of Sciences, Lorenz had quoted an unnamed meteorologist's assertion that, if a butterfly flaps its wings, weather all over the world will change as a consequence. By the time of the 1972 meeting, he had examined and refined that idea for his talk, "Predictability: Does the Flap of a Butterfly's Wings in Brazil set off a Tornado in Texas?" (Sardar, 2002).

It is impossible to make predictions for such complex systems because the underlying conditions for such a small system as a butterfly being responsible for creating such a large and distant effect can never be sufficiently articulated to allow that kind of long-range calculations.

Fractal Geometry

A fractal is defined as a mathematical formula or algorithm that constitutes or defines an efficient way of formulating computer graphics. Fractals are self-similar in that any piece of the fractal design contains a miniature of the entire design. Examples of computer generated fractals are to be found in the www.yochaos.com website.

In the 1960s and 1970s the IBM researcher, Benoit Mandelbrot, invented a new geometry, which he called “fractal” geometry. He coined the term “fractal” to suggest “fractured” and “fractional”, geometry that focuses on broken, wrinkled, and uneven shapes. Mandelbrot was not just interested in predictions, but he was also looking for chaotic patterns, which did not necessarily fit to any linear, predictable curve. What he did find were patterns within patterns.

There are 3 fundamental categories of fractal patterns. Firstly, natural, such as trees, mountains and clouds (See figure 4). Secondly, mathematical, computer simulations (See figure 5), and, thirdly, fractal patterns created by humans, such as cropped sections of abstract paintings (See figure 6).

Fig 4

Natural fractal pattern: Clouds.

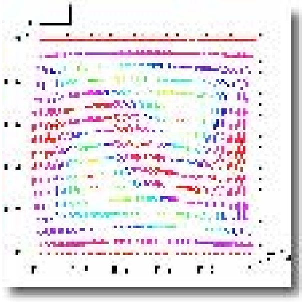

Fig 5

Mathematical fractal pattern: Computer simulation.

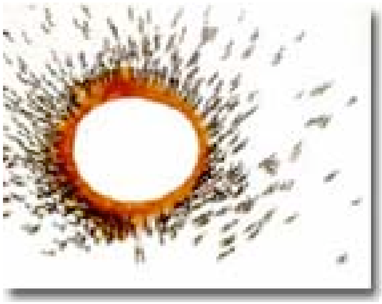

Fig 6

Human fractal pattern: Abstract painting by Juan Genovés.

Today fractals have become part of a new aesthetic, which provides a novel way of visualising the natural world, describing the roughness of the world, its energy, its dynamical changes and transformations.

All those kinds of fractals represent patterns with unique yet predictable characteristics, which arise in dynamic systems (a system in motion that varies with an inconsequential amount of randomness) suspended between order and chaos; in essence, they are images of a chaos artwork.

Fractal images (See figure 7) have led to a growing contemplation of our reality as a place made up of folded worlds within self similar worlds, as patterns folded in between dimensions. Fractals can be found everywhere. A moss-covered rock can be regarded as a miniature mountain range covered with trees, a microcosm of our larger landscape. If we assume that everything on the planet has evolved through intense interaction with everything else, then these self-similar images of holism (a harmony in which everything is understood to affect everything else) are explanatory of this theory.

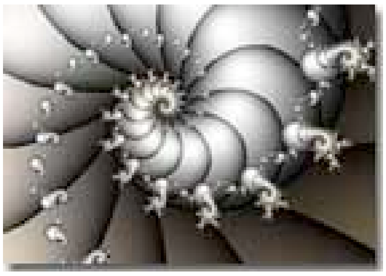

Fig 7

This is an example of a computer generated fractal image created by Karin Kuhlmann

Fractal scientists believe that the fingers on our hands are self-similar to the wings of a hummingbird and the fins of a whale, because we all have evolved inside the same holistic dynamical system called life. If chaos theory tells the story of the wild things that happen to dynamical systems as they evolve over time, fractal geometry records the images of their movement in space.

DISCOVERING A NEW AESTHETICS OF ART, SCIENCE, AND NATURE

The study of chaos has increasingly sensitised scientists to the aesthetic experience of art. When scientists and mathematicians began to work with fractal geometry they learned to their amazement that they could generate intricate fractal forms on their computer screens with fairly simple nonlinear formulas. The chaos theory has generated a great impact not merely on scientists, but also artist have always exploited and valued what might be called “the order that lies in uncertainty”. Moreover, composers are creating fractal music, programmers are studying the effect of chaos in computer networks and ecologists are using the principles of self-organising chaos to reconstruct lost habitats.

Some artists have perennially discovered in the doubt, uncertainty, and haphazard of life a harmony that goes straight to the essence of being. Whatever it is that the painter, poet, musician or programmer depicts, the artist’s final product implies worlds within worlds. Within art there is always something more than meets the eye, the mind, or the ear. Because of this ability to intimate worlds within worlds, art has always been fractal.

The British romantic poet John Keats (1795-1821), for example, admired what he called “Negative capability”, the ability to be “in uncertainties, mysteries, doubts” (Miriam Allott, 2000). He claimed that this capacity was the key to the artist’s creative power. Leonardo Da Vinci (1452-1519) insisted, “that the painter who has no doubts will achieve little” (Michael J. Gelb 2002).

Science & Art: a history of mutual projections

Art and science have a history of mutual projections. Throughout modernity art was habitually identified as the imaginary ‘other’ of science, and vice versa. These identifications implied an ascription of fixed attributes: while science was believed to represent rationality and progress, art was treated as the domain of intuition and primordial human experience.

This polarized interpretation of the essence of art and science in turn was reflected in many manifestos of modernist avant-gardes. Movements like the Futurists, Constructivists or the Bauhaus sought to break with the bourgeois concept of the fine arts, which believed modern science and technology to be the disruptive force, and attempted to sweep away the constraints of tradition. The ‘artist as engineer’ was thought not only to revolutionise art but also to change the shape of society.

Similar ideas can also be found in some of the writings of Walter Benjamin (1892-1940). In ‘The Work of Art in the Age of Mechanical Reproduction’ written in 1935, for instance, W. Benjamin celebrates the new ‘technological’ media of photography and cinematography as tools for the destruction of tradition and its values. He welcomes their propagation as a democratic liberation of the means of cultural production to be put at the service of the masses.

Conversely, other movements like Expressionism and Surrealism understood the inherent rationalism of modern science and technology, not as an agent of liberation, but as a force of alienation complicit with the capitalist and industrialist regime. In this context the identification of art as a residue of primary human experience served to portray art as a liberator, in the sense that art was conceived to be the ‘other’ of science. It was believed to serve as a means to overcome the alienation induced by science and return to the realm of authenticity.

As dated, as it may seem, the modernist fallacy of essentialising assumptions about the nature of science (rational and progressive) and art (intuitive and authentic) still permeates many contemporary reflections on the encounters between art and science.

Mario Markus, a physicist at Max Planck Institute in Dortmund, Germany (See figure 8) and Eve Laramée, a New York based sculptor (See figure 9) have endeavoured to bring the two fields of science and art together. Markus generates fractal images of a relevant set of equations used to model turbulence. He argues, “The particular choices made by one person, as compared to those made by others, allow us to speak of a personal, recognizable ‘style’. Truly one can say that equation can be considered here as new types of painting brushes.”

Laramée, on the other hand, creates ancient-looking constructions out of copper, salt and water. Once she has installed one of her artworks in the gallery, the salt dissolves and begins to eat intricate, ageless fractal shapes into the copper so that the piece evolves over time. While Markus strives to insert himself into his equations and exert some control over the chaos that automatically unfolds, Laramée strives to take herself out of the process and let the inherent chaos roll in. She says, “There is a point where I ‘remove’ the hand of the artist, and allow nature to take over and finish the work.” (Briggs 1992)

Thus the new aesthetic created by chaos ensnares artist and scientists, both as observer and observed. The so-called objective/subjective wall that for centuries has divided scientists and artists in their approach to nature is now being shattered from both sides.

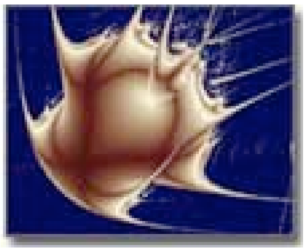

Fig 8

Mario Markus. “Markus Lyapunov fractals”

Fig 9

Eve Laramée. Instalation."Cellular Memories”

Order in Jackson Pollock’s Chaos

Jackson Pollock (1912-1956) was a pioneer of the Abstract Expressionist Movement. He began to study painting in 1929 at the Art Students' League, New York, under the Regionalist painter Thomas Hart Benton. During the 1930s he worked in the manner of the Regionalists, being influenced also by the Mexican muralist painters (Orozco, Rivera, Siqueiros) and by certain aspects of Surrealism.

By the mid 1940s he was painting in a completely abstract manner, and the `drip and splash' style, for which he is best known, emerged with some abruptness in 1947 (See figure 10). Pollock had developed a technique in which he poured a constant stream of paint onto horizontal canvases to produce uniquely continuous trajectories. This deceptively simple act polarized opinion in the world of art.

Fig 10

Jackson Pollock, Blue Poles: Number II, 1952,

Enamel and Aluminium paint with glass on canvas, 82 7/8" x 15' 11 5/8"

Richard P. Taylor, a physicist who also paints abstract art, intrigued by Pollock's work, decided to head back into science to determine whether he could identify tangible traces of nature rhythms in his artwork using computer analysis. He started the investigation by scanning a Pollock painting into the computer; he then covered it with a computer-generated mesh of identical squares. By analysing, which squares were occupied by the painted pattern and which were empty, he was able to calculate the statistical qualities of the pattern. And by reducing the square size he was able to look at the pattern at what amounts to a finer magnification. His analysis examined pattern sizes ranging from the smallest speck of paint up to approximately a meter.

He found the patterns to be fractal. And they were fractal over the entire size range. 25 years before their discovery in nature, Pollock was painting fractals. That means that art has anticipated science, in view of the fact that during Pollock's era, nature, was assumed to be disordered, operating essentially randomly.

Pollock may not have intended to produce fractal paintings, but many contemporary artists, like landscape painter Margaret Grimes (See figure 11), immediately recognized in chaos theory a deep connection to their personal artistic orientation to the world. Grimes say: “These ideas confirmed mathematically something that I had already perceived experientially through observations of nature. The theories thus had great resonance, as of a truth one has always known but has not known how to express”. (Briggs 1992).

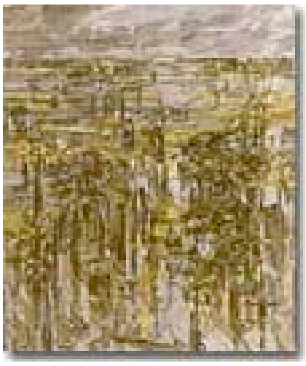

Fig 11

Margaret Grimes, Louisiana Marshlands, 2000

Oil on paper, 36.5" x 36"

Photographer Joe Cantrell describes a similar process in his own work (See figure 12): " The order is out there in so many planes for which we either have no perception or have been trained not to see it. I shoot for the surprise. Very often I get it in some of the most prosaic subjects. There's state you can get into when photography is going well where you lose yourself. At the end of it you've been somewhere that's pretty wonderful but you can't remember the details until you see the final result." (Briggs 1992). The results are a fractal record of his interaction with his subject, which are usually fractal objects themselves such as ferns, volcano's, and turbulent water.

Fig 12

Joe Cantrell, Kelp 3,1998, Gelatine Silver Print

Daniel Txopitea, a Basque painter (1950-1997), presented in December 1980 a body of work that, although he didn't define it as fractal, can be considered fractal art. In the prologue of his exhibition catalogue he argued, " It was inevitable for me to paint this collection. The temptation has arrived a long time ago but only when I finished my last body of work, that desire became manifest in the final paintings as you can now see. I am the first one to be surprised. Therefore, this exhibition consists of a group of monographic paintings: vegetation and undergrowth (Belarrak in Basque language), which are examined from an internal point of view (See figure 13). I have chosen this approach as an alternative to the common panoramic landscape, because observation has taught me a partialised, intimate vision, which also brings with it further possibilities and unlimited surprises." (Txopitea 1980).

Fig 13

Daniel Txopitea, Belarrak, 1982. Oil on Canvas 55 x 45cm

Chaos affirms that individual details matter. Artists know that like the sensitivity of a chaotic dynamical system, a change in one small part of a painting or a poem may destroy or transform the work. Moreover, it is the artist's task to find and express this significant relation between forms and qualities that are simultaneously self-similar and self-different so as to create an artwork that allows us to glimpse the holistic nature of our universe and our existence.

Art and complex systems

A Complex System is any system, which involves a number of elements arranged in structures, which can exist on many scales. These go through processes of change that are not describable by a single rule, nor are reducible to only one level of explanation.

In September 2002, the Samuel Dorsky Museum of Art, organized an exhibition named ‘Complexity’, where 27 contemporary artists displayed their artworks.

Paul Hertz, one of the exhibiting artists, created fine art prints as well as computer based interactive multimedia installations (See figure 14). His work utilises an underlying tilling pattern and a competitive cellular automata mechanism, which results in patches of bright colour in a self-organizing patterns. Nell Tenhaaf showed a DVD that relates to ‘Complexity’ (See figure 15) because it explains how behaviours at different scales (dancers and DNA model) can resemble each other organisationally. Woody and Steina Vasulka, pioneers of electronic art, have accomplished some of the earliest and most innovative use of video feedback as a generative system (See figure 16). Video feedback is now cited in scientific textbooks as a canonical example of deterministic chaos.

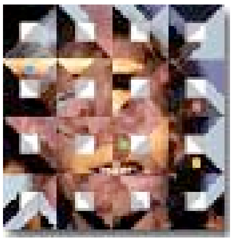

Fig 14

Paul Hertz, Recordatori 3: Bop Cartography I, 1999

Iris Print, 13.75 x 13.75

Fig 15

Nell Tenhaaf, Machines for Evolving and dDNA (d is for dancing), 2002

Figure drawings on computer model, DVD.

Fig 16

Steina & Woody Vasulka.

Interactive historical research installation.1992

The aim of the exhibition was to prove that chaos, fractals, regularities, emergence and other features of the complexity sciences have ramifications of arts. Philip Galanter and Ellen K.Levy, co-organizers of the exhibition stated that: “There is no need to view complexity as the basis for an art movement or style. Part of the appeal of complexity science to artists is that it offers an open-ended model for making art. The artistic response to complexity spans a number of media, including paintings, prints, photography, drawing, and even living arts. There is also sculpture, video, installation, mixed media, and computer screen-based work. Complexity art it’s a matter of content, not complicated technique. The science of complexity is a field of inquiry that not only creates bridges across many branches of science but also offers a revolutionary intellectual force, which has ramifications for other disciplines such as art and philosophy”. (Gallanter and Levy, 2002).

The ways that art uses to describe the world around us, and our internal worlds, are interwoven with the new insights from the study of complex systems. Understanding art as a language, the historical development of art, and the creative process itself are all key areas in which art and complex systems have a common ground. Many artists have become engaged with the rich dynamic pattern forming and generative models characteristic of many studies in complex systems.

COMPUTER ART

The computer possesses some characteristics, which make it uniquely suited for carrying out chance procedures. It can be precise in its ability to measure without accumulating errors as measures are based on one another. Unlike a camera or a painting, it can replicate an image indefinitely, making changes between duplicates with no degradation of resolution or colour. It is also possible to replicate, modify and measure in an unstructured mode, and to allow random changes within very precise parameters.

A computer also allows us to trace our steps and to go back to previous compositions to look for solutions in branching patterns rather than linear process. The drawback to this is that it is still easy to rely on one successful solution and modify it almost indefinitely. This tendency has resulted in a lot of flashy computer graphics, which look immensely similar to one another. By 1988 youth magazines were publishing special issues on the phenomenon of ‘Chaos Culture’. At this time fractal graphics were appearing in music videos, in clubs, on T-shirts, TV programmes and all kinds of books and magazines.

Digital artists have begun to use fractal dimensions to create the illusion of such natural objects as rocks and water. Other computer artists are exploring the creation of new images based on nothing but the pure mathematics of fractal geometry. Without knowing it millions of people around the world have watched fractal mathematics on movie and television screens. Using variations of fractal techniques originally pioneered by Benoit Mandelbrot, computer graphics artists created the alien landscapes for the Star Wars films (See figure 17).

Fig 17

Alien landscape by anonymous author.

What is important to visual designers is not so much the ability to define objects or surfaces in fractal terms, or even to emulate the appearance of natural structures, but the ability to look up the graphic structures in terms of their quality of self-replication across scale.

Digital Art

A digital work is, by definition, composed on or translated by or through a binary computer. A digital work is, collectively, a carefully defined set of "0's" and "1's" which have been used to encode data into files that can contain, for example, text, audio or visual information. With the possibilities offered by computers, peripherals and software, those who become competent with these new and ever-evolving technologies can make or alter images in ways never before available. Many artists and art critics agree, once visual information is converted into binary code it is possible to produce original images that are as visually and aesthetically stunning as those produced through any other medium.

Digital imaging is simply another way to communicate visually and artistically and perhaps the one of means to carry us into brave new worlds in the arts (See figure 18).

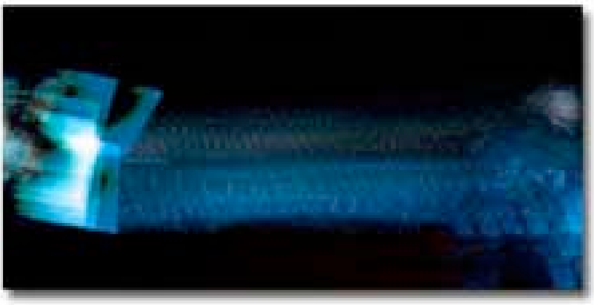

Fig 18

Running Sherman. Digital image. Ione Saizar. 2003

In the middle of the last century, with the beginning of the electric age, the arts have undergone consistent and rapid modification in the face of technical assaults; photography, sound, cinema, radio and television. From this rich stimulant a new generation of artists have evolved, which give birth to a wealth of hybrid forms.

Already, consumer-grade products using digital technologies are getting much smarter. Some futurists conjecture that sometime before 2035 a computer somewhere will be nudged into consciousness and suddenly wake up to find it is capable of performing the processes now exclusively the domain of the human brain, and therefore be "intelligent." In this regard, it has also been suggested that such "smart" machines will be reproductive, creating smarter machines, which will build yet smarter ones, infinitely. Technological progress would then explode, growing toward what seers call the "Singularity". The term comes from mathematics and is the point at which a function goes infinite, consequently chaotic.

The computer not only deprives the artist of a few illusions about uniqueness and originality by taking part in the production process as a barely original and serially manufactured apparatus, but it also offers the possibility to develop new scenarios that express a changing view on the world. The non-linear, non-physical nature of digital media offers new possibilities to express new relationships between man and its surrounding world, and its chaotic nature.

Chaos and Maeda

John Maeda's work is based on the discovery of the evident relations between the evolution of art and the technological advances. Massachusetts Institute of Technology (MIT) Professor John Maeda's powerful artistic ideas combine computer science and visual arts to challenge our common assumptions about designing on the computer.

Born in Seattle, Washington, Maeda received bachelors and masters degrees in computer science from MIT in 1989. Inspired by Paul Rand's book 'Thoughts on Design', Maeda turned his attention to graphic design and creating chaos software using Java script and Flash. In Japan, he began to experiment with ideas on ways to bond the simplicity of good graphic design with the complex nature of the computer. His experiments grew into a series of five "Reactive Books" that today are the world-recognized standard for high-quality, digital media design.

With the arrival in 1984 of the first generation of Macintosh computers he came just in time to participate in the emerging boom of computer graphics. In his works he is concerned with the segregation that exists between the fields of art and technology and how this segregation makes it difficult to understand both.

As an artist and a computer scientist, Maeda views the computer not as a substitute for traditional tools, but as an artistic medium in its own right. He advocates teaching artists and designers computer programming in order to liberate them from the limits of pre-packaged design tools. By thinking about computer code as an art form, Maeda is redefining graphic design.

In a recent article, I.D. Magazine noted: "Maeda takes great pleasure in secreting information within something that looks like pure abstraction. His aesthetic has a kinship with computer language, in which an impenetrable stream of seeming nonsense carries meaning. His style embodies the underlying idea of computing, that you can generate immense complexity through the repetition of very simple elements." (ID 2002).
"As an artist, teacher and writer John Maeda's great contribution is to demonstrate that innovative media-based design grows out of the artist mastering the tools of the craft-in other words, getting inside the

“brain” of the computer and speaking the language of zeros and ones," notes Marina McDougall, curator of art and design at the CCAC Institute. (ID 2002)
Maeda sees the computer not as a substitute for the brushes and pencils but as an artistic medium that itself has an infinite creative capacity. He continues to investigate several fields at the same time and reinvents his work every few months, destroying his latest works. Refusing to be categorised, Maeda explains in his latest book, Maeda@maeda, that the theory of information can be modelled mathematically like a river linked to variable quantities of noise. In essence, the bigger the noise the river produces the more information it takes with it. He argues that, by applying this simple equation one can demonstrate that the expressionist paintings of Jason Pollock definitely have more information than the simplest paintings of Kashmir Malevich.

Maeda developed an interest for creating the biggest volume of information possible in each of his compositions, mixing colour patches and nonsense sentences (See figure 19). Thus escaping from the doctrine of creating meaning and just focus on the shapes like the Dadaists in 1917. He believes that a shortcut to the destruction of order is to introduce lots of irregularities produced by noise.

Fig 19
John Maeda. Coded blue. Graphic Design. 2000.

Maeda creates simple geometrical forms or patches of colour that evolve into a self-organised labyrinth. They are typographic marionettes, that the artist meticulously uses moving the thread of technological advances. His compositions are located in a virtual scenario where colours, positions, size and the possible interactivity of every element is vital, investigating the differences between simplicity and complexity, order and chaos. You can find more information and examples of his work on the website that accompanies this thesis: www.yochaos.com.

Yochaos Website

Yo chaos means I am the chaos. The website is meant to be a demonstration of the main points raised in my thesis. Apart from my essay, which you can download as a PDF, provides the factual background, this site incorporates a visual representation of the butterfly effect, and fractal images that are presented with the cylinder display engine in three-dimensional space. Furthermore it contains a brief introduction to artists whose works are based on chaos, and visual examples of chaos in nature and everyday life. I invite the viewer to create fractal art on their home computer and download chaos software, which will provide him with the experience of chaos created by digital means.

Whilst conducting subject-related research, which took me into the fields of physics, mathematics, philosophy and contemporary art, I decided to avoid lengthy scientific discussions, and instead, create a website, which deals with the subject of chaos theory in relation to digital art in a way, that is easy accessible and comprehensible. Basically, Yochaos functions as an introduction to the subject, with the aim of evoking interest for further exploration. In conjunction with the contents of the site I have chosen a design, which is clear, pleasing to the eye and easy to navigate. The integration of original artworks is meant to help the viewer visualise the subject and intrigue him.

During my research I found that there are only a few sites about chaos theory related to art. However, a lot of material is written about chaos theory as such, or even fractal art, yet very little sites talk about this matter in a populist way. People in general know about the existence of such theory, but don't know what it really is about. Chaos theory and fractals seem complex and therefore confusing at the first encounter. Its language is very difficult to understand, for the very reason that it uses scientific and mathematic terms. Bearing that in mind, my aim was foremost to engage the visitors through visual examples of the different parts of chaos theory and related artworks, and thus catch their attention and trigger a desire to find out more about the subject.

Due to a lack of time I was not able to create a forum for discussion on the site as I initially intended. But in the future the site will feature a platform for artists, scientists and the general public to voice their opinions, give feedback and introduce related works of art.

CONCLUSION

We partially perceive reality through the technology, which surrounds us. William Gibson went even further in stating that: "I find myself thinking there isn't anything other than the impact of technology on society." (Guardian, 03/05/03). Digital technologies, such as email, sound, software, text editors, scanners and servers increasingly characterise our everyday life behaviour. We just need to type www. to access any production. This democratisation of knowledge could be called a zone of fractal order. In this context, the World Wide Web is a territory that lies between the absolute chaos and the geometrical order established by Euclid. It can be viewed as a fractal pattern, comparable to a leaf or cells. In fact, fractal geometry came about because computers made fractal calculations visible (Paul Virilio, 1998). The works of digital artists imply words within words and therefore represent fractal geometry as part of the chaos theory.

The works of Markus, Woody & Steina or Maeda, are inextricably linked with chaos theory, because they use infinitesimal equations to create images to represent life. Chaos theory and fractal geometry extend science's ability to do what it has always done: find order beneath confusion. While cause and effect clearly play a role in digital art, discontinuity, confusion and uncertainty are just as important. The implications of chaos theory have reached far beyond science and academics, but also visionary artists have come to realise, that chaos is just the beginning of something, which is going to evolve and find its order.

Scientific exploration, like artistic creation, is based on an accepted body of knowledge and techniques and it is not until these static approaches are challenged that a revolution in thought can occur.

By disrupting these established conceptual frames both chaos theory and digital artists offer a challenge to these accepted truths. Because chaos theory is an inherent part of a greater present shift in society, it offers contemporary artists a new approach to dynamical systems, which is linked with methodology and philosophy.

Chaos theory and technology have brought a scientific dimension to art. Technology continues to influence and transform society. The artist is representational of those transformations, manifest in the new digital approaches to art. Therefore, I conclude that contemporary computer technology has provided us with the means to see complex macro objects within a micro universe. Moreover, chaos theory has had and continues to have a great impact onto the way we perceive the world and find explanation for our existence. In this sense, the patterns of fractal sets created on computer screens provide a metaphorical analogue for the interwoven patterns of our “reality”.

Ainize Txopitea, 2003

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Image source:

- Fig 1: “The earth”. (http://www.earth.com/)
- Fig 2: “Ying Yang” (http://www.rmha.org)
- Fig 3: “The butterfly effect” (http://avalon.net/~nonie/spike/spindex.htm)
- Fig 4: “Clouds” (http://sprott.physics.wisc.edu/fractals/natural/clouds.jpg)
- Fig 5: “Computer simulation” (http://www.maths.ox.ac.uk/ cmb/dd.html)
- Fig 6: “Abstract painting by Juan Genoves” (http://www.zfm.com/mnav/genoves.htm)
- Fig 7: “Fractal image by Karin Kuhlman” (http://www.KarinKuhlmann.de)
- Fig 8: “Mario Markus” (http://perso.wanadoo.fr)
- Fig 9: “Eve Laramee” (http://www.plexus.org/laramee.html)
- Fig 10: “Blue Poles by Jackson Pollock” (http://www.jacksonpollock.com)
- Fig 11: “Margaret Grimes”(http://www4.nas.edu)
- Fig 12: “Joe Cantrell” (http://photography.cicada.com/gallery/cantrell/)
- Fig 13: “Belarrak by Daniel Txopitea” (http://www.txopitea.com)
- Fig 14:”Paul Hertz, Recordatori”(http://collaboratory.nunet.net/phertz/portfoli/main.ht
- Fig 15: “Neel Tenhaff” (http://www.yorku.ca/tenhaaf/)
- Fig 16: “Steina & Woody Vasulka” (http://www.eai.org/eai/artist.jsp?artistID=299)
- Fig 17: “Alien landscape”
- (http://angelfire.lycos.com/doc/imagebrowser/photos/Backgrounds/Alien_Landscapes/categories1.html
- Fig 18: Original photograph by Ione Saizar. 2003
- Fig 19: “John Maeda” (http://www.maedastudio.com)

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