**Chaos: Scientific and Human Perspectives**

> Where Chaos begins, classical science stops. For as long as the world has had physicists inquiring into the laws of nature, it has suffered a special ignorance about disorder in the atmosphere, in the turbulent sea, in the fluctuations of wildlife populations, in the oscillations of the heart and the brain. The irregular side of nature, the discontinuous and erratic side - these have been puzzles to science, or worse, monstrosities. James Gleick, *Chaos*

I didn't study natural science at university, having chosen the humanities in the sixth form at school. As a result, I grew up scientifically illiterate in the "two cultures" atmosphere of the last century. Art and human sciences seemed much more interesting than natural science anyway. It wasn't until I started looking into the creative science writing of biologists like Richard Dawkins and Stephen Jay Gould that I realised how fascinating science really is. [1] The difficulty was that, without a scientific education, there was a limit to how far one could go, scientifically speaking. Understanding the revolutions of relativity and quantum mechanics, for instance, seemed to require a knowledge of advanced mathematical logic and the esoteric equations used in following it.

At first I was quite angry with an educational system that separated students into two distinct cultures, but, when reading up about quantum mechanics - that branch of science even scientists proclaim they can't understand! - I was fascinated by its insights - for example, the findings that merely observing something changes it - not forgetting the equal changes at the same time in the observer, her- or himself - or that an "atom" is not a fixed entity, but sometimes a particle, sometimes a wave, depending on how you are looking at it. Nor is one individual atom the same as any other individual atom. We forget - in our modern, mechanical culture - that nature never repeats itself exactly. All phenomena may appear the same but they are equally different. Quantum realities seemed to be breaking down the Newtonian certainties of the seventeenth century Scientific Revolution and the European Enlightenment which followed it, in particular the idea that the Universe is a fixed, objective reality we freely and harmlessly observe.

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[1] Richard Dawkins *Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder,* 2006, and Stephen Jay Gould *Life's Grandeur: The Spread of Excellence From Plato to Darwin, 1997*

While both the twentieth century revolutions of relativity and quantum mechanics challenged the empirical science of the Enlightenment and its encyclopaedic view that we only needed to accumulate more knowledge - or data - to have a complete understanding of the Universe - a view still held, consciously or unconsciously, by many orthodox scientists - the revolutions of physics in the early years of the last century only went so far. Many of the famous physicists of that time were, in fact, of a mystical persuasion. In their understandings the Universe was essentially mysterious and ultimately unfathomable to the rational, or linear, mind. Chaos and Complexity theory have built on those revolutions and taken their understandings further, in a way that the "non-scientific", more contemplative mind might be able to understand better - in particular, for instance, the notion that complexity is not so complicated but essentially built up by the infinite replication of simple geometrical forms.

**The yin and yang beauty of the Universe**

What makes Chaos exciting, as *The Graphic Guide* confirms, [2] is that, while modern Western science aims to present a universe at once predictable and conforming to fundamental physical laws, chaos theory suggests that it - the universe - is also a place of disorder, complexity, and unpredictability. In fact, according to chaos theory, predictability is a rare phenomenon. Chaos theory explores the subtle relationships between *randomness* and *orderliness* and, like the ancient Chinese Taoist tradition of *yin* and *yang,* illustrates how they are not two but identified, the one with the other. Both are needed to begin to make sense of the world.

At the same time, as, ourselves, a species of nature, we are humbled by our limited, intellectual understanding. The universe may appear erratic and chaotic to the Enlightenment mind, but, from a Chaos perspective, it is also sublimely beautiful. As Shakespeare's Hamlet said, famously, to his friend, Horatio: "There are more things in heaven and earth than dreamt of in your philosophy". Chaos seems to point to, not just the orderly randomness but the corresponding beauty, itself, of the Universe and all phenomena in it, including ourselves.

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[2] Ziauddin Sardanapalus and Iwona Abrams, *Introducing Chaos,* pp 76-83 (kindle edition)

**Fractal reality**

How Chaos links *simplicity* and *complexity* is something that the science writer, John Gribbin, struggled with, until he realised that "complexity" originates with simple and initial forms that find a regular and rhythmic response in the environment to create the complex phenomena of nature. [3] The flapping of a butterfly's wings, creating storms the other side of the world, is a well known example, but also take Benoit Mandelbrot's concept of fractal geometry, for instance, which James Gleick made popular in *Chaos: The Making of a New Science.* [4] Mandelbrot coined the term "fractal" from the Latin *fractus* which describes a broken stone - broken and irregular. Fractals are geometrical forms that, unlike those of *Euclid,* are not regular at all. But, at the same time, they manifest a mysterious coherence. They look, for instance, the same on a small or large scale, a quality Mandelbrot referred to as "self-similarity", and which reminds one of the poet, William Blake's "universe in a grain of sand", or the Dalai Lama's "universe in an atom".

It is a fantastic idea - and image - that our complex, and seemingly complicated, world could be built up with self-similar forms, replicated infinitely and randomly to account for all the myriad phenomena of the universe, simultaneously in a regular but irregular pattern. You can see how it is beautifully manifest in nature in the growing form of any tree. But Chaos theory suggests how the same figuration can be seen everywhere - in the world of meteorology of course, but also, for example, in economics and industry, the human body and architecture, demographics and cities, and, of course, in the human mind (male and female) - everything in fact.

**Chaos, order, and equilibrium**

Chaos also showed, in fact, how "randomness" was not random but had an order which European modern science had missed. As Ilya Prigogine and Isabelle Stenger demonstrated in their landmark book, order comes out of Chaos. [5] Prigogine was a Belgian chemist who won the Nobel Prize in chemistry in 1977 for his work on what he

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[3] John Gribbin in his Introduction, "The Simplicity of Complexity" in his book, *Deep Simplicity: Chaos, Complexity and the Emergence of Life,* suggested that all the business of chaos and complexity is based on two simple ideas - "the sensitivity of a system to its starting conditions and feedback", p 3.

[4] James Gleick *Chaos: the Making of a New Science,*1987, 1997, see particularly the chapters "A Geometry of Nature" pp 81-118 and "Images of Chaos" pp 213-240.

[5] Ilya Prigogine and Isabelle Stengers *Order out of Chaos: Man's New Dialogue with Nature,* 1984

called “dissipative structures”. This term implies that all phenomena, particularly when they are in a “turbulent” condition, or “far from equilibrium”, are apt to “dissipate” - as it were, self-destruct. But, as Prigogine suggests, a dissipative system also has a capacity to “self-organise”. Biological and social systems are open and readily exchange energy and information with their environment. Therefore, understanding them in mechanical terms - the machine metaphor is the driver of orthodox modern science - will not work. Prigogine maintained that most of reality is actually unstable, and therefore full of disorder and change, but capable of self-organising at the same time.

According to him, there are distinctions between systems that are “in equilibrium”, “near equilibrium” and “far from equilibrium”. [6] In systems that are far from equilibrium matter dramatically reorganises. This reminds one of Rebecca Solnit’s remarkable book where she describes “paradise in hell”. [7] There is a transformation from disorder - “thermal chaos” for the natural scientist - to order. New dynamic states of matter may originate, resulting from a new interaction between a given system and its environment. As William Blake put it, nature is both “prolific” and “devouring”. Its creative capacity depends on its dissipative structure. The two go together.

**The irreversibility of time**

To understand the “prolific” processes of nature, Prigogine introduced the notions of reversible and irreversible time. [8] Newtonian thought saw the Universe as mechanical and time as reversible. Evolutionary time did not enter into the realm of classical physics until the nineteenth century. It posited a system “in equilibrium”. Only in irreversible time did dynamic Time really become manifest, in conditions that were “far from equilibrium” - Chaos, in fact, could be said to reveal “the arrow of time”. But, for Prigogine, irreversible processes were also the source of order. Self-organisation could happen, and it did so spontaneously. To quote Prigogine: “Far from equilibrium studies led me to the conviction that irreversibility has a constructive role. It makes form. It makes human beings”. [9] In other words irreversible time is creative. In times of turbulence, when nature is “far from equilibrium”, new forms emerge.

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[6] Ibid. pp 140-145

[7] Rebecca Solnit, *A Paradise Built in Hell: the Extraordinary Communities that Arise in Disaster,* 2010.

[8] Prigogine, 1984, see “PREFACE: Man’s New Dialogue with Nature”.

[9] Quoted in *Introducing Chaos.*

We are certainly in a time now of turbulence, and, from a social and ecological perspective, very far from equilibrium. In our understandable anxiety and fear of catastrophe, people find it difficult to see the principle of self-organisation, leading to a new equilibrium. In the arts and humanities, we are well acquainted with issues of life and death, the transience of all things, the value of the resurgence of new life following sorrow and despair, grief leading to joy and renewal. Perhaps, in chaos and complexity studies, science is beginning to free itself from the dominance of the closed system of classical physics and to associate itself with more open systems with a more ecological focus. Perhaps we are also seeing the end of the "two cultures" civilisation and embracing the notion of infinitely plural cultures, in welcoming a global, rather than simply Western view.

The idea of self-organisation also counters the entropy view of the second law of thermodynamics, which says that the universe and everything in it is winding down. In the closed system of classical physics this may appear to be the case, but, when the death of a life form is viewed within an environmental or ecological perspective, it is seen to be regenerative and transformed.

**A new/old consciousness**

Prigogine also defined self-organisation as the phenomenon by which a system self-organises its internal structure independent of external causes. In other words Chaos also relies on sensitive responses - or feedback - from individual entities. Where we - human beings - are concerned, this is about a consciousness which is aware of the principles of non-linearity, fractals, dissipative and regenerative structures and so on, but are we not also aware of a "modern" psychology that, like classical physics, may be operating in a system of thought that is inadequate to the challenges of our times?

I ask this question because the speculations of contemporary scientific notions of Chaos are echoing what has always been known to non-Western cultures and to practices and thinking in our own alternative traditions. Chaos is akin to the void, abyss or "emptiness" of Indian Vedanta and Buddhism for example, and to the world-view of many indigenous traditions that Western imperialisms have suppressed and is not acknowledged or practised in the modern world. There is a place for Western science, since its achievements have materially benefited the world, but that doesn't mean we can't also be

aware of how it can be seen as a closed system of thought. We might look to ways in which it can be open to new practices and thinking.

In our psychotherapeutic culture this might be viewed, not just in the way of finding new treatments for the climate change anxieties of clients but how practitioners themselves might come to address their own anxieties and the challenges of a “far from equilibrium” world.  This is both an individual challenge and a cultural one - individual insofar as we professionals are able to experience the real Chaos in our own lives, each in her or his individual way, and cultural in understanding the political and social challenges we face in this new century. We might consider, especially, the inter-connected and global nature of the political identity issues of race, class, and gender, which all affect our understanding of, and response to, climate change. Chaos can open up the “fractal” capacity of both our individual and political/social minds.

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