Chaos Theory

"Chaos often breeds life, while order breeds habit." This observation by Henry Adams is profound for a number of reasons. On the one hand, it emphasizes the ability of complex structures (life) to be derived from simple ones (e.g. sperm and egg). The discovery of this truth in scientific terms earned Ilya Prigogine the Nobel Prize for Physics.

At the same time, Adam's observation ties in with **Time Wave** theory in terms of *Novelty* (a first cousin to Chaos) and *Habit*. Too much habit is hazardous to life, while too much novelty/chaos is hazardous to entrenched views, structures, and anal retentives. As we approach **2012 A.D.**, it might be necessary for everyone to began shedding habit at every opportunity (another word for chaos), and get used to chaos, opportunity, and/or novelty.

Chaos is often thought of as utter confusion, pandemonium, havoc, or disarray. However, in mathematics, Chaos Theory deals with the unpredictable and apparently random behavior of *deterministic* systems, which are extremely sensitive to *infinitesimal* changes in initial parameters. Chaos can thus lead to novelty, innovativeness, and uniqueness (the latter which implies value). In this way, we can think of Chaos as our friend.

An excellent website, complete with *photos* and brief, lucid explanations about everything you wanted to know about Chaos Theory and Fractals has been provided by Jonathan Mendelson and Elana Blumenthal <**http://www.mathjmendl.org/chaos**/>. The website notes, among other things, that "The planet Neptune was discovered in 1846 and had been predicted from the observation of deviations in Uranus' orbit. King Oscar II of Norway was willing to give a prize to anyone who could prove or disprove that the solar system was stable. Henri Poincaré offered his solution, but when a friend found an error in his calculations, the prize was taken away until he could come up with a new solution that worked. He found that there was no solution. Not even Sir Isaac Newton's laws provided a solution to this huge problem. *Poincaré had been trying to find order in a system where there was none to be found*." [*emphasis added*] **Hyperdimensional Physics** is looking better all the time!

For somewhat more technical material, one can also go to <**http://order.ph.utexas.edu**/> or more specifically, <**http://order.ph.utexas.edu/chaos**/>, i.e. and the Ilya Prigogine Center for Studies in Statistical Mechanics and Complex Systems, at the University of Texas (Longhorns) at Austin, where there is also material from Dr. Matthew A. Trump.

For considerably less technical material, but some marvelous designs of art based on fractals and Chaos theory, check out: **http://www.artbycomputer.com**.

One of the more noteworthy books on the subject is *Order Out of Chaos, Man's Dialogue with Nature*, by Ilya Prigogine and Isabelle Stengers [1]. The idea of obtaining "order" out of "chaos" may sound like an oxymoron, but its experimental demonstration is so profound that this must rank as one of the most disturbingly fundamental discoveries of modern science. The fact that it is accepted by mainstream science (or those willing to spend some time with it) is evidenced by the Nobel Prize awarded to Professor Prigogine.

Several of Ilya Prigogine and Isabelle Stengers' observations from the book are included below, with additional comments and observations from other researchers. From this, it should become readily obvious that Chaos Theory is of fundamental importance to life.

Quotes [with comments] from: *Order Out of Chaos, Man's New Dialogue with Nature*, by Ilya Prigogine and Isabelle Stengers, Bantam Books, New York, 1984:

"While some parts of the universe may operate like machines, these are closed systems, and closed systems, at best, form only a small part of the physical universe. Most phenomena of interest to us are, in fact, *open systems, exchanging energy or matter* (and one might add, information) with their environment. Surely biological and social systems are open, which means that the attempt to understand them in mechanistic terms is doomed to failure." [*emphasis* added] [I.e. the universe is fundamentally connected, whether in the guise of **Connective Physics**, **Zero-Point Energy**, **ESP**, or life in general.]

"This suggests, moreover, that most of reality, instead of being orderly, stable and equilibrial, is seething and bubbling with change, disorder, and process." [This is the same process which **Arthur Young** considers so important in the makeup of the universe. This is where the action is [literally!], and what constitutes the basis of **Time Wave** Novelty.]

"In Prigoginian terms, all systems contain subsystems, which are continually 'fluctuating'."

[Such fluctuations may be reflected in elementary particles literally winking in and out of existence in accordance with the **Heisenberg Uncertainty Principle**. But any given fluctuation or combination of them may with positive feedback shatter the organization at a revolutionary moment, which Prigogine and Stengers refer to as a *bifurcation point*. It is inherently impossible to know what'll happen next: whether the system will disintegrate into confusion or become a new, more differentiated, *higher level of structure*. Such an organization is referred to as a *dissipative structure*. The name derives from the fact that compared to simpler structures, a dissipative structure requires *more energy to sustain itself*. Prigogine nevertheless insists that order can arise *spontaneously* out of disorder through a process of *self-organization*.]

[Western science has long been on the trail of determinism, where everything occurs as a result of immutable general laws. This, strangely enough, justified the Law of **Karma** (i.e. cause and effect), or the idea that our lives are the result of karma. But with spontaneous events occurring, "inherently impossible to determine in advance" the outcome of certain "causes" will not yield, even in principle, precise effects. I.e.

the Law of Karma is broken in the case of nonlinear, far-from-equilibrium situations with an energy flux through it. One very specific example would be *forgiveness*.]

[Nevertheless Western science continues to plod on in its quest to determine all outcomes. It seeks a world which is repetitive and reversible, where universal laws always govern, and knowing those laws allows one to always predict what happens next. In other words, to control (or at least know) the outcome beforehand. But to accomplish the goal, science has had to apply reductionism.] "We may compare it to reducing buildings to piles of bricks. Yet out of the same bricks we may construct a factory, a palace, or a cathedral. It is on the level of the building as a whole that we apprehend it as a creature of time, as a product of a culture, a society, a style" [i.e. something unique and specific].

"Paraphrasing Isaiah Berlin [2] we can refer to this as: the cathedral versus the pile of bricks, the specific and unique versus the repetitive and the universal, the inner versus the outer, the abstract versus the concrete, perpetual movement (process) versus rest, quality versus quantity, timeless principles versus culture-bound, mental strife and self-transformation as a permanent condition of man versus the possibility of (or desire for) peace, order, final harmony and the satisfaction of all rational human wishes."

"Reversible processes are those which are independent on the direction of time, while irreversible processes depend on the direction of time. [**Entropy** increases only because of the irreversible processes.] "Irreversibility may be *the source of order*, of coherence, or organization." [*emphasis* added] [Particles coming together and then parting, are reversible. Irreversible is when they stay together and form something new.]

"The remarkable feature is that when we move from equilibrium to far-from-equilibrium conditions, we move away from the repetitive and the universal to the specific and unique. Indeed, the laws of equilibrium are universal. Matter near equilibrium behaves in a 'repetitive' way. On the other hand, far from equilibrium there appears a variety of mechanisms corresponding to the possibility of occurrence of various types of dissipative structures." "The type of dissipative structure depends critically on the conditions in which the structure is formed. External fields such as the gravitational field of earth, as well as the magnetic field, may play an essential role in the selection mechanism of self-organization."

"Equilibrium structures can be seen as the results of statistical compensation for the activity of microscopic elements (molecules, atoms). By definition they are inert at the global level. For this reason they are also 'immortal'. Once they have been formed, they may be isolated and maintained indefinitely without further interaction with their environment. When we examine a biological cell or a city, however, the situation is quite different: not only are these systems open, but also *they exist only because they are open*. They feed on the flux of matter and energy coming to them for the outside world."

[This flux and energy is directly related to the **Zero-Point Field**, **Mach's Principle**, the elements of **Connective Physics**, and the interconnectedness of life in the universe.] "We can isolate a crystal, but cities and cells die, when cut off from their

environment. They form an integral part of the world from which they draw sustenance, and they cannot be separated from the fluxes that they incessantly transform. But it is not only living nature that is profoundly alien to the models of thermodynamic equilibrium. Hydrodynamics and chemical reactions usually involve exchanges of matter and energy with the outside world." [In other words, even water in our universe receives and effects other dimensions (see <**http://www.newphys.se/fnysik/2_1/schauberger/**>, for a brief description of Viktor Schauberger's work. Also [3].]

[In one of their more classic understatements,] "In the world that we are familiar with, equilibrium is a rare and precarious state." [And yet physics has tried to insist that physical order is predictable and reproducible. They have constructed technologies which operate in equilibrium -- and have avoided like the plague, transient behavior and initial conditions. And yet, from the **Connective Physics** viewpoint, transients (process) is where the really interesting stuff occurs. For example, life. Physics had hoped that randomness would lead to irreversibility, *where the initial conditions could be forgotten*. Darwin, on the other hand, thought in terms of self-organizing, ever-increasing complexity.

[Linear thermodynamics (the kind that offers simpler mathematics)] "describes the stable, predictable behavior of systems tending toward the minimum level of activity compatible with the fluxes that feed them. The fact that linear thermodynamics, like equilibrium thermodynamics, may be described in terms of a potential, the entropy production, implies that, both in evolution toward equilibrium and in evolution toward a stationary state, *initial conditions are forgotten. Whatever the initial conditions, the system will finally reach the state determined by the imposed boundary conditions. As a result, the reaction of such a system to any change in its boundary conditions is entirely predictable*."

"Lucretius, concerned about turbulent flow, wrote that sometimes, 'at uncertain times and places, the eternal, universal fall of the atoms is disturbed by a very slight deviation -- the 'clinamen'. *The resulting vortex gives rise to the world, to all natural things*.' This clinamen, this spontaneous, unpredictable deviation, has often been criticized as one of the main weaknesses of Lucretian physics, as being something introduced ad hoc. In fact, the contrary is true -- the clinamen attempts to explain events such as laminar flow ceasing to be stable and spontaneously turning into turbulent flow."

"For a long time turbulence was identified with disorder or noise. Today we know that this is not the case. Indeed, while turbulent motion appears as irregular or chaotic on the macroscopic scale, it is, on the contrary, highly organized on the microscopic scale. The multiple space and time scales involved in turbulence correspond to the *coherent* behavior of millions and millions of molecules. Viewed in this way, *the transition from laminar flow to turbulence is a process of self-organization*. Part of the energy of the system, which in laminar flow was in the thermal motion of the molecules, is being transferred to macroscopic organized motion."

[One of the most amazing of all concoctions is the notion of a "chemical clock". Prigogine illustrates this by conceiving of two kinds of molecules, 'red' and 'blue'. Because of their chaotic motion, one expects in any given moment to have more red

molecules, say, in the left part of a vessel. Later more blue molecules would appear, and so forth. The vessel would appear as violet, with occasional irregular flashes of red or blue.]

[However, in a chemical clock, the system is all blue, then abruptly changes its color to all red, then again to blue. Occurring at regular time intervals, a coherent process is in effect.] "Such a degree of order stemming from the activity of billions of molecules seems incredible, and indeed, if chemical clocks had not been observed, no one would believe such a process to be possible. To change color all at once, *molecules must have a way to communicate*. The system has to act as a whole. Dissipative structures introduce probably one of the simplest physical mechanisms for communication." [*emphasis* added]

[Such molecular communication is akin to the apparent connection of particles in the **EPR Experiment**, and the experimental verification. Not only is there communications among molecules and particles, the communications appears to operate outside the known laws of mainstream physics -- i.e. faster than the speed of light!]

"The 'historical' path along which the system evolves as the control parameter grows is characterized by a succession of stable regions, where deterministic laws dominate, and of instable ones, near the bifurcation points, where the system can 'choose' between or among more than one possible future. Both the deterministic character of the kinetic equations whereby the set of possible states and their respective stability can be calculated, and the random fluctuations 'choosing' between or among the states around the bifurcation points are inextricably connected. This mixture of necessity and change constitutes the history of the system." [As has been often said, it's all about choices!]

"One of the most interesting aspects of dissipative structures is their coherence. The system behaves as a whole, as if it were the site of long-range forces. In spite of the fact that interactions among molecules do not exceed a range of some 10^{-8} centimeters, the system is structured as though each molecule were 'informed' about the overall state of the system." "When a favored direction results from an instability, space ceases to be isotropic. We move from Euclidean to Aristotelian space!" "It is tempting to speculate that the breaking of space and time symmetry plays an important part in the fascinating phenomena of morphogenesis. These phenomena have often led to the conviction that some internal purpose must be involved, *a plan realized by the embryo* when its growth is complete." "Differentiation of cells depend on their position in a morphogenetic field."

"We know today that both the biosphere as a whole as well as its components, living or dead, exist in far-from-equilibrium conditions. In this context life, far from being outside the natural order, appears as the supreme expression of the self-organizing processes that occur." "Slime molds, when threatened with starvation coalesce into a single supracellular mass." "Termites, initially dispersed randomly, will cluster together. If a cluster is introduced peripherally, a second little cluster will also form, in addition to the additional growth of the first cluster."

"*The more complex a system is, the more numerous are the types of fluctuations that threaten its stability*." [Systems as complex as ecological or human organizations exist, perhaps, due to the stabilizing effect of communication, or diffusion processes.] "In complex systems, where species and individuals interact in many different ways, diffusion and communication among various parts of the system are likely to be efficient. There is competition between stabilization through communication and instability through fluctuations. The outcome of that competition determines the threshold of stability."

"The world of dynamics, be it classical or quantum, is a reversible world. No evolution can be ascribed to this world; the 'information' expressed in terms of dynamical units remains constant. There are conditions: a minimum complex is necessary. But the immense importance of irreversible processes shows that this requirement is satisfied for most systems of interest." [This evolutionary paradigm] "includes isolated systems that evolve to disorder and open systems that evolve to higher and higher forms of complexity. On the human level irreversibility is a more fundamental concept, which is for us inseparable from the meaning of our existence. Still it is essential that in this perspective we no longer see the internal feeling of irreversibility as a subjective impression that alienates us from the outside world, but as marking our participation in a world dominated by an evolutionary paradigm."

"You have all heard of the dissipation of energy. It is found that in all transformations of energy a part is converted into heat and heat is always tending to equalize its temperature. The consequence is that the energy of the universe is tending by virtue of its necessary laws toward a death of the universe in which there shall be no force but heat and the temperature everywhere the same... But although no force can counteract this tendency, *chance may and will have the opposite influence*." [I.e. **Entropy** can be reversed... as luck would have it! (pardon the pun)] *Force is in the long run dissipative; chance is in the long run concentrative*. [Within the **Time Wave**, Habit is terminal, Novelty is expansive!] The dissipation of energy by the regular laws of nature is by these very laws accompanied by circumstances more and more favorable to its reconcentration by chance. There must therefore be a point at which the two tendencies are balanced and that is no doubt the actual condition of the whole universe at the present time." [*emphasis added*]

[**Finally, in a profoundly stunning concept**, Prigogine and Stengers write,] "Systems are highly sensitive to fluctuations. This leads both to hope and a threat: hope, since even small fluctuations may grow and change the overall structure. As a result, *individual activity is not doomed to insignificance*. On the other hand, this is also a threat, since in our universe *the security of stable, permanent rules seems gone forever*. We are living in a dangerous and uncertain world that inspires no blind confidence, but perhaps only the same feeling of qualified hope that some Talmudic texts appear to have attributed to the God of Genesis: 'Twenty-six attempts preceded the present genesis, all of which were destined to fail. The world of man has arisen out of the chaotic heart of the preceding debris; he too is exposed to the risk of failure, and the return to nothing. 'Let's hope it works' exclaimed God as he created the World, and this hope, which has accompanied all the subsequent history of the world and mankind, has emphasized right from the outset that *this history is branded with the mark of radical uncertainty*." [emphasis added]

This might be the end of this treatise. But then again...

According to Charles W. Misner, Kip S. Thorne, and John Archibald Wheeler [4]

“Classical general relativity thinks of the spacetime manifold as a deterministic structure, completely well-designed down to arbitrarily small distances. No so quantum general relativity or 'quantum geometrodynamics’. It predicts *violent fluctuations in the geometry* at distances on the order of the Planck length” (1.616 X 10^{-33} cm). [*emphasis* added]

“No one has found any way to escape this prediction. As nearly as one can estimate, these fluctuations give space at small distances a 'multiply connected' or 'foamlike' character. This lack of smoothness may well deprive even the concept of dimensionality itself of any meaning at the Planck scale of distances." In other words, all things in the universe are connected, when one arrives at the Planck scale of distance.

"Physics is simple only when viewed locally; that is Einstein's great lesson." Additionally, "Time is defined so that motion looks simple." And most of physics is defined in order for the physicists to be able to do the math. Nature, on the other hand...

References:

[1] Ilya Prigogine and Isabelle Stengers, *Order Out of Chaos, Man’s Dialogue with Nature*, Bantam Books, New York, 1984.

[2] I. Berlin, *Against the Current*, selected writings ed. H. Hardy, New York: The Viking Press, 1980), pg 109.

[3] Olof Alexandersson, *Living Water, Viktor Schauberger and the Secrets of Natural Energy*, Gateway Books, Bath, England, 1976, 1982.

[4] Charles W. Misner, Kip S. Thorne, and John Archibald Wheeler, *Gravitation*, W. H. Freeman and Company, San Francisco, 1973.