The world is essentially an incomprehensible tangle of chaotic systems. Life itself is an example of chaos, unpredictable and complex, with change being the only constant. Equilibrium is reached only in death. Creation and destruction happen simultaneously. The contributing factors are endless and attempts at controlling chaos are futile. Somehow, functioning order rises from the disorder that surrounds and lives inside us.

As time moves the universe forward, entropy or disorder expands as well. The second law of thermodynamics states that, “Entropy must always increase in the universe and in any hypothetic system within it” (Gleick). Entropy is the gradual decline into disorder. Time is what keeps everything from happening at once. Only when a system behaves in a sufficiently random way, may the difference between past and future and, therefore, irreversibility enter its description (Sardar and Abrams). Without the irreversible quality of chaos as a point of reference there is no perception of time.

A butterfly flaps its wings in Brazil and sets off a tornado in Texas. The butterfly effect is a classic example describing the chaos theory. Weather is so sensitive that the contributing factors are essentially infinite. Also, these infinite and tiny, initial conditions are magnified so that two nearly identical starting points will turn out unrecognizably different (Ives). It is no wonder why the forecasts are never entirely accurate. Chaos is also behind the spread of epidemics, changing populations of insects and birds, the rise and fall of civilizations, rush-hour traffic and the propagation of impulses along our nerves (Sardar and Abrams). Chaotic systems are extremely sensitive to internal conditions and, therefore, are unpredictable in the long term.

Chaotic systems generate unpredictable results and irregularity, as well as order without periodicity. A chaotic system operates according to a set of rules, but constant feedback loops, time delays and tiny changes cause the system to behave randomly without repetition. They generally tend to swing between chaos and order. As the system becomes increasingly unstable, at a critical point it branches out into a different direction, restoring order. This is called bifurcation. Bifurcation results in new possibilities that keep the system alive and random (Ives).

In a far-from equilibrium system, we can see matter being dramatically re-organized. When a far-from-equilibrium system enters a chaotic period, it changes into a different level of order “spontaneously” through what is called “self-organization” (Sardar and Abrams). Self-organizing systems and the flow of energy within them creates new structures and spontaneous behavior. Instances of disequilibrium and self-organization are called “dissipative structures.” This term expresses a paradox as dissipation suggests chaos and falling apart and structure is its opposite. Dissipative systems are capable of maintaining their identity only by remaining continually open to the flux and flow of their environment (Briggs and Peat).

Complex behavior is produced by nonlinear systems, which express relationships that are not strictly proportional. Linear systems can be captured with a straight line and are solvable. Nonlinear systems generally cannot be solved and cannot be added together (Gleick). In a nonlinear equation a small change in one variable can have a disproportional, even catastrophic impact on other variables. Plots of nonlinear equations show breaks, loops, and recursions—all kinds of turbulence. One difference between linear and nonlinear systems is feedback—that is, nonlinear equations have terms which are repeatedly multiplied by themselves (Briggs and Peat). Most systems in nature play by the ever-changing rules of nonlinearity.

A visual aspect of chaos is fractal geometry. Fractals were first created using computers to iterate nonlinear equations, letting the internal sensitivity of the equation create shapes and figures on the screen (Ives). Fractals embrace not only the realms of chaos and noise, but a wide variety of natural forms which the geometry that has been studied for the last two and a half thousand years has been powerless to describe—forms such as coastlines, trees, mountain, galaxies, clouds, polymers, rivers, weather patterns, brains, lungs, and blood supplies. The complex systems of nature seem to preserve their detail on finer and finer scales (Briggs and Peat). They are "self-similar," implying that any subsystems of a fractal system reflect the whole system. Within their overall shape, there is a repetitive pattern whose exquisite substructure characterizes the nature of chaos, when predictably breaks down (Sardar and Abrams).

The human body is not a simple machine, but a complex chaotic system able to maintain life far from equilibrium. A prime example of chaos in the human body is the beating of our own hearts. Although a heartbeat seems periodic, sensitive instruments show irregularity in the intervals between beats. No two beats are exactly the same (Ives). The rhythm of the heart is sensitive and dynamic, a product of feedback that is going on between different parts of the body. A healthy heart is delicately balanced between order and disorder.

The way that blood vessels branch and become increasingly complex is fractal in nature. They divide until blood cells must move single file through the vessels. The language of anatomy tends to obscure the unity across the sales. The fractal approach, by contrast, embraces the whole structure in terms of the branching that produces it, branching that behaves consistently from large scales to small scales (Gleick). We have traditionally appreciated the simple regularity of order in our familiar world, neglecting the infinitely higher orders (or chaos) woven within it (Briggs). Human beings are creatures of chaos.

According to the chaos theory, the mind is a chaotic system. Signals in the brain travel in endless feedback loops, carrying vast amounts of information. It contains billions of neurons connected to each other (Sardar and Abrams). The brain naturally finds order in the chaos of the world. Information is stored in a plastic way allowing fantastic juxtapositions and leaps of imagination (Gleick). Creativity is the product of chaotic activity. Our ability to process information and generate new ideas is due to aperiodicity and instability of the complex levels of our minds.

When you reach an equilibrium in biology, "You're dead," as stated by Bernardo Huberman. A seizure in epilepsy is due to abnormally periodic order in the brain due to loss of chaos. The brain needs to be highly irregular to survive. A victim of schizophrenia suffers from too much order, a trapped order, which paradoxically appears, in the epileptic seizure, as a massive attack of chaos. In the brain, chaos is normal, yet chaos induced by too much order is devastating (Briggs & Peat).

Do the principles of non-linearity apply to the creative process of human beings? In the chaotic universe the possibilities are endless. The breakdown of cycles leads to confusion and then to new perceptions of order. When faced with a problem, the mind searches increasingly erratically for a solution. The frustration of the creator produces a far-from-equilibrium mental state. At this point, the bubbling of thoughts causes a trivial observation to become amplified and a thought branches to a new plane of reference—a plane that contains the solution (Briggs & Peat). The disruption of the usual patterns of our minds results in innovation.

In this complex universe, order exists within chaos. Order leads to a slow decay into destruction. Chaos leads to exciting possibilities and creation. The self-similarity that exists in the perfection of nature is evidence that there are worlds within worlds. Once we accept our lives as chaotic, our reality gains new significance. Our existence is a spontaneous fluctuation in the fabric of time and space.

Works Cited

Briggs, John, and F. David Peat. *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Science of Wholeness*. New York: Harper & Row, 1989. Print.

Gleick, James. *Chaos: Making a New Science*. New York, N.Y., U.S.A.: Penguin, 1988. Print.

Ives, Crystal. "Human Beings As Chaotic Systems." *Fractal.org*. Web. 4 Dec. 2011.

Sardar, Ziauddin, Ziauddin Sardar, and Iwona Abrams. *Introducing Chaos*. Thriplow: Icon, 2008. Print.