

*Why Does Smoke Never Go Back
into the Cigarette?*

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"If you mix the mashed potatoes and sauce, you can't separate them later. It's forever. The smoke comes out of Daddy's cigarette, but it never goes back in. We cannot go back. That's why it's hard to choose. You have to make the right choice. As long as you don't choose, everything remains possible."

- Mr. Nobody

We are faced with decisions every single day. It's a natural, unpredictable, chaotic thing; the lives we lead. There is a theory that defines the disorder and inability to calculate future events, The Chaos Theory. It deals with nonlinear events that are impossible to predict or control. The theory is broken down into three main aspects *The Butterfly Effect, unpredictability, and fractal geometry*. Scientists have been searching for a single theory that defines all of nature. The chaos theory brings us one step closer unified theory of the universe (3). The decisions we make now, regardless of how miniscule they seem, play a huge role in determining the significant parts of our future; sensitive dependence upon initial conditions lead to larger changes (15). With this poetic notion in mind, we come to realize that we hold very little control within our lives. The only control we have is in the moment; whether we manifest positive or negative, it all causes a chain of events that affect us. Do we really have control over the events that transpire in our lives? Does an initial moment shape our future?

The chaos theory asks questions about the long-term effects of a condition. The theory does not make predictions about the future, but looks at behavior that is unstable and aperiodic (occurs without order or pattern). The "Signature of Chaos" that primarily sums up its identity is that a system is sensitive to initial conditions, meaning that the starting conditions greatly determine the outcome; small changes at the start lead to drastic changes later on (11). There are three main categories that define the chaos theory: unpredictability, fractals, and the butterfly effect (14). It all started with Edward Lorenz, a meteorologist in the early 1960's. He was working on mathematical models of air currents in the atmosphere. There was an assumption that the heat process was so vast that small changes in the system would ultimately cancel each other out. However, Lorenz had found that the results were unexpectedly different over time, the system was sensitive to the small variations he had placed in the starting configuration (12). Thus, the theory was born and organized. Chaos is an ancient idea, and it is still such a mystery to us today. The ancient Chinese thought deeply that chaos and order were related and interchangeable, much like a Yin Yang. They created beautiful analogies to translate the idea of order and chaos to a more grounded level for example, each representing the male and female principles, respectively. If the theory fulfills its potential, it will dramatically change the way we view the natural world and ourselves (11). There is light and dark within everything, within us and around us. This is an important fact. Within chaos there is order; They cannot exist without each other because each state moves towards each other. Say you have a clean desk at the beginning of the week but slowly over the course of a hectic work period, the desk becomes messy and chaotic without you even realizing. So, why does the smoke in a cigarette never go back in? Why does a spilled drop of ink never reform? Because entropy makes it that way. The principle of *entropy* is the evolved state of the universe that moves to disorder or chaos (9). There is organization in chaos and there is chaos in organization. The Chaos theory deals with the nonlinear, like the weather, the stock market, our own minds, etc (14). Chaos is intriguing because it can connect our experiences to the laws of nature by showing us the Yin Yang of order and chaos. Chaos is extremely dynamic and change is inevitable to a system. The human

body is a distinct system that shows chaos in a complex form.

All events spawn from a single point; it might be a butterfly flapping its wings in Brazil and causing a hurricane in Florida a few days later or meeting a childhood friend many years later and falling in love. Everything has a cause and effect (13). The butterfly effect is the major principle to the chaos theory; it speaks to the small decision that drastically impacts the larger picture. Our lives are an ongoing demonstration of this principle. We should understand that no matter where we are today, we came to this point as a result of our past actions and experiences. When we make a decision we set off a series of events in motion that is out of our control (14). To be more conscious of this effect is to create an “illusion of control”, an effort to better or worsen your life. Like I said before, we have the ability to choose to manifest positivity or negativity, and ultimately choosing positivity will encourage the end result to be a better one (2). It really is a poetic notion, that something small could impact something larger than itself. Although the butterfly effect is intended to give sense to the scientific mystery of the incalculable, like the weather system that cannot even be accurately predicted a few days before (15). The butterfly effect opens your eyes to all the small, seemingly miniscule, decisions in your life and brings meaning and importance to each path. “Each of these lives is the right one, each path is the right path. Everything could have been anything else and have just enough meaning” (9). It's interesting to think about how your life could have taken a drastic change by simply not buying that coffee on Saturday morning, or never meeting the person that introduced you to the meaning of life. It's really quite beautiful to imagine that we're on this path right now and in this dimension for a reason. We can experience what we are feeling right now, because it is happening in this moment and reality.

Before the discovery of fractal geometry there were only the Euclidean shapes such as squares, triangles, circles and so on. Benoit Mandelbrot introduced fractals in 1924. He described fractals as being “irregular all over” and “having the same degree of irregularity at all scales”(11). He went on to discover equations that would generate them. By the 1960's he began to see the repeating geometry in plants like ferns and broccoli. Each miniature part related to the plant as a whole, also known as self-similarity; no matter how far out or close in you “zoom” you see the same design. The equations he made underwent the process of feedback, which are observable in many natural chaotic phenomena. An example of this is the wake behind a moving boat or the way the smoke forms a curl when it exits the cigarette. In both of these examples, the smallest curling pattern in the turbulence had the same shape as the larger curls. Here nature has an overarching regularity in its chaotic nature (12). Fractals showed a type of infinity within a finite space. Before fractals, people saw a mountain and categorized it as a “cone” shape, measuring only its relative space, same with the coastline of any state, only measuring it by simple terms (4). However fractals introduced the intricate and detailed space in all the cracks and crevices along the coastline and mountainsides. Fractals are never ending patterns; they are infinitely complex patterns that are self-similar within the entire shape (13). Repeating a simple shape or process in a loop makes them. They are the image of Chaos (14). They are everywhere in nature and even in our modern technology; the trees, rivers, clouds, seashells, hurricanes, blood vessels and so on (13). Even our own cell phones are wired into fractals to carry out all the complicated functions (4). They are a paradox, simple in theory but infinitely complex (7). Fractal geometry is used to describe many complicated phenomena in our natural world. This type of geometry is also responsible for many special effects in movies; Computer Generated Images requires it to carry out its job. Fractal dimensionality is what we observe when we are positioned a certain way and how we see it in that position. A football for example from far away

it is perceived as a two-dimensional object, but when we move closer it is clear that it is three-dimensional (11). "Nothing is stable, nothing is true, and nothing matters for very long." (9) All cities today have some sort of chaotic irregularity in their system; they are untamed and ever changing. With this being said they are clear examples of fractal geometry in our own world. Chaos has brought a new perspective to the understanding of cities, showing that an ordered, self-organizing system can turn into something chaotic and uncontrollable, again the Yin Yang of chaos. The ideas of transport, neighborhoods, and economic dependence all are examples of fractal systems. We are covered in Fractals; our bodies are able to do the functions we are capable of because of fractals, from our circulatory system to our lungs and even the folding patterns in our brains. Even our thinking pattern is chaotic, which helps with performing useful functions. The human brain is a nonlinear feedback system that self-organizes itself when too much chaos appears (11).

An attractor is defined by a point or set of values around which the outcome of a nonlinear system clusters (12). In theory, complex systems show an attractor. They represent the state to which a system eventually settles, for example when a marble settles at the bottom of a bowl (11). Strange attractors live in an imaginary mathematical space called a phase space. It is made up of infinite numbers of curves and surfaces. They are basically fractal objects; however, they make a dynamic system easy to observe (11). The Lorenz Attractor was the most famous strange attractor. It was of course created by Edward Lorenz, who in 1972 submitted a paper to a conference in Washington titled, "Does the flap of a butterfly's wing in Brazil set off a tornado in Texas?" Although he didn't actually answer the question in his paper he made the butterfly effect a major part of chaos theory (11). The model he created to go along with the paper was an altering spiral that went around two adjacent ovals, this mapped out the chaotic solution to a set of interrelated equations. The system was extremely sensitive to initial decisions (15). Attractors show that a certain unplanned combination of events can cause a system to jump abruptly between states. To apply this idea to the real world, variables such as the ocean temperature, ocean currents, or wind direction can cause a shift in the global climate (12). This is why there is such a fluctuation in weather all across the world, constantly. It all goes back to chaos theory. If you turn a sink on slightly, only allowing a tight flow of water to fall from it, it remains steady and smooth. However, if you open the faucet all the way the water becomes chaotic and out of control. The pulsations become irregular, and this is called turbulence. Although there is no real answer to why this happens it is a direct link within the chaos theory. Turbulence drains energy and creates drag, obviously not something that is effective or beneficial. Again, back to the example of smoke from a cigarette, the smoke flows smoothly at first but then suddenly breaks into various streaks. This creates an infinite amount of curls of smoke in a finite space, also known as fractals. (11) Everything connects.

The nonlinear dynamic systems studied by chaos theory are complex systems. Complex systems are able to maintain entropy, maintaining both order and chaos, also known as the balancing point. It is held between stability and total turbulence. The way birds form a specific organized shape when they take off in flight is an example of a complex system to transition into self-organization. Another main characteristic of complex systems is their adaptive nature; they are certainly not passive. They respond and alter themselves to their advantage. The way animals adapt to their environment, and even the way humans organize the connections in our brains to learn from experiences. Complex systems are highly inter-related. It is another example of how everything connects to everything else. Trees are related to climates and people with the environment. Nothing stands alone (11).

Chaos is a word of many definitions; it is the universe itself. Chaos is complex and aperiodic, it grapples with the real questions that no one can simply answer. The smoke never goes back into the cigarette because everything moves towards a state of dissipation. We have to decide and make choices, or else time wouldn't exist. We have to keep moving, and that is simply the law that governs our lives. There is tremendous importance in the chaotic disorder that surrounds us. Life resists order and predictability, although we need it just as much as the disruptive chaos. We should listen and understand the chaos that is thrown in our path, rather than resist it. None of us would be the same without it. We are connected to all things, and self-similarity is tremendously common in everything. We may become obsessed with controlling all the events that transpire in our lives but that doesn't do any good; in fact, it worsens the situation. The only way we can really have some sort of control over our lives is be present. We have such influence in the events that transpire around us, whether we understand this or not (2). If we make an effort to play according to the moment we can determine the outcome of the rest of our lives. We are the sum of our decisions.

I've experienced difficult decisions and choices in my life, we all have. When we reflect on these pivotal moments it forces us to be aware of our lives. I remember the exact moment when my mother asked me if we should move from New Gloucester to Freeport, Maine. It was the last chance we had to turn back and I decided to move, move on with both of our lives. I wouldn't be here right now, at oxbow, if I didn't say yes to her in that moment; A small initial chance drastically impacted the rest of my life. If I didn't move I wouldn't have met the people I know today, the people that have impacted my life the most. I'd be in a whole different reality if I stayed in New Gloucester, I'd be friends with the same small group of friends I had. I wouldn't have developed and grew like I did on this path, and that's scary to think about. I know I would be happier if I stayed there, I'd still have love and blind faith. The person I left behind in New Gloucester is so vastly different than who I am now. I know I'm on this path for a reason because it happened this way, rather than the other. Moving was the most pivotal moment in my life so far, and I'm thankful that I walked this path even if it isn't the easiest. Everyday I think about the moments that determine my reality right now, past decisions that seemed so insignificant then. I believe that this fact is one of the most beautiful and humane experiences, we consist of chaos no matter how much we strive for order and control over our lives, it's all chance.

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