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Chaos: A New Order?

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Abstract:- Although chaos theory is used in very wide areas and has very different meanings as a concept, it also points to a study of science. Chaos theory has spread to very wide areas in a short time. The fact that our world is constantly and rapidly changing is an indication that we live in an environment of chaos. In this research, chaos theory and its historical and scientific development and philosophical interpretations that may be related are discussed. The aim of this research is to try to reveal the chaos theory and its main results and to refer to the studies on this subject.

Keywords:- Chaos, Chaos Theory, Chaos Management.

I. INTRODUCTION

Karaçay (2004) There are some events that occupy the minds of human beings. Movement and time come first. When we talk about Movement, the concept of time will inevitably come into play. Unfortunately, there is no (single) mechanical theory that can explain all the motions in the universe, nor is there a concept of time that everyone can accept. We are trying to explain the movements in our immediate environment with Newtonian Mechanics, the movements of subatomic particles with Quantum Mechanics, and the movement of galaxies with the Theory of Relativity. It is utopian to propose a (single) mechanical theory that explains all this.

It is known that information about Chaos Theory was obtained through some studies in the West at the end of the 19th century and at the beginning of the 20th century. But the information obtained in this period was not put into a system; Those who laid the foundations of Chaos Theory with the studies carried out did not make an effort to present the information they obtained to the scientific world in the form of a theory. It was in the last half of the 20th century that the theory was put into a system and took its current name. American James A. Yorke gave the name of the theory (Ruelle, 2006). In Chaos Theory, it is argued that small changes and interventions can lead to large and qualitative effects. This situation makes us think that it is possible to gain significant advantages in social and inter-communal relations by using very small forces. In this context, in this study, we will try to discuss how and under what conditions the Chaos Theory provides the opportunity to intervene in social events in sociology, and what kind of results they reveal.

When Henri Poincaré, known as the pioneer of Chaos Theory, presented his first studies on recognizing chaos to the scientific world, it is known that not many people realized what they really meant. At the very beginning of the 20th century, Poincaré's work will reveal one of the most fundamental features of Chaos Theory; will show that some systems are extremely sensitive to initial conditions and that small effects lead to large changes over time (Ruelle, 2006). A point that should not be overlooked here is Henri Poincare, the pioneer of Chaos Theory, and James Yorke, who gave the theory its name.

The fact that the situations and events that we observe in daily life that seem to be unrelated to each other and that seem irregular and coincidental, when considered from a different perspective, are actually part of a great order characterizes the transition from classical science to chaos. The concept of chaos, in terms of its lexical meaning, evokes expressions such as "complexity, disorder, uncertainty" and even anarchy in everyday language. The concept comes from the Greek word "Khaos" meaning "emptiness, cleft, borderlessness". The concept of chaos is used in the scientific sense of "order within disorder", unlike its use in everyday language. In short, there is a very important difference between its use in everyday language and its scientific use. The theoretical physicist Jensen, who gives the most accurate definition of the concept, describes Chaos as "the disorderly and unpredictable behavior of complex, nonlinear dynamical systems" (Gleick, 1997).

The word “chaos” may seem frightening at first glance; because chaos is thought of as chaos, confusion, an inextricable state. In this respect, it is necessary to distinguish the concept of “confusion”, which is used as a synonym for chaos, but which must have a difference in meaning; because when we say chaos we do not mean chaos and confusion. The part of Chaos that differs from chaos or confusion is that it has a unique deterministic structure; Whereas, there is no such feature in chaos (or we can say disorder).

The hallmark of chaos is its sensitive dependence on initial conditions and its so-called "strange attractors". These features are not found in chaos or confusion (Ural, 2007). According to Farazmand (2003), Chaos Theory emerged as a new element of social sciences. We live in a complex world full of uncertainties, randomness, unpredictable developments. In all this, it is leading our world and organizations into chaos and catastrophic collapse. The key feature of paradigmatic chaos is “instant societies,” as Warren Bennis calls it, “the age of discontinuity,” as Peter Drucker calls it, or the “age behind ambiguity without cause," as Charles Handy calls it. To be ready to rule our private lives and societies in the modern world, we must hold the imagination, think in undesirable ways, and do things without reason.

Isaac Newton is regarded as the scientist who placed determinism at the center of modern science with his work. Beyond that, it is believed that Newton accomplished such important things that he could be declared a national hero while he was still alive. It is known that with the influence of Laplace, he was regarded as the symbol of the scientific revolution in the West. However, it would be wrong to limit Newton's attention to the Laplace effect alone. In this period, it is known that the Newtonian system did not disappoint in practice and inspired many new inventions (Prigogine, 1998).

The first lesson to be learned is; In order to manage the chaos, one must first identify the key parameters and the points that further increase create entirely new basins of results. According to Chaos Theory, there are times in any nonlinear system; large parameter differences are absorbed by the system and cause a big difference when there are small changes in key parameters. At this point, a small change can broaden the targeted watershed in the administrative science or policy position. Control efforts are useless when major changes are absorbed by system-environment interactions. In a second important point in terms of social control theory, while the variations around the basic tendency can be understood in terms of individual differences and individual decisions; Qualitative changes from one social form to another are found in interactions between members of a group or in two or more interacting systems, rather than differences between members of a group per se. In short, there are times when; social control efforts are directed to specific individuals and there are times when; societal control efforts target system parameters. Another general point is that every nonlinear dynamic system has a dynamic key hidden under temporary perturbations. If a person can find that dynamic key to a political or economic system, that person can calculate the driving force needed to turn those systems into near-stable dynamics. This is the cutting edge of control theory today. The lesson to be drawn from all this is that only diversity can cope with the diversity in the environment. H. Ross Ashby said the same thing in the 1950s. What Ashby didn't add, however, was that diversity itself was non-linear. Although linear response seems intuitively correct, fair and rational, it does not give the desired result as non-linear (Young, 1992).

According to Uçar (2010), Chaos Theory has some unique features as a theory. In order to explain the Chaos Theory below, we will list the concepts of the theory. Before explaining these concepts, it is useful to list the basic propositions of Chaos Theory. The basic propositions of Chaos Theory can be listed as follows:

1. Order reveals disorder.
2. There is order in disorder.
3. Order consists of disorder.
4. In the new order, reconciliation manifests itself for a very short time after the change.
5. The new order that has been reached develops towards an unpredictable situation.

II. BASIC CONCEPTS OF CHAOS THEORY

According to the literature, we can state that the basic concepts of Chaos Theory are grouped under four headings. These concepts are: sensitive dependence on initial conditions, butterfly effect, odd attractors, and fractal geometry.

A. Sensitive Dependence on Initial Conditions

There is a phenomenon in science called uncertainty. This fact means that the initial conditions of a physical system cannot be known with certainty. We said that Henri Poincare was the first person to determine the negativity of the mentioned phenomenon in the principle of determinism. Here is the story of it:

"Newton's laws fit perfectly into the motion of two celestial bodies, but analytical solutions cannot be obtained when there are more than two bodies. The solution to this problem, known as the Three-Body Problem, became a popular topic in astronomy as we entered the 20th century. King of Norway II. Oscar announced that he would give an award to anyone who proves whether the solar system is stable or not. Henri Poincaré showed in 1900 that the solution of the system of equations that determines the motion of the solar system is sensitively dependent on the initial conditions, but the initial conditions can never be determined accurately, so it cannot be determined whether the solar system is stable or not. He was the first to use the term 'chaos' for this unpredictable situation. Thus, Poincaré won the prize without solving the desired problem" (Karaçay, 2005).

One of the main reference points determining the concept of chaos was the work of a mathematician working on meteorology named Edward Lorenz in 1961. Lorenz was making the weather forecasts on a nonlinear function by inputting iterations of this function into the computer. Then he expressed the temperature values he found on the computer in a graph. Lorenz was showing the days on the horizontal plane of the coordinate system and the temperature values on the vertical plane in this graph shown in Figure 1 below. The curves of this graph exhibited the expected ups and downs (Lorenz, 1995).

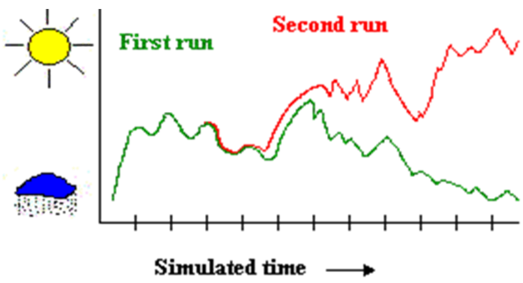

Figure 1. Lorenz's Weather Graph

By coincidence, Lorenz rounded up an average temperature and ran the function again. He instructed the computer to round the value to the third digit after zero. In other words, the computer was making the temperature value of 15,4086 Fahrenheit, 15,409 Fanrenheit. In everyday life, 0.004 degrees between 15.409 degrees Fahrenheit and 15.4086 degrees Fahrenheit is negligible. Even the most sensitive thermometer cannot measure such a small temperature difference. A change of 0.004 degrees corresponds to the change that a butterfly placed in a room can create in its body temperature or air velocity by flapping its wings. Lorenz initially ignored such a minor change. He drew the function on the computer. Normally, there would be no difference between the results of the two functions with a difference of as little as 0.004 degrees. However, on his computer, Lorenz detected a very large difference in temperature after 30 days for different initial values (Parker, 1996).

Chaos Theory is a theory that shakes the rules of classical determinism. It has been revealed that the cause-effect relationships on which classical determinism is based cannot be applied to all systems in the universe with Chaos Theory. Classical deterministic equations still maintain their validity in determining the exact dates of solar-lunar eclipses in the long-term movements of the planets. However, the short-term behavior of chaotic systems is unpredictable. According to David Ruelle, “the distinguishing feature of the theory today called Chaos in science is a temporal evolution with a delicate dependence on the initial state (Ruelle, 2006).

In fact, since the past, sensitive commitment to initial conditions has perhaps always attracted people's attention. It is possible to find this idea in the following classic saying:
A nail saves a horseshoe;
A horseshoe saves a horse;
A horse saves a soldier;
A soldier saves a battle;
A war saves a homeland (Gleick, 1997).

B. Butterfly Effect

The concept of the 'Butterfly Effect', which is known as an indispensable part of Chaos Theory, was first pronounced by Lorenz in 1961. As we mentioned before, the image of the graph Lorenz obtained after entering his weather forecast information into the computer resembles the wings of a butterfly, as shown in Figure 2. Edward Lorenz explained the butterfly effect in a meeting he attended in Washington in 1972: “A butterfly flapping its wings in Brazil can cause a storm in Texas (Lorenz, 1995).

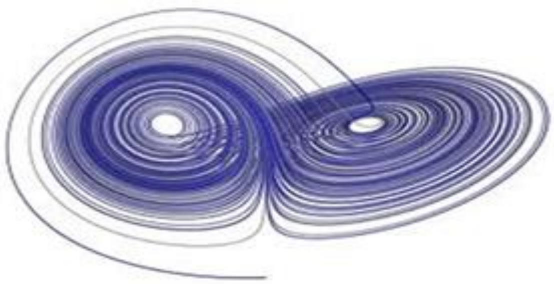

Figure 2. Lorenz Attractor

This feature, which we call the butterfly effect and sensitive dependence on the initial conditions, tells that in understanding what is happening in the world, it is necessary to go beyond the classical determinist understanding; because unpredictability covers not only meteorological events, but also the physical world, as well as the human, society and living world, in other words all kinds of phenomena. In a way, it is a chaotic operation in terms of process. Therefore, almost everything we know, in short, the universe, needs to be reinterpreted and re-interpreted with the shaking of determinism and, accordingly, various concepts (Ural, 2005).

C. Strange Attracts

Another important concept in Chaos Theory is attractors. The control of dynamic systems is in the tractors. The simplest type of attractor is a zero-dimensional fixed point. An example of this is an oscillating pendulum. As a pendulum swings, it makes a periodic movement to the right and left. As shown in Figure 3, this pendulum is pulled towards the centre.

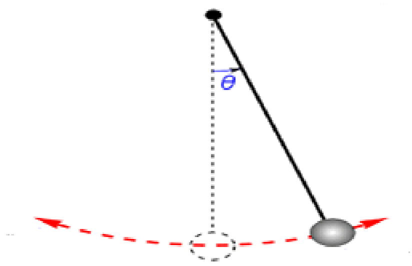

Figure 3. Simple Pendulum

Position and speed are important in the movement of the pendulum. In the coordinate plane of these two parameters, a circle is formed in the middle as shown in Figure 4.

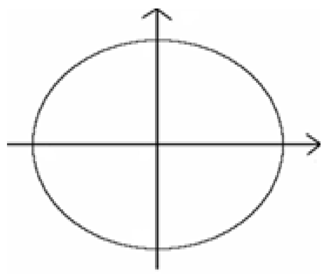

Figure 4. Position-Velocity Graph of Simple Pendulum

In a pendulum that is constantly losing energy due to friction, all circular motions point towards the center where there is no motion. This point is called the equilibrium point. Over time, the orbit spirals towards the centre. In other words, regardless of the initial condition of the pendulum, the pendulum will eventually be at equilibrium, and this point is the attractor of this system (Ruelle, 2006). To give some examples about this situation; moth flying around the light, Light is stationary and the moth is exhibiting unpredictable behavior by drawing curvilinear trajectories and revolving around the center without leaving its place.

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The motion of each molecule that makes up the boiling water in the kettle has a simple trajectory. Although the shape of this orbit is in phase space, it is neither a simple Euclidean shape nor amorphous. This system is also managed by attractors. However, the attractor of the chaotic system here is much more complex than the attractor of a simple pendulum swing (Bird, 2003). Figure 5 shows the shapes of strange attractors.

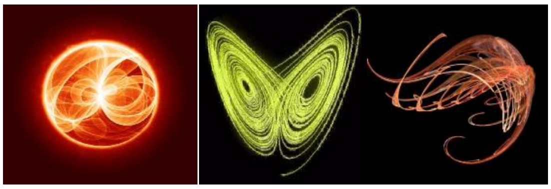

Figure 5. Strange Attractors

Ruelle, who gave her name to strange attractors, expresses her concern about their future as follows: I haven't mentioned the aesthetic appeal of strange attractors yet. These curves, these point clouds, sometimes resemble fireworks or galaxies, and sometimes the strange and frightening proliferation of cells. Among all this lie forms waiting to be discovered and harmonies waiting to be revealed (Gleick, 1997).

D. Fractal Geometry

Mandelbrot (1983) derived the fractal from the Latin adjective fractus. This adjective is derived from the verb frangere, which means to break. He thought that the English equivalents of these words, fracture and fraction, would be very appropriate, and thus he created the word fractal (which can be used as a noun and adjective in both English and French).

Fractal geometry, which is of great importance for Chaos Theory, was first introduced in 1975 by Polish-born mathematician Beneoit B. Mandelbrot. Fractal Geometry has led to the birth of a new geometry system that has important effects not only on mathematics but also on different fields such as physics, chemistry, physiology and fluid mechanics. Mandelbrot, in his book 'The Fractal Geometry of Nature', explained the unnoticed face of nature, which was explained by Euclidean geometry, apart from these explanations. According to Mandelbrot, “Compared to the shapes of Classical Euclidean Geometry, the shapes in nature are actually irregular and fragmented (Mandelbrot, 1983).

The most basic determination that people have made since ancient times is that there is nothing in nature that does not change. But on the other hand, although change is continuous, there is a situation of repetition. This repetition is not a one-to-one repetition, just like photocopying, but in a more accurate way, it takes the form of similitude. For example, an apple seed becomes an apple sapling when mixed with the ground. The sapling turns into a tree and the tree produces apple fruit. When the fruit falls to the ground, it rots and the seed produces seedlings again. In this example there is constant change, but there is also repetition. But it is not exactly repetitive. Because no apple tree is an exact copy of another apple tree, and no apple is a copy of another apple. The color is slightly different, the shape is different, the size is different, but they are all apples. Although there is a common structure, a basic analogy, in the systems we observe in nature, it is not possible to express this complex structure with linear (linear and continuous) equations. The view that there is a common ground that creates many natural events that seem very complex at first glance is now stated as an inevitable fact. Mathematicians called this base "Fractal" because it contains a fractional dimension. The universe explained by fractal geometry is not round or flat; indented, broken, bent, entangled, knotted, etc. It is a universe of shapes. Compared to Euclidean geometry, fractal geometry is a geometry that gives objects not their simplified appearance, but the shapes they actually have. But more importantly, it has a feature that can explain the formation of these objects. Expression of the dynamic aspect of the universe has become possible with fractal geometry (Ural, 2005). In the case of chaos, also, if the structure of the universe is chaotic, its language should be fractal geometry (Mandelbrot, 1983).

Before Mandelbrot, mathematicians argued that most shapes in nature were too complex, irregular, and fragmented to be expressed mathematically. Mandelbrot's fractal geometry showed that even the most irregular and chaotic shapes of the real world can be expressed mathematically. According to Mandelbrot, the world exhibits an ordered disorder (Mandelbrot, 1983). This property of fractals is explained as 'self-similarity'. The irregular details of fractals are repeated on increasingly smaller scales and can last indefinitely. Fern, cauliflower, broccoli shown in the figure below can be given as examples of fractal structures with self-similarity.

Figure 6. Fractal Structures

As seen in the figures above, in an object similar to itself, the parts that make up the object resemble the whole of the object. That is, when each part of each part is enlarged, it is seen that the object is in the same shape as itself. Leibniz imagined that a whole universe was hidden in a droplet of water, that inside that water droplet there were other water droplets and other universes within them (Gleick, 1997).

Mandelbrot, with his fractal concept, "Can we calculate the length of the English coastline?" tried to answer the question. If we try to solve this question with the help of a ruler, a new problem arises according to Mandelbrot. Mandelbrot explains this situation as follows: The length you find depends on the length of your ruler. If you are measuring with a 1 meter long ruler, folds under one meter will not be measured. The more you refine your measurement, the greater the result will be, and the result will be measuring each grain of sand one after the other (Mandelbrot, 1983).

As can be seen from a careful look at the figures below, a fractal does not only consist of irregular shapes, but also reveals the hidden order within these irregular shapes (Mandelbrot, 1983).

Figure 7. Fractal Images

Our aim with chaos and fractal geometry is to comprehend the order (disorder) in the universe. The universe is full of shapes that cannot be seen but are interwoven and waiting to be revealed. The universe stated by Newtonian physics must be replaced by the universe that emerged with chaos. This new painting should only be explained with fractal geometry (Ural, 2005).

Ural (2005) says the following for the understanding that changes with chaos: The innovation brought by the Chaos Theory means a worldview that allows us a new perspective, new and very different interpretations. Chaos theory is not limited to the explanation of new phenomena; In a sense, it means seeing old phenomena from a different and brand new perspective. For this reason, it means a new worldview.

III. ORGANIZATIONAL CHAOS AND CHAOS MANAGEMENT

According to Öge (2005), the ways to be successful in a chaos environment; Ensuring participation and organizational flexibility by empowering individuals, a leadership style that includes control, guidance, leadership and change that tolerates optimal confusion, control provided through simple core support systems that measure the right things, customer responsiveness to encourage flexibility and increase sensitivity, and within the organization It is the rapid monitoring of market innovations by all units and individuals in these units.

Many researchers think that this theory will attract the attention of organizations in the near future. This view also means challenging any change in the organization by claiming that the new realities differ dramatically from the past. An organizational model based on scientific management can only be sustained with regularity, predictability and effectiveness. If the future seems predictable, organizational leaders may make an effort to interpret and plan for a fixed and visible future. In the face of the unpredictability of the future, it is now a necessity for managers and leaders to rethink the different models that they have been using effectively for years (Töremen, 2000). This situation, which can be expressed as that they can affect each other in very simple situations and in the formation of perfect behaviors, actually shows that chaos organizes itself and reveals the essence of chaos theory. He treats self-organization as follows: "Life searches for order in disorder, complexity after complexity, and so on until something happens". Contrary to the understanding of organization that fits the structure introduced by Newton, chaos theory reveals a complex and self-adaptive, living and self-organizing organizational model. According to him, when we consider a group of people on the move; they can organize themselves mutually in complex and unexpected situations (Ruelle, 2006).

Farazmand (2003) chaos theory has various applications for organizations. To express this situation in articles;

1. Organizations are open systems and have the ability to produce themselves, they have their own rules. These develop self-organization and order-building skills.
2. Historically, we can say that the theory of organization has turned from the classical closed systems understanding to its new form produced by chaotic changes.
3. Recognized the importance of perceiving change, environmental interaction, feedback, and the need to understand subordinate organizations as broader socio-political systems. Both chaos and systems theory are influenced by the environment.
4. Organizational change and behaviors and their management may not always be causal and linear. Nonlinear connections, variation, randomness can characterize many modern organizational systems.
5. Chaos theory can explain the current highly pervasive chaotic changes in the management of public, private and non-profit organizations around the world.
6. Chaos theory can help us predict probable future features of order and chaotic behavior features of the past and future. How should it be used in organizations? For this, it is necessary to aim to learn, to establish organizational culture on learning to learn, to think the unthinkable and to do the undoable.

Education is a dynamic system. Learning and thinking are nonlinear processes. The simplest nonlinear systems can contain very rich dynamic behaviors. Chaos is an effective element for education. Our education system provides a mechanical world where everyone strives to learn with a fashion sense. The education system is built on a system in which everyone develops their views on the order of activities in which they try to learn certain things at certain times. This linearity-based situation cannot be the education system we need in the current information age. Newton's linearity-based research model is adapted to education systems as it stands. Absolute determinism has now given way to structuralism and chaos. The acceptance of this deterministic model constitutes the education system of the information age. At this stage, it is imperative that we create nonlinear models that will truly evoke learning (Ruelle, 2006).

Chaos thinking emphasizes the futility of long-term planning and the need to look at precise statistical data with suspicion. Instead of planning for the future, chaos theory points out how to benefit from future changes and provide the best benefit and the importance of strategy development. Instead of what should be done tomorrow, it is necessary to have the thought of what should I do today in order to achieve a desired tomorrow (Öge, 2005). Chaos theory not only accepts long-term planning, but also accepts that short-term planning can be done. This theory points out that it is not a fatalistic understanding that it attaches importance to learning, creativity and self-realization through past experiences. Mutlu and Sakınç's (2006) chaos theory suggestions to organizational managers to get rid of the chaos that organizations are in; information exchange, relying on accumulated knowledge, giving importance to innovation and creativity, working in groups and allowing differences.

IV. CONCLUSION

With the Chaos Theory, the understanding of the changing universe, which we explained above, has been tried to be revealed. To date, the view that the world has an ordered structure is controversial not only from a scientific point of view but also from a philosophical point of view. Objects should not be perceived in a regularity, but within the framework predicted by Chaos theory. Because there is not order in nature, but chaos. To be more clear, a deterministic view of understanding the movement of objects leaves its place to a determinism that Chaos Theory says.

The limits of chaos are not limited to physics alone. Social order, natural life, economy and some sociological events have a similarly chaotic system. It seems that the language of the universe is fractal geometry, which has replaced classical geometry (Euclidean and non-Euclidean geometries). Geometric shapes used to describe objects are not regular shapes, but broken (fractal) shapes. It turns out that objects, their apparent shapes and processes can now be understood using the language of fractal geometry. Thanks to the Chaos Theory, the explanation of the disordered, chaotic structure underlying the visible order of nature has emerged. Therefore, Chaos Theory is proof that the theories and universe structure that have been believed until today are not actually like that. The emphasis of our study is to draw attention to this need; It was to explain the inconsistent features of the new understanding of the universe with the old one. To understand the present, we must take the future more into account.

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