REDISCOVERING THE STANDARD TWO-VALUED TOPIC OF THE HEART AND MIND IN TESS OF THE D`URBERVILLES AND THE FRENCH LIEUTENANT`S WOMAN VIA POINCARÉ`S CHAOS THEORY

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Abstract:The paper expands upon the influential scientist and mathematician,Jules Henri Poincaré`s theory, with soft touches upon literary texts. One of the most well known theories that Poincaré has elaborated is that of relativity. Poincaré is also the philosopher who discovered a chaotic deterministic system. Our concern will be to underline the basic issues related to the fact that Poincaré discovered that the evolution of this kind of system is chaotic, which means that even a small perturbation in the initial state , for example a change in the initial poistion, could produce another later state which would be generated by the unperturbed system. The final state which would occur could not be predicted unless the change is detectable. This is the manner in which Poincarés research demonstrated that determinism and predictibility are two distinct issues. The systems are applied to different fields, such as weather, population dynamics or the structure of life.

Keywords: Poincaré, chaos theory, dynamics, attractors, effect

The paper entitled Rediscovering the standard two-valued topic of the Heart and Mind in Victorian and Postmodern literature via Poincaré`s Chaos Theory, our basic concern, could be best construed by first introducing the definition proposed by Macmillan Dictionary regarding the term chaos as : "a situation in which everything is confused "(Macmillan Online Dictionary) and terms chaos theory as: "the scientific study of complicated systems whose behaviour is strongly affected by minor changes in conditions. "(Macmillan Online Dictionary).The technical definition of the word chaos is: "(physics) a dynamical system that is extremely sensitive to its initial conditions."(Web site: Wolfram Math World).

Jules Henri Poincaré, born on 29th April 1854, in Nancy, France, was not only a French philosopher of science and mathematics, but also an influential scientist and mathematician. One of the most reputable theories that Poincaré has elaborated is that of relativity. The principle of relativity states that: "no mechanical or electromagnetic experiment can discriminate between a state of uniform motion and a state of rest."(Internet Encyclopedia of Philosophy).

The theorem according to which: "every isolated mechanical system returns after a finite time to its initial state" (Internet Encyclopedia of Philosophy) is the basis of numerous philosophical and scientific analysis. Poincaré is also the philosopher who discovered a chaotic deterministic system, which establishes that: "Given the law of gravity and the initial positions and velocities of the only three bodies in all of the spaces, the subsequent positions and velocities are fixed--so the three-body system is deterministic." (Internet Encyclopedia of Philosophy).

Thus, Poincaré discovered that the evolution of this kind of system is chaotic, which signifies that even a trivial perturbation in the initial state, for example a change in the initial position, could produce another later state which would be generated by the unperturbed system. The final state which would occur could not be predicted unless the change is

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detectable. This is how Poincaré`s research demonstrated that determinism and predictability are two distinct issues.

Jules Henri Poincaré is considered to be the founder of Chaos Theory. As Poincaré himself stated:

> If we knew exactly the laws of nature and the situation of the universe at the initial moment, we could predict exactly the situation of that same universe at a succeeding moment. But even if it were the case that the natural laws had no longer any secret for us, we could still only know the initial situation approximately. If that enabled us to predict the succeeding situation with the same approximation, that is all we require, and we should say that the phenomenon had been predicted, that it is governed by laws. But it is not always so; it may happen that small differences in the initial conditions produce very great ones in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible, and we have the fortuitous phenomenon. (www.chaos.umd.edu/misc/poincare.html)

Poincaré`s Chaos theory is reckoned to be "one of the opportunities that science forwards" (Coşer, 2014: 230). He uttered that in order to decode the dynamics of complex systems, a new science was mandatory. He discovered the fact that there is "an inherent lack of predictability in some physical systems, known as dynamical instability" (Coşer, 2014: 231). The term chaos received the meaning of "randomness", which was substituted with a term which alludes to "deterministic, non-random phenomenon." This phenomenon and its properties are assumed to "make the predictability of outcomes very difficult." (Coşer, 2014: 231).

What chaos theory assumes is the fact that there are a variety of phenomena when it comes to real-world non-linear, which indicates that they are not random or inconceivable. These systems are applied to different fields, such as weather, population dynamics, and the structure of life.

Catherine Hayles explains in her book *Chaos Bound* how the science of chaos was born. She explains how it all arose with the moon. The king of Sweden decided to offer a prize to the person who could solve the three-body problem. The three-body problem refers to the fact that when taking the moon into account, Newton`s equation of motion would not work adequately, namely:

> The moon attracted to the earth, causing perturbations in the earth`s distance from the sun, which in turn altered the moon`s orbit around the earth, which meant that the original basis for the calculations had changed and one had to start over from the beginning (Hayles, 1991: 1).

Poincaré received the award for producing proof of the fact that that there was no solution via the Newtonian equations. By these means, Poincaré stated that "a new kind of science and mathematics was necessary to account for the dynamics of complex systems" (Hayles,1991: 2). He demonstrated that the insertion of small perturbations into linear equations was not enough to solve nonlinear problems. This is how the science of chaos appeared.

In the aforementioned period of time, an intellectual shift came into sight in the human sciences. New types of reading and writing criticism appeared. The New Critics stated that textual boundaries are "arbitrary constructions whose configurations depended on who was reading, and why" (Hayles, 1991:2). Hayles states the fact that texts lack a ground for

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their systems of signification; therefore, they are neither deterministic, nor predictable. Texts could become unstable every time they encounter a small perturbation.

Hayles introduces in her book the metaphor "archipelago of chaos" (Hayles, 1991:2) and explains it as it follows:

> The connecting theme is a shift in the way chaos is seen; the crucial turn comes when chaos is envisioned not as an absence or void but as a positive force in its own right. This is a three-sided study, triangulating among chaos theory, poststructuralism, and contemporary fiction. (Hayles,1991: 3).

The writer also states the fact that it is essential how these three sides interact. The study is concerned with the way in which language creates reality and how reality has potential to constrain and direct language. The metaphor "archipelago of chaos" utters the fact that there is relatedness between the three sides. Even though there are several similarities between the sides, the fact that they have also real differences must be also taken into account.

The similar parts appeared due to the movements in culture "which made the deep assumptions underlying the new paradigms thinkable, perhaps inevitable, thoughts" (Hayles, 1991: 3). The differences point "to the importance of disciplinary traditions in guiding inquiry and shaping thought" (Hayles,1991: 4). Hayles explains the connection among contemporary literature, science and critical theory through the similar experiences that writers, critics and scientists surpass day by day. Information theories and technologies had a foremost role in assigning a positive value to chaos. This is how the "theoretical foundation for conceptualizing chaos as a presence rather than an absence"(Hayles,1991: 6) has been laid. The distinction between information and meaning helped scientists see "chaotic systems as rich in information, rather than poor in order" (Hayles,1991: 6).

Hayles defines chaos theory as:

> A wide-ranging interdisciplinary research front that includes work in such fields as nonlinear dynamics, irreversible thermodynamics, meteorology, and epidemiology. It can be generally understood as the study of complex systems, in which the linear problems that perplexed Poincaré`s contemporaries are considered their own right, rather than as inconvenient deviations from linearity (Hayles, 1991: 9).

There are two emphases which can be attributed to chaos theory. The first one is that chaos is the precursor and partner of order: "the focus here is on the spontaneous emergence of self-organization from chaos; or, in the parlance of the field, on the dissipative structures that arise in systems far from equilibrium, where entropy production is high" (Hayles, 1991: 9).

The second emphasis is on the fact that there is a hidden order in the chaotic systems. This connotes that chaos contains "deeply encoded structures called strange attractors" (Hayles, 1991: 9). Chaotic systems, contrary to random systems, show discernible patterns. Even though there have been some translations, communication between the two branches is difficult, for the reason that they use different types of analysis.

Prigogine concluded that: "the primary importance of the order-out-of-chaos branch in its ability to resolve a long-standing metaphysical problem: it reconciles being with becoming" (Hayles, 1991:10). An important conclusion that arises from Prigone's contribution refers to the fact that:"nature, too complex to fit into the Procustean bed of linear dynamics, can renew itself precisely because it is rich in disorder and surprise" (Hayles, 1991: 10).

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Chaotic systems have several characteristics. One of these characteristics is nonlinearity. Linearity offers a kind of proportionality: small causes produce small effects, whereas large causes lead to large effects. This effect is called orderly systems. Orderly systems are another topic that can be encountered when focusing on chaos theory.

Briggs and Peat expound orderly systems as it follows: "a system is orderly if its movements can be explained in the kind of cause-and-effect scheme represented by a linear differential equation" (Hayles, 1991: 23). As stated in the definition, small changes produce small effects and large changes produce large effects. These orderly systems do not need to be associated with the assumption from the nineteenth-twentieth century according to which an élan vital is at the heart of nature, "propelling life in an upward linear movement from simple primitive forms two more complex and sophisticated systems" (Slethaug,2000: XVIII).

Slethaug also attests regarding the orderly systems that:

> They challenge the vitalistic belief in a progressive cosmic force or a soul-like intelligence that has foresight into systemic development and universal goals believed to correspond from system to system, creating a certain global wholeness (Slethaug,2000: XVIII).

American tradition promotes a phenomenon often correlated to vitalism. It is entitled transcendentalism, and Ralph W. Emerson and Henry D. Thoreau describe it as: "a firm relationship between disorder and order, and believe that a comprehensive divinity ultimately created a cosmic order" (Slethaug, 2000: XVIII).

Another characteristic is represented by their complex forms. This brings into bold relief the awareness of the importance of scale which leads to a change in focus from individual unit to recursive symmetries between scale levels. Hayles explains this, as it follows:

> ...turbulent flow can be modeled as small swirls within larger swirls, nested in turn within still larger swirls. Rather than trying to follow an individual molecule, as one might for laminar flows, this approach models turbulence through symmetries that are replicated over many scale levels (Hayles, 1991: 13).

She pursues the explanation by stating that the levels are linked through coupling points and that "at any one of these coupling points, minute fluctuations can cause the flow to evolve differently, so that it is impossible to predict how the system will behave"(Hayles,1991: 13).

Complex systems have also an additional characteristic, and this is their sensitivity to initial conditions. This alludes to the fact that there are systems which can bring small uncertainties up to macroscopic expression. They also have feedback mechanisms which "create loops in which output feeds back into the system as input" (Hayles, 1991: 14).

Chaos theory questions "whether an effect is proportional to a cause; how scale variance affects facts; what it means to model a physical system; and what cosmological scenario we are taking part in" (Hayles, 1991: 16).

As Hayles asserts, the reason why physical systems become chaotic is the fact that primary conditions cannot be mentioned with infinite accuracy: "deconstructive readings operate upon texts to reveal the indeterminacy that results from the lack of an absolute ground for language" (Hayles, 1991:16).

Hayles claims that creative writing is situated within:

> Complex fields of intertextual resonances that affect signification not only in the narrow sense of the way words are understood but also in the broader sense of the way plots are structured, characters conceived, and actions represented. Combined, these factors make the

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> literary texts more concerned than either chaos theory or deconstruction with the aura of cultural meaning that surrounds chaos. (Hayles,1991: 19).

The Western tradition, as Hayles writes in her book, regarded chaos as "the unformed, the unthought, the unfilled, the unordered" (Hayles, 1991: 19). Shakespeare describes chaos as a failure of love. The Renaissance period offers a variety of references to chaos: 'lack of differentiation, a gaping void, a confused mass, an undigested lump" (Hayles, 1991: 20). Chaos, after the Renaissance period, became notorious as "the most ancient of all gods, the companion of Eros, and the stuff from which the world was gradually grew obscure" (Hayles, 1991: 20).

An additional view of chaos promoted it as the antagonist of order. During the period between 1860s and 1870s, thermodynamics became popular. This led to the reinforcement of the "antagonistic connection between order and chaos through predictions of a cosmic dissipation that would end with all heat sources everywhere being exhausted, resulting in the so-called `heat death` of the universe" (Hayles, 1991: 21).

Throughout the time of the nineteenth century the term chaos was reconceptualized as "a tension between a short-term release of energy and a long-term price paid for that release" (Hayles, 1991: 22). The long-term and the short-term were often interpreted in different ways. This view also changed, after World War I, due to fact that an ambiguity within order appeared. Hayles explains this as: "order connoted stability, regularity and predictability," (Hayles, 1991: 22) on one hand, but "it also signified a directive or a symbolic configuration one is not free to disobey," (Hayles, 1991: 22) on the other. In this way, chaos began to be seen as a "liberating force" and order was considered "correspondingly inimical, associated with the mindless replication of military logic or with the oppressive control of a totalitarian state, of state of mind" (Hayles, 1991: 22).

By the year 1960, the concept of chaos received other significations. Literature writers and literary critics consider chaos to be the opposition of order. Chaos theorists, on the other hand, believe that a more complex type of order could be obtained through chaos. This theory was also embraced by several writers before 1960. As Hayles writes, Henry Adams, Edgar Allan Poe and Hesiod also inscribed it, granting more popularity and interest to chaos theory.

In literature, we can easily find the two branches of chaos theory which reveal the fact that there is a division between: " texts that see chaos as a void from which something can emerge and those that see chaos as a complex configuration within which order is implicitly encoded"(Hayles,1991: 25).

Hayles brings into bold relief the fact that objects are defined in relation to something else. This is how other questions arise. The questions refer to "how metaphors are constituted in the two disciplines, science and literature, how they change over time and how they are affected by the interpretive traditions in which they are embedded" (Hayles, 1991: 25). As concerns the word entropy, Hayles states the fact that the meaning of this word must be commented upon in relation to other questions: "what it meant to whom, for what reasons, in what context and with what consequences" (Hayles, 1991:38). She succeeded in demonstrating the fact that if we acquire several significations, while analyzing a text, they might lead us to unrecognized territory and that "disorder in not necessarily bad, and the void is not always empty" (Hayles, 1991: 60).

Another problem that Hayles argues in her book is chaos as self. She avers that, in direct relation to the suppositions offered by the dynamic theory, history could be outlined as "the attraction between the human mind and the explosive forces of supersensual chaos" (Hayles, 1991: 61). Traditional modes of thought are different from the extant ones, because the latter are believed to have absorbed more chaos within them. By analyzing Adam`s work

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The Education, Hayles concludes that: "the chaos that tore him from his roots is also the thread connecting him to the future he dread and anticipated" (Hayles, 1991: 90).

Chaos is also interpreted in connection to the arrow of time. This means that it could be seen as "the breakdown of systems or their birth" (Hayles, 1991: 90). Prigogine and Stengers`s view on chaos related to time is the following: "chaos theory provides a resolution to the long-standing philosophical debate about whether being or becoming is the essential reality" (Hayles, 1991: 91).

Entropy refers to the inert and revert state, to randomness and disorder which take place when everything possesses the same temperature and no further energy is available. Gordon E. Slethaug writes in his book entitled *Beautiful Chaos*:

> The entropic condition of man-made machines and other closed systems is not, however characteristic of open, self-organizing natural systems, nor for matter of social systems, in which energy is constantly imported from outside. Indeed, `inside` and `outside` or `boundary ` and `center` are far-from-absolute terms in self-organizing systems because these systems are interpenetrating and mutually dependent.(Slethaug, 2000: XVI).

The term entropy is also used when enunciating about a system which loses energy and starts becoming inert, and also to refer to disorder and randomness which results from depletion. Slethaug also states that:

> The term entropy, however, is equally important in far-from-equilibrium systems or chaotics in which it refers to the tendency of every system toward disorder; indeed, entropy can become a measure of disorder within a system (Slethaug, 2000: XVII).

The disorder in these systems might tend towards serendipitous randomization and systematic breakdown or toward inertia or even to "replenishment by process involving turbulence" (Slethaug, 2000: XVII).

Slethaug's conclusion regarding entropy reveals the fact that:

> Entropy theory is important to both closed and open systems and, in a sense, becomes the limit or constraint of finiteness against which all activity is finally calculated, regardless of the system. System theorists are generally more interested in how a system operates and works against entropy (Slethaug, 2000: XVII).

Bifurcation is another term, employed to describe "radical systemic change, often marking a change from a regular or periodic system to an irregular and aperiodic one" (Slethaug, 2000: XXII). This bifurcation point represents the moment which marks the onset of change. After this change, there are two situations which might happen. The results can be unpredictable or, on the contrary, they can be more determinate. What happens after the bifurcation consists in a part of the system`s self-organization, a "particular pattern or activity that supersedes the old" (Slethaug, 2000: XXII).

Slethaug utters:

> The fluctuations can undermine and destroy a system or impel it toward new states, different kinds of stability, better adaptation to environment, or other possibilities. The reliability of the old systemic steady-state yields to new adaptations (Slethaug, 2000: XXII).

The specialists' approach to chaos reveals it as standing for a randomized energy which has potential for growth and order. The contemporary understanding of the word chaos is the following: "The paradoxical state in which irregular motion may lead to pattern and disorder and order are linked" (Slethaug, 2000: XXIII).

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In what follows, I will apply two characteristics of chaos theory to Tess of the d`Urbervilles, Thomas Hardy`s Victorian novel and The French Lieutenant`s Woman, John Fowles`s Postmodern novel. Chaotic systems have several characteristics. One of these characteristics is nonlinearity. Linearity offers a kind of proportionality: small causes produce small effects, whereas large causes lead to large effects. This effect is called orderly systems. Orderly systems are another topic that can be encountered when focusing on chaos theory. This characteristic could represent the code for construing two literary masterpieces belonging to different periods of time: Thomas Hardy`s Tess of the d`Urbervilles and John Fowles`s The French Lieutenant`s Woman.

The Victorian novel Tess of the d`Urbervilles follows the story of a poor girl, Tess Durbeyfield who understands that her family is blood related to a wealthy family from Trantridge Cross, the d`Urbervilles. Even from the beginning of the novel, one characteristic of chaotic systems could be perceived. Tess`s decision to search the d`Urbervilles, after killing the family`s horse, could be interpreted as that small cause which will, later on, produce a large effect. The lack of proportionality represents a characteristic of chaotic systems- nonlinearity.

Slehaug`s perception upon attractors and strange attractors could be a good entry to a `credible detector` of the characters` troublesome experiences: `The issue of attractors and strange attractors in fiction is vexing, for patterns, whether based on stability or turbulence, cannot readily be depicted because of their diverse behavior. Strange attractors are the shapes that chaos and nonlinearity take` (Slethaug, 2000:181). Strange attractors could be found in both the aforementioned masterpieces, under the sign of seduction.

Tess of the d`Urbervilles and The French Lieutenant`s Woman are both romantic novels, which exhibit seduction, love, sin and eroticism. The novel Tess of the d`Urbervilles renders Thomas Hardy successful because of its `scandalous notoriety` (Seymour-Smith, 1995:426-427). The novel was controversial and criticized by many literary critics of that age. Readers from nowadays would say that the erotic scenes are barely observable and they might even seem inexistent. In terms of strange attractors, seduction might be seen as one of them. The novel presents the story of a young woman, Tess, who encounters Alec d`Urbervilles, the villain, who performs the act of seduction. Alec, the son of the d`Urbervilles is the person who Tess meets when she arrives in Trantridge Cross. After she return home, Tess receives a letter, that Alec wrote in his mother`s name, telling her that she was hired at the mansion. Not long after Tess starts working for Mrs. d`Urbervilles, Alec starts courting her. Alec does not cease his courting until he contrives to take advantage of her.

The French Lieutenant`s Woman is a postmodern novel that John Fowles started writing after he dreamed a young girl standing on a quay. He believes that the woman encountered in his dream was facing backwards to the Victorian society. The novel presents the story of a young woman called Sarah Woodruff, who is supposed to be the lover of a French officer named Varguennes. Sarah spends her time on a cliff, looking at the sea. Charles Smithson, who is engaged to Ernestina Freemen, a wealthy salesman`s daughter, starts feeling an attraction for Sarah. In this novel, the act of seduction is performed by a woman, by Sarah.

There is a major difference between the protagonist in Tess d`Urbervilles and the protagonist in The French Lieutenant`s Woman. Tess Durbeyfield, the main character in Tomas Hardy`s novel is pictured and perceived as a victim of men, as a woman whose destiny is influenced by the men encountered in her life. Sarah Woodruff however is pictured as a predator; she finds her victim in the person of Charles Smithson. In Victorian society, women had no power, not even the opportunity of choosing their husbands. John Fowles disregards this aspect and imagines a dominant woman who does not only have the

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possibility of choosing her lover, but she also turns him into her victim. This initiative may be explained by the fact that John Fowles himself declared he was a feminist and he `hates macho viewpoint` (Acheson, 1998:4).

Sarah Woodruff is the character that Fowles uses in order to challenge the Victorian woman`s image. She is regarded as `the French lieutenant`s whore`, because, in the Victorian age, a woman could not have a relationship with a man unless they were married, and Sarah and Varguennes were not married. People in Lyme Regis perceived her as a promiscuous, villain woman.

The strange attractors from these two novels, the people who perform the act of seduction, namely Alec d`Urbervilles and Sarah Woodruff, are not based on stability. On the contrary, they both produce turbulence in other characters` lives. Tess commits a crime and in one ending, Charles leaves Ernestina, his fiancé, for Sarah, the promiscuous woman who is seen as a `destructive temptress` (Acheson, 1998:38)

Butterfly effect is represented by the following phenomenon: if only one butterfly flaps its wings in Brazil, a tornado in Texas could be produced due to different effects that would happen. The strange attractor in both these novels produces the butterfly effect. The simple act of seduction performed by Alec towards Tess leads to the change in Tess`s destiny. Her life becomes a tornado of painful events: her and Alec`s child dies, she encounters Angel but she cannot find her happiness with him and at the end, she is sentenced to death because she murders Alec. In The French Lieutenant`s Woman, the presence of Sarah Woodruff represents the flap of a butterfly`s wing in Charles` life. The tornado could be construed when discussing Charles and Ernestina`s life. One alternative ending suggests that Charles leaves his fiancé Ernestina, for Sarah, the promiscuous woman who disturbs the tranquility from Lyme Regis.

Chaos theory can be, therefore, encountered in literature, more exactly in two masterpieces which belong to two different literary periods, through its characteristics such as the butterfly effect and strange attractors.

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