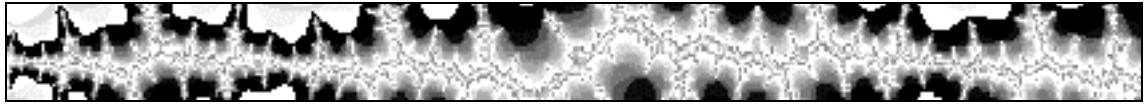


# THE PHYSICS OF THE TEXT



The Introduction and first two chapters of this thesis have dealt with the history, the development, and the politics of the literary interest in chaos theory. This chapter will delve deeper into the cultural dynamics of deterministic chaos to examine how it is represented in novels and how its principles may be used to establish critical readings of these novels.<sup>1</sup> Through its application of chaos theory to contemporary narratives, literary criticism has expanded its lexicon to include terms associated with the Second Law of Thermodynamics (or Second Law), information theory, and the concept of the ‘open’ system, and in the process it has gained far more than a new set of terms: it has appropriated a set of concepts which embody a worldview that is analogous to that perpetuated through many postmodern narratives.

The first section of this chapter will examine the Second Law of Thermodynamics and the associated concepts of entropy, negentropy, and the open system. Scientists propose that systems may be divided into two types depending on how they process energy and information. P. W. Atkins states in *The Second Law* (1984) that systems may be described as either ‘open’ or ‘closed’ in terms of how they use energy: open systems have reciprocal relationships with their surroundings, exchanging matter, energy and information with their environment, whereas closed systems do not.<sup>2</sup> Chaos theory is concerned with open systems because they demonstrate self-organising behaviour. Chaologists use the Second Law to elucidate the characteristics of open systems and have, in recent years, expanded its implications to incorporate the concepts of entropy and negentropy from information theory, which are used to measure the degree of organisation of open systems.

<sup>1</sup> I cannot claim credit for the title of this chapter - it belongs to Bruce Clarke, from his article “Resistance in Theory and the Physics of the Text,” in *New Orleans Review*, Volume 15, No. 1, 1991, pp. 86-93.

<sup>2</sup> P. W. Atkins, *The Second Law*, New York: W. H. Freeman and Company, 1984, p. 179.

In “Unity of Physical Laws and Levels of Description” (1971) Prigogine argues that the concepts of the Second Law and self-organisation “have deep philosophical implications.”<sup>3</sup> The literary interpreters of chaos theory have seized on such claims and have begun exploring the implications of the open system for social and fictional systems. Informed by chaos theory, literary criticism is developing a series of metaphors and analogies to explore the similarities critics perceive between open systems and narratives.<sup>4</sup> One such analogy defines fictional social systems in terms of the open systems normally studied by science. Hayles and other critics hypothesise that through the use of concepts appropriated from the Second Law and from information theory they will be able to establish new interpretations of narratives. The open system and its remarkable ability to undergo ‘self-organisation’ is particularly important, for it is employed to describe the structures of novels, which are characterised as open narrative systems.

The second section will examine Claude E. Shannon’s information theory and its relationship to chaos theory. Although the Second Law and information theory are often considered in tandem within chaos theory, for the sake of clarity each will be discussed separately here. One aspect of Shannon’s information theory has attracted significant literary attention: his hypothesis that meaning and information are distinct concepts. Hayles argues in *Chaos Bound* that the separation of meaning and information has become obvious in a variety of postmodern contexts due to the growth of information technologies and the implications of Ferdinand de Saussure’s linguistic theories.<sup>5</sup> The distinction between information and meaning has become a useful concept in critical discourse because it provides an avenue for questioning whether or not novels contain inherent meaning. This idea has significance for poststructuralist thought and chaos

<sup>3</sup> Prigogine, “Unity of Physical Laws and Levels of Description,” p. 2. Support for this claim is provided by the physicist Christian Vidal, who argues in *Order Within Chaos* that chaos theory is rich in “epistemological consequences.” However, this is a more general claim and does not specify any disciplinary limitations in relation to the epistemological implications of chaos theory. See Christian Vidal in Pierre Berge, Yves Pomeau, and Christian Vidal, *Order Within Chaos*, translated by Laurette Tuckerman, Paris: Hermann, 1984, p. 268.

<sup>4</sup> For a more detailed discussion of this subject see my “The Entropy of the Text: Postmodern Narratives as Open Systems,” in *Colloquy*, Volume 1, 1996, pp. 47-55.

<sup>5</sup> Hayles, *Chaos Bound*, p. 271.

theory; both are concerned with the ‘noisy’ information that pollutes meaning in complex systems.

Some critics assert that information theory’s separation of information and meaning complements the postmodernist argument that narratives contain no inherent or pre-determined meaning. Open systems are considered to be “information-rich,” to use a term conceived by Ary Goldberger, and Shannon suggests that the more complex systems are, the more information they contain.<sup>6</sup> One hypothesis that has emerged from the literary interpretation of chaos theory is that novels follow complex patterns of organisation that may be so subtle as to be invisible to readers, yet although the information they contain may appear randomly disordered, it is in fact ordered in highly complex ways. The literary application of chaos theory suggests that the complex ordering of information in novels destabilises traditional methods of interpretation, and indicates that new methods are required to come to terms with it.

Thomas Docherty argues in *Alterities: Criticism, History, Representation* (1996) that:

[The] postmodern narrative attacks the possibility of the reader herself or himself becoming a fully enlightened and imperialist subject with full epistemological control over the fiction and its endlessly different or altered characters. In order to read the postmodern narrative at all, the reader must give up such a singular position.<sup>7</sup>

The very structure of postmodern narratives prevents critics from maintaining an omniscient point of view in relation to their subject matter. The circumstances outlined by Docherty are analogous to the way in which deterministic chaos makes it difficult for order to be perceived in complex open systems. If novels are analogous to open systems, then it is possible to hypothesise that the chaotic information they contain prevents readers from gaining “epistemological control” over the events they inscribe. The use of chaos theory by literary criticism aims to achieve more than to corroborate the deconstructionist hypothesis that narratives contain no inherent meaning, however: it has the potential to provide new methods of comprehending fictional chaos.

<sup>6</sup> The term “information-rich” was conceived by Ary Goldberger, who is quoted by Gleick in *New Science*, p. 293. See also Hayles, *Chaos Bound*, p. 6.

<sup>7</sup> Docherty, *Alterities: Criticism, History, Representation*, p. 65.

The idea that novels chaotically encode information which must then be decoded provides one approach to fictional chaos. Section three will compare the task of deciphering coded signals and the reading of metafiction to suggest that readers need to use a series of ciphers based on the principles of chaos theory to decode postmodern narratives. One of these ciphers is defined by the organisational theorist Margaret J. Wheatley in *Leadership and the New Science: Learning about Organization from an Orderly Universe* (1992); Wheatley hypothesises that meaning in narratives is analogous to the notion of the strange attractor in chaotic systems. Chaologists study the nonlinear dynamics of chaotic systems by examining their strange attractors, the nonlinear forces that determine their behaviour. By considering narrative events to be chaotically determined by one or more strange attractors, critics can examine their causal mechanisms and how these contribute to the production of meaning.

A series of further sections will outline other ciphers based on the butterfly effect, the edge of chaos, eternal return or recursive symmetry, the accident, and the bifurcation point. These ciphers will all be critically applied to novels: for example, the edge of chaos cipher will be used to consider Milan Kundera's conception of the border in *The Book of Laughter and Forgetting* and *Immortality*, and the recursive symmetry cipher will be used to discuss Friedrich Nietzsche's concept of eternal return as this is examined in another of Kundera's fictions: *The Unbearable Lightness of Being*. The bifurcation point and strange attractor ciphers will then be applied to Italo Calvino's *If on a Winter's Night a Traveler*. Finally, some concluding remarks will be made regarding the potential of the critical application of chaos theory to the process of explicating fictional systems.

## OPEN SYSTEMS

The application of chaos theory to complex systems studied not by science but by other disciplines was first hinted at by Prigogine and Stengers in *Order out of Chaos*. More recently, other chaologists have also begun comparing physical and social systems. For example, the biologist Christopher Langton - whose work is discussed by Gleick in *New Science* and by Waldrop in *Complexity: The Emerging Science* - argues that biological

and cultural evolution are two examples of the same phenomenon of self-organisation.<sup>8</sup> Although chaos theory's analysis of self-organisation has developed it into a general principle that may be applied to various types of open systems, Langton's comparison of biological and cultural evolution does little in itself to indicate how similar the self-organisation of living and social systems may be. To bridge this gap, the literary interpreters of chaos theory have developed the metaphor of the narrative as open system.

The Second Law of Thermodynamics states that all matter in the universe moves in one direction - away from order and organisation and towards disorder and eventual thermodynamic equilibrium. This tendency towards disorder is expressed in the form of entropy: increasing entropy indicates increasing energy loss and greater disorder. Open systems use 'free' or available energy to perform tasks, such as producing motion and heat. Free energy is low in entropy, but once it is used, this free energy is transformed into what is called 'bound' energy. Bound energy is high in entropy, and can no longer be harnessed for useful work. Entropy therefore functions as a measure of the disorder of an open system.<sup>9</sup> Gleick explains in *New Science* that "[e]verything tends toward disorder. Any process that converts energy from one form to another must lose some as heat. Perfect efficiency is impossible."<sup>10</sup>

According to the Second Law, the process of energy dissipation is irreversible and unavoidable. Davies explains in *The Runaway Universe* (1978) that "the inexorable disintegration of the universe as we know it seems assured," for "the organization which sustains all ordered activity, from men to galaxies, is slowly but inevitably running down, and may even be overtaken by total gravitational collapse into oblivion."<sup>11</sup> Gleick declares glibly in *New Science* that the Second Law means that "[t]he universe is a one-

<sup>8</sup> Langton, paraphrased by Waldrop in *Complexity: The Emerging Science*, p. 214.

<sup>9</sup> The concept of entropy has gained literary and cultural connotations. See Eric Zency, "Some Brief Speculations on the Popularity of Entropy as Metaphor," in *North American Review*, Volume 271, No. 3, 1986, pp. 7-10; and "Entropy as Root Metaphor," in *Beyond the Two Cultures: Essays on Science, Technology, and Literature*, edited by Joseph W. Slade and Judith Yaross Lee, Ames: Iowa State University Press, 1990, pp. 185-200.

<sup>10</sup> Gleick, *New Science*, p. 308.

<sup>11</sup> Davies, quoted by Prigogine and Stengers in *Order out of Chaos*, p. 116. See Davies, *The Runaway Universe*, London: J. M. Dent and Sons, 1978, p. 197.

way street.”<sup>12</sup> This interpretation of the Second Law remained consistent from the time of its conception through to the end of the nineteenth century, and until recently has been considered an accurate perception of the long term future of the universe. Recently, some chaologists have argued that the Second Law does not accurately describe the behaviour of living systems, especially in the short term, and that its prediction of the inevitability of thermodynamic equilibrium should be reconsidered.<sup>13</sup> The prevailing nineteenth century interpretation of the Second Law has thus been revised to incorporate the concepts of negentropy and organisation, which were both previously regarded as contradictions to the Second Law. Negentropy, the opposite of entropy or disorganisation, is a measure of the order that open systems create from the energy and matter they obtain from their environments.

The biologist James E. Lovelock, author of *Gaia: A New Look at Life on Earth* (1979), proposes in *The Ages of Gaia: A Biography of our Living Earth* (1989) that “[l]iving organisms are open systems in the sense that they take and excrete energy and matter.”<sup>14</sup> Prigogine and Stengers argue similarly in *Order out of Chaos* that “biological and social systems are open [systems],” capable of “exchanging energy or matter (and, one might add, information) with their environment.”<sup>15</sup> These views are shared by the biologists Daniel R. Brooks and E. O. Wiley, who argue in *Evolution as Entropy* (1988) that open systems go through a two stage process which lowers their internal entropy. The first stage occurs when open systems import low entropy ‘free’ energy into themselves, which leads to an increase in their ‘negentropy’ or organisation and a decrease in their internal entropy.<sup>16</sup> The absorption of energy is demonstrated by the human body, which imports energy and matter in the form of food and air from its

<sup>12</sup> Gleick, *New Science*, p. 308.

<sup>13</sup> Gleick argues that scientists have found it necessary to reconsider the definition of the Second Law due to its perceived inability to explain the behaviour of living things, in which negentropy and organisation play significant roles. See James Gleick and Eliot Porter, *Nature's Chaos*, edited by Janet Russek, London: Cardinal, 1991, p. 34.

<sup>14</sup> Lovelock, *The Ages of Gaia: A Biography of our Living Earth*, Oxford: Oxford University Press, 1989, p. 27.

<sup>15</sup> Prigogine and Stengers, *Order out of Chaos*, p. xv.

<sup>16</sup> Daniel R. Brooks and E. O. Wiley, *Evolution as Entropy*, second edition, Chicago: University of Chicago Press, 1988, p. 52.

environment. When digested, nutrients become a part of the body, allowing growth, a form of self-organisation, to occur.

The second stage of this process occurs when living systems divest themselves of high entropy waste products. Self-organising systems reduce their entropy by expelling their bound or used energy, which is high in entropy, into their environment. Again, the human body can be used to demonstrate how this process occurs. Lovelock argues that the individual is bound up in the rules which map out the behaviour of open systems:

You, as you read these words, are creating entropy by consuming oxygen and the fats and sugars stored in your body. As you breathe, you excrete waste products high in entropy into the air, such as carbon dioxide, and your warm body emits to your surroundings infrared radiation high in entropy.<sup>17</sup>

Heinz Pagels explains in *The Dreams of Reason* (1988) that this used energy ‘dissipates’ into the environment, allowing living systems to avoid deterioration.<sup>18</sup> Brooks and Wiley suggest that the environment surrounding a living system gains in entropy in two ways during the process of self-organisation, firstly as it loses the free energy taken by living systems, and secondly as it receives back used or bound energy in the form of waste matter.<sup>19</sup> They state that “so long as living systems take up low-entropy material and return high-entropy waste products to the environment, the second law is not violated by biological systems.”<sup>20</sup>

The nineteenth-century definition of the Second Law is overwhelmingly negative, whereas chaos theory’s reinterpretation of it defines entropy as a positive and essential feature of open systems. Brooks and Wiley argue in *Evolution as Entropy* that the complexity and organisation of open systems occurs as a result of, rather than at the

<sup>17</sup> Lovelock, *The Ages of Gaia: A Biography of our Living Earth*, Oxford: Oxford University Press, 1989, pp. 25-6.

<sup>18</sup> Heinz Pagels, *The Dreams of Reason*, New York: Simon and Schuster, 1988, p. 65. The term ‘dissipative system’ was defined by Prigogine to describe the self-organising behaviour of open systems, which ‘dissipate’ or expel their entropy into their environments. Prigogine and Stengers state: “[w]e have called these new structures *dissipative structures* to emphasize the constructive role of dissipative processes in their formation.” See Prigogine and Stengers, *Order out of Chaos*, p. 12.

<sup>19</sup> Brooks and Wiley, *Evolution as Entropy*, p. 76. Self-organisation is also known as ‘autocatalysis.’ Brooks and Wiley argue that biological systems are “autocatalytic” in that they provide the impetus for their own growth and change.

<sup>20</sup> *Ibid.*, p. 9. The revision of the Second Law does not contradict the hypothesis that the thermodynamic decline is irreversible in the long term. In the short term, at least, it indicates that living systems can obtain energy from their environments and avoid thermodynamic equilibrium, which in living things manifests itself as death.

expense of, entropy.<sup>21</sup> The idea that organisation occurs in opposition to entropy is an over-simplification of the behaviour of open systems: organisation can only occur in open systems because entropy also occurs. In “Information or Noise? Economy of Explanation in Barthes’ *S/Z* and Shannon’s Information Theory” (1987), Hayles suggests that entropy is an essential feature of open narrative systems and that entropy is constructive in its ability to create order.<sup>22</sup> Chaos theory and literary criticism have therefore reversed the implications of entropy in scientific and social contexts. Entropy is no longer considered a destructive force but a constructive one, deeply implicated in the production of order and meaning. With reference to this reinterpretation of the Second Law, critics argue that the principles that define the behaviour of biological open systems also apply to human and social systems. In comparing natural and human systems these critics are supported by a number of scientists, who agree that open systems theory is applicable to both.

Davies, for example, notes in *The Runaway Universe* that “[h]uman history is a story of struggle to preserve order against the natural tendency to collapse into disorder, and in a sense this is the history of the cosmos. Our own fate is inextricably bound up with that of the universe to which the same laws apply.”<sup>23</sup> Other scientists, including Brooks and Wiley, and Marcelo Alonso, agree that science’s physical laws have the epistemological power to describe the properties of social systems. Brooks and Wiley assert that the “behavior embodied in the second law of thermodynamics” is “more general than the concept of energy flows for which the law was originally formulated,” thus allowing for the extrapolation of scientific ideas to define social circumstances.<sup>24</sup> In his Introduction to *Organization and Change in Complex Systems* (1990), Marcelo Alonso also hints at the applicability of chaos theory to social systems, arguing that social and living systems both exhibit self-organising behaviour.<sup>25</sup> The literary interpreters of chaos theory, encouraged by these representations, argue that complex social systems may be defined as open systems and that the principles that describe one

<sup>21</sup> *Ibid.*, p. xiv.

<sup>22</sup> Hayles, *Chaos and Order*, p. 13.

<sup>23</sup> Davies, *The Runaway Universe*, p. 16.

<sup>24</sup> Brooks and Wiley, *Evolution as Entropy*, p. xiii.

<sup>25</sup> Marcelo Alonso, Introduction to *Organization and Change in Complex Systems*, edited by Marcelo



set of circumstances, such as the behaviour of global weather patterns, can now be applied to another set of circumstances, such as the behaviour of artificial systems like computer networks and fictional narratives.

## INFORMATION THEORY

This section will discuss information theory in relation to the open system. Claude E. Shannon outlines his information theory in *The Mathematical Theory of Communication* (1949), which also features a commentary by Warren Weaver entitled “Recent Contributions to the Mathematical Theory of Communication.” As an employee of the Bell Telephone Company, Shannon defines information in a technical sense to describe the transmission of information in physical systems, and does not speculate as to whether it has implications for other disciplines.<sup>26</sup> Nonetheless, information theory may be interpreted in a more general sense than Shannon intended. The following discussion is based partially on Shannon’s ideas, and partially on Weaver’s interpretation of his ideas. In *Chaos Bound* Hayles notes that Weaver interprets Shannon’s ideas and shapes them into a form that is accessible to the general reader.<sup>27</sup> Weaver proposes that “the mathematical theory [of communication] is exceedingly general in its scope.”<sup>28</sup> The literary and cultural interpreters of chaos theory have taken this comment literally.

Weaver describes the process of communication as the transmission of signals from a source to a receiver.<sup>29</sup> These signals contain information in the form of messages. Shannon and Weaver define information as “a measure of one’s freedom of choice in selecting a message.”<sup>30</sup> This means that if there is a small amount of choice available in the selection of a message, the information content of a particular signal will be low. If, on the other hand, there is a large degree of choice, then the amount of information

Alonso, New York: Paragon House, 1990, pp. xiv-xvi.

<sup>26</sup> Warren Weaver, “Recent Contributions to the Mathematical Theory of Communication,” in *The Mathematical Theory of Communication*, Urbana: The University of Illinois Press, 1949, pp. 94-117, p. 95.

<sup>27</sup> Hayles, *Chaos Bound*, p. 193.

<sup>28</sup> Weaver, “Recent Contributions,” p. 114.

<sup>29</sup> *Ibid.*, pp. 98-9.

<sup>30</sup> *Ibid.*, p. 108.

contained in a signal will be high. Weaver argues that “information in communication theory relates not so much to what you *do* say, as to what you *could* say.”<sup>31</sup> Shannon and Weaver argue that a single signal may contain more than one message. The amount of information contained in any signal is therefore determined by the amount of choice that exists in the selection of a message. The greater the choice, the higher the number of possible messages, and the higher the amount of information.

Furthermore, signals do not contain random messages. Shannon argues that signals contain one ‘intended’ or ‘actual’ message, and numerous non-intended or ‘possible’ messages: “the actual message [in any signal] is one selected from a set of possible messages.”<sup>32</sup> If a signal contains only a few possible messages, then there will be a high probability that its intended message will be distinguished from its possible messages by its receiver. On the other hand, if a signal contains a large number of possible messages, then there will be a correspondingly smaller chance that the receiver will be able to determine which is the intended message. Weaver argues that “[t]he greater this freedom of choice, and hence the greater the information, the greater is the uncertainty that the message selected is some particular one.”<sup>33</sup> The total number of possible messages in any signal will determine how difficult it is to unearth its ‘intended’ or pre-determined message.

Information theory is based on the idea that information may be considered a form of energy. Therefore, the concept of entropy can be used to measure the information or organisational content of signals.<sup>34</sup> A signal that contains only a few comparatively discernible messages will be low in disorganisation or ambiguity, and consequently low in entropy. Conversely, a signal that contains a multitude of possible messages will appear highly disorganised or ambiguous, and will be highly entropic. Weaver argues that one of the basic principles of open systems is that the amount of information in an open system will rise when its entropy also rises.<sup>35</sup> The level of a message’s entropy will determine the variability of its meaning. In “Information or

<sup>31</sup> *Ibid.*, p. 100.

<sup>32</sup> Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication*, Urbana: The University of Illinois Press, 1949, p. 3.

<sup>33</sup> Weaver, “Recent Contributions,” p. 109.

<sup>34</sup> *Ibid.*, p. 103.

Noise?” Hayles considers the application of information theory to literature, and argues that information is not only measured in terms of uncertainty, or entropy, but it is possible that information generates uncertainty.<sup>36</sup> As the amount of information (the freedom of choice in selecting a message) increases in a narrative, so does the complexity and uncertainty of this information. Hayles proposes that the chaotic complexity of narratives allows for both a high level of information and a high degree of entropy.<sup>37</sup> Paulson in *The Noise of Culture* also considers the literary implications of information theory: he argues that information and entropy are essential features of open narrative systems. He describes entropy as “a positive factor in an unforeseen organizational complexity, rather than simply a negative factor inhibiting the transmission of pre-established information.”<sup>38</sup>

Entropy introduces ambiguity into texts and makes the process of determining meaning more complex. Shannon suggests that messages “[f]requently... have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities.”<sup>39</sup> Meaning is a property of information, but it is not the same as information; Weaver makes this distinction clear by stating that “information must not be confused with meaning.” To further explain the differences between information and meaning, Weaver hypothesises that two messages may possess similar amounts of information, although one message could be significantly meaningful and the other entirely meaningless.<sup>40</sup> The possibility that meaning may be construed from information depends in part, therefore, on its receiver. The combination of possible and actual messages in any given signal defines a complex and ambiguous relationship between information and meaning in all forms of communication, including fictional narratives. The process of transmission and deciphering fictional narratives results in the discovery that these texts present their readers with no obvious inherent messages.

<sup>35</sup> *Ibid.*, p. 109.

<sup>36</sup> Hayles, “Information or Noise? Economy of Explanation in Barthes’ *S/Z* and Shannon’s Information Theory,” in *One Culture: Essays in Science and Literature*, edited by George Levine, Madison: The University of Wisconsin Press, 1987, pp. 119-42, p. 123.

<sup>37</sup> Hayles, “Information or Noise?” p. 123.

<sup>38</sup> Paulson, *The Noise of Culture*, p. 95.

<sup>39</sup> Shannon, *The Mathematical Theory of Communication*, p. 3. By a system, Shannon means a system external to the communication system itself, a system that places a message in a specific context.

Narratives contain a plurality of possible messages, any of which could be the 'intended' message. Consequently, the act of identifying any one message as the 'intended' message has become an extremely difficult, if not impossible, task for the reader to achieve. Information theory and poststructuralist literary theory outline analogous perceptions of the information contained within textual systems. Although he was not first critic to consider the implications of a decline in authorial agency in the twentieth century, Roland Barthes has advanced some of the most influential arguments on the subject. In "The Death of the Author" (1968) he argues that narratives do not contain predetermined authorial messages, and that the meaning found in narratives by readers is predominantly created during the process of reading.<sup>41</sup> Barthes argues that the authority of the author is subverted by the process of reading and places emphasis on the role of the reader in creating meaning in texts, and rejects the possibility that evidence of authorial intention can be reconstructed from texts.

Poststructuralist critics argue after Barthes that authors are unable to transmit a specific message to the reader through narratives because the ideas that readers bring to narratives destabilise those of the author. The idea that texts contain information that has not been placed in them by their author has been appropriated from information theory by literary criticism: Weaver argues in "Recent Contributions to the Mathematical Theory of Communication" that "[i]n the process of being transmitted... certain things are added to the signal which were not intended by the information source."<sup>42</sup> Weaver's 'information source' is the set of ideas available to the author, and the 'extraneous information' is the information readers refer to in the process of reading. This additional material increases narrative information, but distorts and introduces errors into the

<sup>40</sup> Weaver, "Recent Contributions," p. 99.

<sup>41</sup> This series of papers outline the 'Death of the Author' debate: Roland Barthes, "The Death of the Author," in *Modern Criticism and Theory: A Reader*, edited by David Lodge, London: Longman, 1988, pp. 167-72; Michel Foucault, "What is an author?" in *Modern Criticism and Theory*, pp. 196-210; William H. Gass, "The Death of the Author," in *Salmagundi*, No. 65, 1984, pp. 3-26; Alexander Nehamas, "Writer, Text, Work, Author," in *Literature and the Question of Philosophy*, edited by Anthony J. Cascardi, Baltimore: The Johns Hopkins University Press, 1987; Colin MacCabe, "The Revenge of the Author," in *Critical Quarterly*, Volume 31, No. 2, 1989, pp. 3-13; Clara Claiborne Park, "Author! Author! Reconstructing Roland Barthes," in *The Hudson Review*, Volume 43, No. 3, 1990, pp. 377-98; and Umberto Eco, "Between Author and Text," in *Interpretation and Overinterpretation*, edited by Stefan Collini, Cambridge: Cambridge University Press, 1992.

<sup>42</sup> Weaver, "Recent Contributions," p. 99.

possible messages received by readers. The transmission of authorial ideas through narratives is interrupted by the information that readers introduce into narratives, and authorial agency is thus negated. In the terminology of information theory, the author is unable to inform the reader about the intended meaning of the narrative because the intended message has become entangled with numerous possible messages.

The process of communication - the transmission of a signal from a source to a receiver - may be compared to the transmission of literary information from an author to a reader. Weaver argues that a transmitter does not merely shape a message into a form suitable to be transmitted as a signal, but that it encodes the information into a signal: the “function of the transmitter is to *encode*, and that of the receiver to *decode*, the message.”<sup>43</sup> The informational processes of narratives may therefore be described thus: a transmitter (an author’s mind) selects a message from an information source (a set of ideas) and encodes this information into a signal (a narrative), which is then transmitted (published). The signal is received (read) and the signal decoded into a message (the text is interpreted, and transformed into meaning) by the reader. During the process of reception other information enters the text, increasing its sum of information and hence its complexity and ambiguity. The reader, therefore, plays an essential role in the production of literary meaning.

The application of information theory to literary criticism superficially supports the poststructuralist hypothesis that authors do not transmit meaning through narratives. However, it differs from poststructuralism in its appraisal of why it is impossible for readers to identify authorial or intended meanings in novels. Whereas poststructuralists argue that authors do not place intended messages in novels, the literary interpreters of chaos theory recognise that it is possible for authors to place intended messages in novels, but argue that it does not matter whether authors do this or not, for the multiplicity and ambiguity of their texts will make it impossible for readers to determine which messages are authorial messages. The modernist literary ideal that narrative enable authors to present a set of ideas or values to readers is therefore not repudiated through the literary application of chaos theory as it is by deconstruction. Instead, the meaning readers gain from narratives is a chaotic confusion of the meaning that authors intend

them to receive which is reinterpreted in different ways. Paulson argues in *The Noise of Culture* that authors do write with an intended message in mind, but that “the message is not always received, intact, as it was sent.”<sup>44</sup> He hypothesises that what the reader receives from a narrative “is less clear and orderly (but more complex) than what was ‘sent’” by the author.<sup>45</sup>

Paulson’s application of information theory to literary criticism suggests that authorial efforts to pre-determine the novelistic meaning are ineffective and do not take into account how open narrative systems process information. Statistical improbability accounts for the inability of readers to uncover authorial narrative messages; it is extremely improbable for readers to correctly identify any one message as the intended message. However, Paulson does not attempt to prove that it is impossible for readers to attempt to uncover authorial messages; unlike poststructuralists concerned with debunking the role of the author, the literary interpreters of chaos theory are primarily interested in examining how narrative systems process information. They endorse a compromise between the modernist literary ideal of authorial agency and the poststructuralist ‘Death of the Author’ position by suggesting that texts may contain authorial messages that will be almost impossible to uncover. The application of information theory to literary criticism outlines a new perception of the relationship between information and meaning in fictional texts.<sup>46</sup>

The focus of this new perception of information and meaning in fictions is discussed further by Paulson, who argues in *The Noise of Culture* that the literary exploration of fictional complexity is equivalent to science’s exploration of complexity

<sup>43</sup> Weaver, “Recent Contributions,” p. 107.

<sup>44</sup> Paulson, *The Noise of Culture*, p. 92.

<sup>45</sup> Weaver, “Recent Contributions,” p. 93.

<sup>46</sup> To give a brief example of how information theory may inform reading practice, consider for example Umberto Eco’s *The Name of the Rose* (1983). The reader of may or may not be aware that the character ‘Jorge’ is a satirical representation of the author Jorge Louis Borges. If the reader is not aware of this form of possible meaning, then the character Jorge will appear to have little symbolic value. The uninformed reader therefore has less choice in determining the meaning of the narrative: the degree of choice in selecting a message is reduced, and, as a result, less information is produced. Conversely, if the reader is aware of Eco’s allusions to Borges’ “The Library of Babel” (1962), then his description of Jorge will represent an accumulation of meaning. See Borges, “The Library of Babel,” in *Labyrinths*, London: Penguin, 1970.

and, therefore, that it is appropriate for readers to decode narratives just as receivers decode signals:

Literature, with its exploitation of language's ambiguity, its strange bringing together of the sensuous and intellectual aspects of language in a synthesis that cannot be fully explained or predicted, places us in immediate contact with a system of relations, a system that we can neither reduce to something simpler nor account for by adding together simple things. To read as fully as possible the literary text, we need codes that we do not at the outset possess, because only by experiencing the text's complexity can we begin to construct them. Literature, and to an even greater extent its study, can thus constitute the cultural apprenticeship of a science or knowledge of the complex.<sup>47</sup>

Ciphers appropriated from chaos theory contribute to the tools available to, and constitute a significant new development in, contemporary criticism.

### THE BUTTERFLY EFFECT

The term 'the butterfly effect' has multiple sources: it may be traced to Ray Bradbury's "A Sound of Thunder" (1962), but the meteorologist and chaologist Edward Lorenz claims it as his own in "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" (1972). Bradbury does not actually use the term 'the butterfly effect' in "A Sound of Thunder," but he does combine a clear example of the dynamics of the butterfly effect with an evocative description of a butterfly as the effect's catalyst. In Bradbury's story, several men travel back in time to hunt dinosaurs, and in so doing they accidentally kill a butterfly. When they return to their present time, they find that the presidential election which had been decided in favour of candidate A before they left has now been decided in favour of candidate B, and they realise that the death of the butterfly has effected the history of the entire world.<sup>48</sup> Given this correlation, it appears obvious to literary theorists that the term and principle of 'the butterfly effect' is literary in origin, yet Lorenz claims not to have read or heard of Bradbury's story when he first defined the term 'the butterfly effect' a decade after Bradbury published his story.<sup>49</sup>

<sup>47</sup> Paulson, *The Noise of Culture*, p. 143.

<sup>48</sup> Ray Bradbury, "A Sound of Thunder," in *R is for Rocket*, New York: Bantam, 1962.

<sup>49</sup> Lorenz, *The Essence of Chaos*, pp. 14-15. Lorenz claims to have given the butterfly effect its name in his paper titled "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" Address at the 139th meeting of the American Association for the Advancement of Science (AAAS) in Washington D. C., 29 December 1972. The article was not published at the time, but was

The butterfly effect, the notion that one small or seemingly insignificant event may have dramatic consequences, is an underlying feature of many narrative fictions. In “Prigogine, Chaos, and Contemporary Science Fiction” (1991), Porush sites Jane Austen and Leo Tolstoy as authors who use the trope of a small or insignificant episode in a character’s life as the motif or catalyst from which great and often tragic consequences evolve.<sup>50</sup> More recently, the concept of the butterfly effect has come to occupy a significant place in the science of catastrophe theory and chaos theory, where the hypothesis that small or seemingly insignificant causes can lead to large and dramatic effects is known as the ‘sensitive dependence on initial conditions.’ The initial conditions of a system, or what happens at the beginning of a system, determine the possible outcomes of that system.

Science’s acceptance of complex nonlinear causal systems represents a significant moment for literature: for literary critics, it provides confirmation that causal relations are as ambiguous and indeterminate in ‘reality’ as they are in fictional narratives. Porush suggests in “Prigogine, Chaos, and Contemporary Science Fiction” that:

without a recognition of the powerful role the Butterfly Effect plays in human destiny, virtually every great novelist and dramatist, including Shakespeare, would have been out of business. But before Chaos Theory, such a view of human experience was alien to science, dismissed as pertinent only to the realm of accident, coincidence, kismet, and messy human affairs.<sup>51</sup>

Because it embraces the ambiguity of nonlinear causal systems, chaos theory “unfolds to our view a nature that seems to be speaking the same language as great mimetic artists” like Austen and Tolstoy.<sup>52</sup> Whatever the origins of ‘the butterfly effect,’ it is now entrenched in contemporary scientific and literary discourse, and its nonlinear causality is currently being applied to human historical systems by scientists and critics.

Kellert contends in *Wake of Chaos* that historical events can be seen to unfold according to the dynamics of the butterfly effect because history teems “with examples of small events that led to momentous and long-lasting changes in the course of human

subsequently published in *The Essence of Chaos*, pp. 181-84.

<sup>50</sup> Porush, “Prigogine, Chaos, and Contemporary Science Fiction,” p. 381.

<sup>51</sup> *Ibid.*, p. 382.

<sup>52</sup> *Ibid.*, p. 382.



affairs.”<sup>53</sup> The physicist Marcelo Alonso, for example, draws a comparison between the butterfly effect and human causality by arguing that because “social systems are not linear, certain local fluctuations (inventions, discoveries, revolutions, wars, [the] emergence of political leaders, etc.) may result in major changes.”<sup>54</sup> Furthermore, in a brief *Scientific American* article, John Horgan describes the work of Gottfried Mayer-Kress, who hypothesises that “nation-states can be described mathematically as nonlinear and even ‘chaotic’ systems” in which small events, such as terrorist bombings or minor military deployments, “can trigger large and unpredictable consequences - such as nuclear war.”<sup>55</sup> To these scientists, the applicability of the butterfly effect to social systems is entirely valid in scientific as well as a literary context.

#### RECURSIVE SYMMETRY - ETERNAL RETURN

Recursive symmetry is a term used by chaologists to describe the repetitive behaviour of open systems. Many natural systems follow recursive or cyclical patterns of behaviour over periods of time. The changing of the seasons is a form of recursive symmetry. On January 10 in Perth, Australia, for example, the weather is likely to be hot, because it is summer. From year to year, however, the maximum temperature recorded on January 10 varies, sometimes substantially. This variation in maximum temperature is an example of recursive symmetry: a system returns close to its original behaviour without returning exactly to the same behaviour, in this case, precisely the same temperature. Hayles draws attention to the significance of the concept of recursive symmetry by arguing that one of the keys to understanding chaotic systems is to examine whether systems exhibit the concept of recursive symmetry: when recursive symmetry is evident in a system, so too is chaos.<sup>56</sup>

The concept of ‘eternal return’ advanced by the nineteenth-century philosopher Friedrich Nietzsche defines a form of repetitive behaviour similar to the chaos-theory

<sup>53</sup> Kellert, *Wake of Chaos*, p. 5.

<sup>54</sup> Alonso, Introduction to *Organization and Change in Complex Systems*, p. xvii.

<sup>55</sup> Gottfried Mayer-Kress, discussed by John Horgan in “Nonlinear Thinking,” in *Scientific American*, Volume 260, June 1989, pp. 12-13, p. 12.

concept of recursive symmetry. This section will endeavour to demonstrate that recursive symmetry is remarkably similar to Nietzsche's idea of eternal return, and that this similarity is due to the influence of philosophical ideas, such as those of Nietzsche, on the development of chaos theory. In assessing whether eternal return is analogous to recursive symmetry, two difficulties associated with the study of Nietzsche's ideas must be overcome. Firstly, as with many of his ideas, Nietzsche did not define eternal return in a thorough or systematic manner. The Nietzsche scholar George Allen Morgan notes in *What Nietzsche Means* (1941) that "[t]he end came before Nietzsche had completed his statement of his cosmology, and he did not fully clarify the relation of the eternal recurrence to the rest of his theories."<sup>57</sup>

Secondly, references to eternal return are scattered throughout at least four of Nietzsche's texts: *The Gay Science* (1882), *Thus Spoke Zarathustra* (1883-5), the posthumously published collection of writings entitled *The Will to Power* (1885-8), and Nietzsche's autobiography *Ecce Homo* (1888).<sup>58</sup> In *Nietzsche: The Ethics of an Immoralist* (1995), Peter Berkowitz argues that *Thus Spoke Zarathustra* provides "the most sustained treatment of the eternal return in Nietzsche's writings."<sup>59</sup> While this may be the case, *The Gay Science* is also significant because it contains Nietzsche's first discussion of eternal return. Reference will also be made to a number of critical texts, including Morgan's *What Nietzsche Means*, Berkowitz's *Nietzsche: The Ethics of an Immoralist*, Gilles Deleuze's *Nietzsche and Philosophy* (1983), William V. Spanos' *Repetitions: The Postmodern Occasion in Literature and Science* (1987), and Prigogine's and Stengers' *Order out of Chaos*. Despite its age, Morgan's *What Nietzsche Means* is particularly useful in assessing the significance of eternal return. Spanos considers the language implications of eternal return, while Deleuze is concerned with explicating some of the complexities of Nietzsche's philosophy, including the 'will

<sup>56</sup> Hayles, *Chaos Bound*, p. 154.

<sup>57</sup> George Allen Morgan, Jr., *What Nietzsche Means*, Cambridge: Harvard University Press, 1941, p. 289.

<sup>58</sup> Friedrich Nietzsche, *The Gay Science*, translated by Walter Kaufmann, New York: Vintage Books, 1974; *Thus Spoke Zarathustra*, translated by Alexander Tille, London: Fisher Unwin, 1899; *The Will to Power*, translated by Walter Kaufmann and R. J. Hollingdale, edited by Walter Kaufmann, London: Weidenfeld & Nicolson, 1968; *Ecce Homo*, translated by R. J. Hollingdale, New York: Penguin, 1979.

<sup>59</sup> Peter Berkowitz, *Nietzsche: The Ethics of an Immoralist*, Cambridge: Harvard University Press, 1995, p. 207.

to power' and eternal return, for he considers these concepts to be the most misunderstood aspects of Nietzsche's thought.<sup>60</sup> Prigogine's and Stengers' brief discussion of Nietzsche's views on science in *Order out of Chaos* will also be referred to here.

Nietzsche's concept of eternal return defines a cyclical process of historical recurrence which applies equally to human history and to the universe as a whole: events occur, and are repeated in near perfect symmetry at later points in time. These recurrences then re-occur, and re-occur, into infinity. Nietzsche argues in *Thus Spoke Zarathustra* that "all things recur eternally, and we ourselves too... we have already existed an eternal number of times, and all things with us."<sup>61</sup> Coupled with the principle of eternal return is the notion of chaos. In *The Gay Science* Nietzsche argues that "the total character of the world is chaos to all eternity."<sup>62</sup> Eternal return allows for an eternity of recurrence, but Nietzsche argues that this does not signify that the natural world is comprehensively ordered; on the contrary, he argues that the examples of order we perceive in the world through science or other forms of critical thought are merely local and temporary exceptions to the rule of disorder.<sup>63</sup> In *The Will to Power*, for example, he states that "[u]niversal chaos... does not contradict the idea of the cycle."<sup>64</sup> Nietzsche views chaos as a part of the cycle of eternal return, and declares, again in *The Will to Power*, that "if ever there was a chaos of forces the chaos was eternal and has reappeared in every cycle."<sup>65</sup> Deleuze comments that for Nietzsche, chaos and chance exist within each and every cycle of an eternally returning system.<sup>66</sup>

As a cosmological principle, eternal return signifies the influence of the pre-Socratic philosophers on Nietzsche. Morgan argues that Nietzsche was an admirer and follower of the pre-Socratic philosophers, particularly Heraclitus, whose idea that the

<sup>60</sup> Gilles Deleuze, *Nietzsche and Philosophy*, London: Athlone, 1983, p. xi.

<sup>61</sup> Nietzsche, from *Thus Spoke Zarathustra*, quoted by Berkowitz in *Nietzsche: The Ethics of an Immoralist*, p. 205.

<sup>62</sup> Nietzsche, from *The Gay Science*, quoted by Morgan in *What Nietzsche Means*, p. 269.

<sup>63</sup> Morgan, *What Nietzsche Means*, pp. 282, 289.

<sup>64</sup> Nietzsche, from *The Will to Power*, quoted by Deleuze in *Nietzsche and Philosophy*, p. 28.

<sup>65</sup> *Ibid.*, p. 29.

<sup>66</sup> Deleuze, *Nietzsche and Philosophy*, pp. 28-9.

world is in constant flux seems to have significantly influenced Nietzsche.<sup>67</sup> Modern scholars have identified in the fragments attributed to Heraclitus keen interest in the natural world's processes of change and the transient nature of human experience. Heraclitus claims in one fragment that "[u]napparent connection is better than apparent."<sup>68</sup> This idea relates to causality, and is relevant to Nietzsche's belief that causal structure of eternal return is not easily observable by most individuals. In another fragment, Heraclitus claims that "all things come about in accordance with strife."<sup>69</sup> Strife, war, or conflict are all catalysts for change, or flux. Nietzsche, like Heraclitus, is predominantly concerned with the processes of change, with understanding what he describes in *The Gay Science* as "the flux of occurrence."<sup>70</sup>

Deleuze argues that we misrepresent the concept of eternal return if we believe it to be the return of the same, or the re-occurrence of precisely the same events and situations.<sup>71</sup> He states that "every time we interpret the eternal return as the return of the identical or the same, we replace Nietzsche's thought with childish hypotheses."<sup>72</sup> Eternal return signifies the return of the similar, not the same: in each recurrence of an event, something new or different is also evident in the pattern of recurrence. This crucial difference is identified by Lyotard in *The Inhuman* when he states that "repetition escapes from repetition in order to repeat. That in trying to have itself forgotten, it fixes its forgetting, and thus repeats its absence."<sup>73</sup> In *Repetitions: The Postmodern Occasion in Literature and Science* William V. Spanos also discusses the principle of repetition or eternal return, remarking that each recurrence of an event suggests *differance* in Derrida's terminology: "the act of repetition discovers the difference of the same."<sup>74</sup> This paradoxical difference within the same is characteristic of the change in scientific worldviews embodied by deterministic chaos. Deleuze notes that "eternal return is

<sup>67</sup> Morgan, *What Nietzsche Means*, pp. 306-7, 337.

<sup>68</sup> Heraclitus, cited in *Early Greek Philosophy*, edited by Jonathan Barnes, London: Penguin, 1987, p. 102.

<sup>69</sup> Heraclitus, cited in *Early Greek Philosophy*, p. 114.

<sup>70</sup> Nietzsche, from *The Gay Science*, quoted by Morgan in *What Nietzsche Means*, p. 283.

<sup>71</sup> Deleuze, *Nietzsche and Philosophy*, p. 48.

<sup>72</sup> *Ibid.*, p. xi.

<sup>73</sup> Lyotard, *The Inhuman*, p. 153.

<sup>74</sup> Spanos, *Repetitions*, p. 227. See Jacques Derrida, *Writing and Difference*, translated by Alan Bass, London: Routledge and Kegan Paul, 1978.

linked, not to a repetition of the same, but on the contrary, to a transmutation.”<sup>75</sup> This transmutation symbolises the eternity of becoming and “the reproduction of diversity.”<sup>76</sup> He concludes from his analysis of eternal return that “we can only understand the eternal return as the expression of a principle which serves as an explanation of diversity and its reproduction, of difference and its repetition.”<sup>77</sup> Eternal return allows for stability as well as originality, order as well as chaos.

In *Order out of Chaos* Prigogine and Stengers discuss Nietzsche’s views on science. Nietzsche was well acquainted with the fundamentals of the Second Law and other scientific principles, and they point out that Nietzsche counters the implications of these concepts in his writings.<sup>78</sup> Just as Heraclitus’ views conflicted with those of Parmenides, Nietzsche opposed the order-oriented mechanist-reductionist Newtonian worldview of his day. He also rejected the nineteenth-century interpretation of the Second Law of Thermodynamics and its prediction that the universe would eventually suffer total thermodynamic equilibrium. Morgan suggests in *What Nietzsche Means* that Nietzsche’s doctrine of eternal return offers an alternate perspective of the Second Law, for it precludes the need for any form of closure, such as that signified by the concept of ‘heat death’ or thermodynamic equilibrium.<sup>79</sup> Deleuze similarly acknowledges in *Nietzsche and Philosophy* that “Nietzsche’s account of the eternal return presupposes a critique of the terminal or equilibrium state.”<sup>80</sup> These theorists demonstrate that Nietzsche’s critique of the Second Law gives his principle of eternal return a scientific context, at least to modern readers.

It is more difficult to establish whether Nietzsche intended eternal return to be a scientific principle, and whether it was perceived as such during his lifetime. Given his familiarity with the Second Law, Nietzsche may have intended eternal return to function as a scientific hypothesis. In *What Nietzsche Means*, Morgan suggests that Nietzsche’s conception of eternal return was guided by the idea that “his theory could be supported

<sup>75</sup> Deleuze, *Nietzsche and Philosophy*, p. xii.

<sup>76</sup> *Ibid.*, p. 46.

<sup>77</sup> *Ibid.*, p. 49.

<sup>78</sup> Prigogine and Stengers, *Order out of Chaos*, pp. 111, 136, 323.

<sup>79</sup> Morgan, *What Nietzsche Means*, p. 287.

<sup>80</sup> Deleuze, *Nietzsche and Philosophy*, p. 47.

by the rigorous standards of modern thought.”<sup>81</sup> To support this assertion, Morgan quotes Nietzsche from *Ecce Homo* as stating that eternal return is “the most scientific of all possible hypotheses.”<sup>82</sup> Unfortunately, there is little other evidence to indicate that Nietzsche considered eternal return a scientific (as opposed to a philosophical) principle or that this principle gained any scientific recognition at the end of the nineteenth-century.

While eternal return may not have attained a recognisable scientific context in the late nineteenth-century, it has gained a convincing scientific context in the late twentieth-century. To give an example of the convergence of the principles of eternal return and recursive symmetry, the chaologist David Ruelle explicitly references eternal return in his definition of recursive symmetry in *Chance and Chaos* (1991). He argues that the:

ideas of chaos apply most naturally to time evolutions with ‘eternal return.’ These are time evolutions of systems that come back again and again to near the same situations. In other words, if the system is in a certain state at a certain time, it will return arbitrarily near the same state at a later time.<sup>83</sup>

Ruelle acknowledges that Nietzsche’s concept of eternal return is fundamental to the science of chaos theory, and that it represents fundamentally the same concept as recursive symmetry. The appropriation of the principle of eternal return by the science of chaos theory further demonstrates the extent of the convergence of scientific and cultural worldviews. Given this convergence, and the slippage between eternal return and recursive symmetry, it is reasonable to suggest that texts which makes reference to one of these concepts simultaneously, if implicitly, refers to the other.<sup>84</sup> This slippage also effects literary texts, for when novels incorporate references to eternal return, it is reasonable to consider these references as implicit indicators of the presence of recursive symmetry. This hypothesis is particularly relevant to readings of Milan Kundera’s *The Unbearable Lightness of Being*: a novel that contains repeated references to Nietzsche’s eternal return.

<sup>81</sup> Morgan, *What Nietzsche Means*, p. 285.

<sup>82</sup> Nietzsche, quoted by Morgan in *What Nietzsche Means*, p. 285.

<sup>83</sup> Ruelle, *Chance and Chaos*, p. 86.

<sup>84</sup> Most chaos theory texts discuss recursive symmetry, but only Ruelle acknowledges that eternal return has been instrumental in defining recursive symmetry.

*The Unbearable Lightness of Being* describes the lives of three people: Tomas, Tereza, and Sabina; their relationships; and their responses to the Russian invasion of Czechoslovakia in 1968. Interwoven with the narrative of the three characters is an extended philosophical reflection on the concept of eternal return. *The Unbearable Lightness of Being* will be discussed only very briefly here, for while its representation of chaos theory principles is important, it is not within the scope of this chapter to develop a substantial critique of it. *The Unbearable Lightness of Being* has received a significant amount of critical attention, including Kundera's interpretation of eternal return, the moral themes of the novel, and its depiction of the 'Prague Spring' uprising of 1968. For example, Petra von Morstein discusses Kundera's interpretation of eternal return in "Eternal Return and *The Unbearable Lightness of Being*" (1989).<sup>85</sup> This theme is also addressed by Maria Nemcová Banerjee in *Terminal Paradox: The Novels of Milan Kundera* (1990).<sup>86</sup> In "Kundera, Nietzsche, and Politics: On the Questions of Eternal Return and Responsibility" (1993), Erik Parens discusses the political implications of eternal return.<sup>87</sup> Jolanta W. Wawrzycka examines the moral depths of Kundera's novel in "Betrayal as a Flight from Kitsch in *The Unbearable Lightness of Being*" (1992), and suggests that "the style of Kundera's novel approaches at times the dimensions of a profoundly philosophical inquiry."<sup>88</sup> Finally, in "From *Lightness* to *Immortality*: Kundera's Incestextual Abyss" (1992), Clarisse Zimra discusses the intertextual play that occurs between *The Unbearable Lightness of Being* and *Immortality* in the latter novel.<sup>89</sup>

Despite the variety of the response to *The Unbearable Lightness of Being*, nothing has been written about the correlation between Kundera's use of eternal return and the concept of recursive symmetry. However, just as the chronology of Baudrillard's

<sup>85</sup> Petra von Morstein, "Eternal Return and *The Unbearable Lightness of Being*," in *The Review of Contemporary Fiction*, Volume 9, No. 2, 1989, pp. 65-78.

<sup>86</sup> Maria Nemcová Banerjee, *Terminal Paradox: The Novels of Milan Kundera*, New York: Grove Weidenfeld, 1990, pp. 192-251.

<sup>87</sup> Erik Parens, "Kundera, Nietzsche, and Politics: On the Questions of Eternal Return and Responsibility," in *Philosophy Today*, 1993, pp. 285-97.

<sup>88</sup> Jolanta W. Wawrzycka, "Betrayal as a Flight from Kitsch in *The Unbearable Lightness of Being*," in *Milan Kundera and the Art of Fiction: Critical Essays*, edited by Aron Aji, New York: Garland, 1992, pp. 267-80, p. 268.

<sup>89</sup> Clarisse Zimra, "From *Lightness* to *Immortality*: Kundera's Incestextual Abyss," in *Milan Kundera*

interest in chaos theory appears to have been influenced by that of Lyotard's, so too Kundera's portrayal of eternal return may be implicitly informed by the developing cultural interest in chaos theory. Published in 1984, *The Unbearable Lightness of Being* dates from the period between Lyotard's and Baudrillard's early cultural analyses of chaos theory and the popularisation of chaos theory that occurred a few years later. Kundera alludes to chaos theory through his use of the butterfly effect and eternal return in *The Unbearable Lightness of Being*. He tells us that "Nietzsche called the idea of eternal return the heaviest of burdens," and suggests that in "the world of eternal return the weight of unbearable responsibility lies heavy on every move we make" (5). This is a reference to *The Gay Science*, in which Nietzsche discusses accepting the experience of eternal return: "the question in all and everything: 'do you want this again and again, times without number?' would lie as the heaviest burden upon all your actions."<sup>90</sup>

Kundera also considers what life would be like without eternal return in *The Unbearable Lightness of Being*. He argues that if eternal return did not exist, then life would have no meaning for us, because it would have no consequences: "the absolute absence of burden causes man to be lighter than air, to soar into the heights, take leave of the earth and his earthly being, and become only half real, his movements as free as they are insignificant" (5). The moral theme of *The Unbearable Lightness of Being* is the idea that eternal return exists, but that it is not possible for human beings to consciously experience it. Tomas tells us that "[w]e can never know what we want, because, living only one life, we can neither compare it with our previous lives nor perfect it in our lives to come" (8). This paradox is central to chaos theory. The concept of deterministic chaos, which defines events as predictable in theory but usually unpredictable in practice, is reflected in Kundera's explication of Nietzsche's eternal return. The physicist Marcelo Alonso echoes Tomas' enunciation of eternal return when he declares in *Organization and Change in Complex Systems* that "we cannot, in principle, predict future knowledge-induced changes, since that would mean that we already possessed that knowledge

*and the Art of Fiction: Critical Essays*, edited by Aron Aji, New York: Garland, 1992, pp. 320-47.

<sup>90</sup> Nietzsche, *The Gay Science*, p. 341.



now.”<sup>91</sup> While Kundera’s use of eternal return in *The Unbearable Lightness of Being* is literary, it also represents the importance of chaos theory in contemporary literature.

To understand the discontinuous and indeterminate complexity of history, Nietzsche and Kundera suggest that we would need to consciously experience eternal return, to live over and over again. While the process of eternal return occurs within our bodies in the form of biological self-organisation, we are often unable to synthesise the multiplicitous strands of eternally returning events to form a coherent understanding of the nonlinear causal structures of human events. Spanos comments that:

For the postmodern literary consciousness... the real is neither chronometric (Newtonian) nor spatialized (Kantian) time, a necessary time purged of contingency, but the radically *occasional*, the radically temporal... It is the opening/closing process of existential time that, in disseminating difference, activates and sustains *attention* to and *interest* in the phenomenal world.<sup>92</sup>

The eternal return that occurs around us in our everyday lives therefore remains predominantly indecipherable and inexplicable. While simple examples of eternal return, such as the changing of the seasons, can be easily understood, more complex examples can be beyond our comprehension. Heraclitus comments in one fragment that “men fail to notice what they do when they are awake, just as they forget what they do when asleep.”<sup>93</sup> This failure to observe the signs of eternal return, despite the fact that that we are aware of its possibility, only heightens our impression of loss, alienation, and bewilderment in the face of complexity: this is the social consequence of the paradox of deterministic chaos.<sup>94</sup>

<sup>91</sup> Alonso, Introduction to *Organization and Change in Complex Systems*, p. xvii.

<sup>92</sup> Spanos, *Repetitions* pp. 240-241

<sup>93</sup> Heraclitus, cited in *Early Greek Philosophy*, p. 101.

<sup>94</sup> The process of eternal return is also evident in Jorge Louis Borges’ short story “The Library of Babel,” which describes a mythical library which stores every possible text that can exist, an infinite library: “The Library is unlimited and cyclical. If an eternal traveller were to cross it in any direction, after centuries he would see that the same volumes were repeated in the same disorder (which, thus repeated, would be an order: the Order).” Borges, “The Library of Babel,” pp. 85-6. Casti cites Borges’ story as a good example of chaos and unpredictability. See Casti, *Complexification*, p. 289.

## THE EDGE OF CHAOS

According to Roger Lewin in “Order for Free” (1993) the concept of the ‘edge of chaos’ was conceived by Norman Packard to describe the area of maximum change and complexity between order and disorder.<sup>95</sup> Several American chaologists, including Chris Langton and Stuart Kauffman, have contributed to the development of the concept of the edge of chaos; Lewin paraphrases Langton in *Complexity: Life at the Edge of Chaos* to suggest that complexity occurs between total order and total randomness.<sup>96</sup> Lewin suggests that the edge of chaos is a point where maximum change may occur and, with reference to Langton, argues that “as you leave ordered territory and enter the region of chaos you traverse maximum computational capacity, maximum information manipulation.”<sup>97</sup> The edge of chaos is where maximum complexity and information processing takes place: it represents the best possible compromise between order and disorder, but it is also where one small perturbation can push an open system into complexification or collapse.

Kauffman uses the concept of the edge of chaos to describe the self-organisation of living systems, and argues that biological systems evolve towards the edge of chaos: where change and complexity flourish.<sup>98</sup> The edge of chaos represents a border between order and disorder: at the edge of chaos there is enough disorder to create new information, which is essential to evolution, and enough order to allow evolution or complexification to take place. The edge of chaos cannot be envisioned in terms of Euclidean space as an area of considerable width; if anything, the edge of chaos is razor thin - a precise point between order and disorder. Chaologists like Langton indicate that the concept of the edge of chaos is not only applicable to biological systems: as chaotic open systems, contemporary novels are drawn to their own edges of chaos, where maximum information manipulation and meaning production occurs.

The concept of the edge of chaos will be illustrated with reference to Milan Kundera’s concept of the border as he defines it in *The Book of Laughter and*

<sup>95</sup> Lewin, “Order for Free,” in *New Scientist* Volume 137, Supplementary, 13 Feb., 1993, pp. 10-11.

<sup>96</sup> Lewin, *Complexity: Life at the Edge of Chaos*, p. 10.

<sup>97</sup> *Ibid.*, p. 50.

*Forgetting* (1981) and *Immortality* (1991). The subject of the border is a topic that fascinates Kundera, and is one of the terms that he acknowledges as crucial to his work in *The Art of the Novel* (1988).<sup>99</sup> There are specific similarities between Kundera's concept of the border and the concept of the edge of chaos. In *The Book of Laughter and Forgetting*, Kundera declares that:

It takes so little, so infinitely little, for a person to cross the border beyond which everything loses meaning: love, convictions, faith, history. Human life - and herein lies its secret - takes place in the immediate proximity of that border, even in direct contact with it; it is not miles away, but a fraction of an inch [away]... (206-7).

Then, in *Immortality*, Kundera suggests that:

the world is at some sort of border; if it is crossed everything will turn to madness: people will walk the streets holding forget-me-nots or kill one another on sight. And it will take very little for the glass to overflow, perhaps just one drop: perhaps just one car too many, or one person, or one decibel. There is a certain quantitative border that must not be crossed, yet no one stands guard over it and perhaps no one even realizes that it exists (23).

The edge of chaos represents an intangible division between order and disorder.

Kundera tells us in *Immortality* that this border is "quantitative," but he also tells us that it is impossible to specify the location of this border or to judge when it is crossed. This is also the case with the edge of chaos: it is impossible to determine what will push a system over the edge of chaos. Kundera's border represents the same kind of indeterminate division between order and disorder as the concept of the edge of chaos. The most interesting characteristic of Kundera's concept of the border is that it defines social systems: it separates meaningfulness and meaninglessness, history and forgetfulness, sanity and madness. Human life exists in "immediate proximity" to the border; we exist in close proximity to the edge of chaos, and when the border is crossed, the meaning of life is lost.

<sup>98</sup> Lewin, "Order for Free," pp. 10-11.

<sup>99</sup> Kundera, *The Art of the Novel*, New York: Harper and Row, 1988, p. 124.

## THE ACCIDENT

Kundera hypothesises that in a life without eternal return, chance rules. He draws attention to the similarities between chance and everyday life in *The Unbearable Lightness of Being*, and strives to show that “day to day life is bombarded with fortuities or, to be more precise, with the accidental meetings of people and events we call coincidences” (51). Nietzsche’s concept of eternal return incorporates a recognition of the importance of chance in eternally recurring systems. According to Deleuze in *Nietzsche and Philosophy*, Nietzsche “identifies chance with multiplicity, with fragments, with parts, with chaos...”<sup>100</sup> This correlation between chance and chaos is perpetuated by chaologists, who define chance events not as random accidents but as events that are determined by complex and ambiguous initial conditions. They assert that chance events, which are commonly dismissed as accidents or as meaningless coincidences, fulfil pivotal roles in complex open systems. This section will examine the concept of the accident, and consider how chance events have been defined in causal systems from Nietzsche’s eternal return to chaos theory.

Nietzsche argues in *The Gay Science* that causality is marked by chaos and ambiguity: “[c]ause and effect: such a duality probably never exists - in truth a continuum confronts us, of which we isolate a few pieces...”<sup>101</sup> Nietzsche implies that this eternally recurring continuum is too complex for us to fully comprehend: the best that human perception can achieve is to study isolated fragments of causal systems. The reductionist approach to causal systems followed by classical science links discontinuous fragments of continuous systems into linear causal models of nonlinear causal systems. Due to the reduction of continuous, nonlinear events to discontinuous linear events, the resulting description of these systems bears little resemblance to the actual events being described. The reductionist methodology of modern science was scorned by Nietzsche: he refutes the usefulness of linear causal models by arguing that they are the product of specific modes of subjective perception, and that linear causal patterns not widely evident in ‘reality.’ In *Coping with Uncertainty*, Merry discusses the discrepancy between reality

<sup>100</sup> Deleuze, *Nietzsche and Philosophy*, p. 26.

<sup>101</sup> Nietzsche, from *The Gay Science*, quoted by Morgan in *What Nietzsche Means*, p. 283.

and our perception of it when he argues that “[p]eople create order by conceptually breaking up the natural interconnectedness between things.”<sup>102</sup> Our subjective desire for order interferes with our ability to objectively perceive reality; in the process of interpreting chaotic events, we so disrupt the evidence that we are unable to interpret it accurately.

The complex nonlinearity of causal systems has led some critics and historiographers to consider that historical events may be characterised as randomly occurring events or accidents. The Mexican poet and critic Octavio Paz, for example, provides a theory of the accident that corresponds closely to the causal implications of chaos theory. In *Symbolic Exchange and Death* (1993), Jean Baudrillard draws attention to Paz’s discussion of causality in *Conjunctions and Disjunctions* (1974).<sup>103</sup> Paz defines accidents in *Conjunctions and Disjunctions* as events that occur without reason, without expectation: they are effects without obvious causes:

Accidents are part of our daily life... The accident is the imminently probable. Imminent because it can happen today; probable not only because gods, spirit, cosmic harmony, and the Buddhist law of plural causality have disappeared from our universe but also because, simultaneously [the] confidant determinism of the nineteenth century has collapsed. The principle of indetermination in contemporary physics and Gödel’s proof in logic are the equivalent of the Accident in the historical world.<sup>104</sup>

The final sentence of this passage is the most telling: Paz considers the science of indeterminism, or what has been defined as the study of deterministic chaos, and the indeterminism apparent in human systems to be two examples of the same phenomenon. Paz’s concept of the Accident has special significance in the scheme of the literary and cultural interest of chaos theory, especially for Baudrillard, whose texts demonstrate the influence of Paz’s ideas about accidents and causality.

*Conjunctions and Disjunctions* predates the conception of chaos theory as a discipline of science, yet it anticipates the convergence of science and culture, particularly when Paz argues that the concept of the ‘Accident’ defines causality in postmodern culture. Paz argues that:

<sup>102</sup> Uri Merry, *Coping With Uncertainty: Insights from the New Sciences of Chaos, Self-Organization, and Complexity*, Westport: Praeger, 1995, p. 20.

<sup>103</sup> Baudrillard, *Symbolic Exchange and Death*, London: Sage, 1993, pp. 160-1.

<sup>104</sup> Octavio Paz, *Conjunctions and Disjunctions*, London: The Viking Press, 1974, pp. 111-2.

deterministic systems have lost their consistency and revealed an inherent defect. But it is not really a defect: it is a property of the systems, something that belongs to it as a system. The Accident is not an exception or a sickness of our political regimes; nor is it a correctable defect of our civilization: it is the natural consequence of our science, our politics, and our morality.<sup>105</sup>

For Paz, the “Accident has become a paradox of necessity: it possesses the fatality of necessity and at the same time the indetermination of freedom.”<sup>106</sup> People typically interpret events that they do not understand as accidents, as chance events.

The application of Paz’s concept of the Accident to social systems implies otherwise: that historical events are determined by actual, though obscure, causes. This cultural perception of the nonlinearity of causality is substantiated by the science of chaos theory. Deterministic chaos destabilises prediction and necessitates the development of other interpretations. Rather than attempting to identify the causes or initial conditions of social systems, we should examine the ongoing chaotic behaviour of social systems. Kundera proclaims in *The Unbearable Lightness of Being* that “it is right to chide man for being blind to... coincidences in his daily life” (52). The application of chaos theory to reading practice represents the development of one strategy designed to refute Kundera’s claim that we are blind to the nonlinear dynamics of social systems.

## BIFURCATION POINTS AND STRANGE ATTRACTORS

Bifurcation points signify the initiation of change in open systems, and occur when, in the words of Prigogine and Stengers, systems are pushed “beyond the threshold of stability”<sup>107</sup> and perturbations force systems to either collapse or evolve. A good example of a bifurcation point is when the surface tension of a body of water breaks, and ‘smooth’ ripples turn into ‘rough’ waves. The ripples become more and more unstable until they break, which is the bifurcation point, and the surface tension of the water turns into waves. Chaotic systems are able, to an extent, to cope with stresses, or perturbations that trigger bifurcations. Nicolis and Prigogine argue in *Self-Organization*

<sup>105</sup> *Ibid.*, p. 112.

<sup>106</sup> *Ibid.*, p. 112.

<sup>107</sup> Prigogine and Stengers, *Order out of Chaos*, p. 167.

in *Nonequilibrium Systems* that complex systems generally exist in metastable states.<sup>108</sup> Metastability allows complex systems to survive perturbations, but it can only protect systems against certain levels of fluctuation. When chaotic systems can no longer tolerate continual perturbation they collapse, triggering widespread change and reorganisation. Prigogine and Stengers argue in *Order out of Chaos* that “[w]henever we reach a bifurcation point, deterministic description breaks down. The type of fluctuation present in the system will lead to the choice of the branch it will follow.”<sup>109</sup> Bifurcation points represent a breakdown in prediction where the nature of the instability or perturbation becomes the only clue to the future behaviour of chaotic systems.

The concepts of the bifurcation point and the strange attractor will be examined in this section in relation to Italo Calvino’s *If on a Winter’s Night a Traveler*. The chaologist David Ruelle conceived the term ‘strange attractor’ to describe the attractors, or focal points, of chaotic systems.<sup>110</sup> All systems possess at least one attractor, which is a point that guides or ‘attracts’ behaviour. Attractors signify causal structures: they determine the behaviour of systems, and cause events to take place. Scientists identify four types of attractors: point, periodic, quasi-periodic, and ‘strange.’ The first three are linear, and their behaviour can be predicted. The fourth type of attractor, the strange attractor is, in contrast to the previous three, chaotic and unpredictable. Ruelle indicates in *Chance and Chaos* strange attractors cause the unpredictable behaviour of nonlinear dynamical systems.<sup>111</sup> To understand the behaviour of chaotic systems, it is necessary to identify and understand their strange attractors.

All of the principles of chaos theory that have been discussed in this chapter are represented in Italo Calvino’s *If on a Winter’s Night a Traveler* (1982), a multi-faceted narrative that describes two readers who search in vain for a single, linear, narrative hidden within multiplicitous, nonlinear, narratives.<sup>112</sup> This metafictional chase occurs in the context of a series of first chapters from different narratives that are linked together

<sup>108</sup> Nicolis and Prigogine, *Self-Organization in Nonequilibrium Systems*, p. 463.

<sup>109</sup> Prigogine and Stengers, *Order out of Chaos*, p. 177.

<sup>110</sup> Lorenz, *The Essence of Chaos*, p. 136; see also Briggs and Peat, *Turbulent Mirror*, p. 50.

<sup>111</sup> Ruelle, *Chance and Chaos*, p. 64.

<sup>112</sup> Italo Calvino, *If on a Winter’s Night a Traveler*. London: Picador, 1982 (*Se una notte d’inverno un viaggiatore*, 1979). This interpretation is designed to complement, rather than supplant, other interpretations of *If on a Winter’s Night a Traveler*.

by a series of publishing mistakes, misappropriations, and mistranslations. At the end of the first chapter of each new novel, the unnamed male ‘Reader’ starts reading the first chapter of another novel, hoping that it is the narrative he wants to read, and each time he realises that this new story is the ‘wrong’ narrative, which leads him to yet another narrative, and then another. Each time the Reader selects a new narrative to read, he moves further away from the original narrative. In the process of chasing this original narrative, the Reader becomes closer to the subject/object of his desire, Ludmilla, the female ‘Other Reader’ (for the sake of easing confusion in this section, the term ‘Reader’ refers to the character within *If on a Winter’s Night a Traveler*, whereas the ‘reader’ refers to external readers of Calvino’s novel).

Most critiques of *If on a Winter’s Night a Traveler* focus on its representation of sexual politics. In “Reading the (Post)Modern Text: *If on a Winter’s Night a Traveler*” (1989) Teresa de Lauretis concentrates almost exclusively on the sexual politics of the relationship between the Reader and Ludmilla.<sup>113</sup> Similarly, in *Understanding Italo Calvino* (1993), Beno Weiss focuses on the subject of sexual politics.<sup>114</sup> Furthermore, although Wiley Feinstein in “The Doctrinal Core of *If on a Winter’s Night a Traveler*” (1989) includes a short critique of the narrative’s structural complexities, he too discusses the sexual dynamics of the Reader and the Other Reader.<sup>115</sup> In comparison, there are relatively few critiques of *If on a Winter’s Night a Traveler* that develop different approaches to the narrative. One exception is Albert Sbragia’s “Italo Calvino’s Ordering of Chaos” (1993), which focuses on Calvino’s representation of chaos. Sbragia begins by quoting Calvino as saying that “[t]he conflict between the chaos of the world and man’s obsession with making some sense of it is a recurrent pattern in what I’ve written.”<sup>116</sup> Sbragia suggests that Calvino is acutely aware of the concept of

<sup>113</sup> Teresa de Lauretis, “Reading the (Post)Modern Text: *If on a Winter’s Night a Traveler*,” in *Calvino Revisited*, edited by Franco Ricci, University of Toronto Italian Studies Volume 2, Ottawa: Dovehouse Editions, 1989, pp. 131-45.

<sup>114</sup> Beno Weiss, *Understanding Italo Calvino*, Columbia: University of South Carolina Press, 1993.

<sup>115</sup> Wiley Feinstein, “The Doctrinal Core of *If on a Winter’s Night a Traveler*,” in *Calvino Revisited*, pp. 147-55.

<sup>116</sup> Albert Sbragia, “Italo Calvino’s Ordering of Chaos,” in *Modern Fiction Studies*, Volume 39, No. 2, 1993, pp. 283-306, p. 283.



deterministic chaos and that “much of his writing is involved with creating structures that investigate the question of order within disorder.”<sup>117</sup>

*If on a Winter's Night a Traveler* is primarily concerned with the issue of finding order and meaning in disordered information. It is surprising, therefore, that Sbragia does not examine *If on a Winter's Night a Traveler* in “Italo Calvino’s Ordering of Chaos,” which instead discusses Calvino’s early fictions and *Mr. Palomar*.<sup>118</sup> “Italo Calvino’s Ordering of Chaos” is nonetheless significant because it discusses the prevalence of the theme of deterministic chaos in Calvino’s writing. It constitutes a sound basis from which to develop a critique of the nonlinear dynamics of *If on a Winter's Night a Traveler*, which may be able to explain how it is simultaneously complex, ambiguous, and meaningful. *If on a Winter's Night a Traveler* was first published in Italian as *Se una notte d'inverno un viaggiatore* (1979): the same year as Prigogine’s and Stengers’ *La Nouvelle Alliance* and Lyotard’s *La Condition Postmoderne*. This historical convergence substantiates Sbragia’s hypothesis that Calvino was actively engaged in narrating the principles of chaos theory, and suggests that Calvino’s detailed references to chaos theory in *If on a Winter's Night a Traveler* may have originated from scientific, rather than cultural, sources.

Sbragia also provides other evidence to support this hypothesis. Firstly, Sbragia argues that Calvino was “an assiduous reader of *Scientific American*,” the popular science journal that participated in and contributed to the initial popularisation of chaos theory in the mid-1980s.<sup>119</sup> This is confirmed by Calvino himself, who tells us in *Six Memos for the Next Millennium* (1993) that “scientific books” were a “stimulus of the imagination” for him.<sup>120</sup> Secondly, Sbragia points out that Calvino makes familiar references to Shannon’s information theory and to the principle of self-organisation in his

<sup>117</sup> *Ibid.*, p. 294.

<sup>118</sup> Calvino in *Mr. Palomar* examines various instances that are chaotic in nature. For example, Palomar buys a pair of slippers in a market, but finds later that he has two odd slippers. At first he worries, thinking that this mistake has increased the disorder of the world. He thinks that “Every process of disintegration in the world is irreversible; the effects, however, are hidden... by the... virtually limitless possibilities of new symmetries, combinations, pairings.” Palomar then considers the possibility that his two odd slippers cancel out a former mistake - a previous customer may also have been given two odd slippers. This disintegration of order into disorder can also be perceived as a resolution of disorder into order. Calvino *Mr. Palomar*, San Diego: Harcourt Brace Jovanovich, 1985, p. 100.

<sup>119</sup> Sbragia, “Italo Calvino’s Ordering of Chaos,” p. 286.

<sup>120</sup> Calvino, *Six Memos for the Next Millennium*, London: Jonathan Cape, 1993, p. 70.

1967 essay “Cybernetics and Ghosts,”<sup>121</sup> thus providing evidence of Calvino’s long-standing interest in scientific ideas and principles. Calvino further demonstrates his familiarity with scientific principles in *Six Memos for the Next Millennium*, in which he states that when:

The universe disintegrates into a cloud of heat, it falls inevitably into a vortex of entropy, but within this irreversible process there may be areas of order, portions of the existent that tend toward a form, privileged points in which we seem to discern a design or perspective.<sup>122</sup>

Thirdly, Sbragia points out that Calvino wrote an appreciative review of Prigogine’s and Stengers’ *La Nouvelle Alliance* for the Italian newspaper *La Repubblica* in 1980.<sup>123</sup>

Fourthly, Sbragia argues that a manifestation of science’s acceptance of chaotic phenomena is evident in Calvino’s fictions.<sup>124</sup> Sbragia’s reference to the concept of paradigm shifts is essentially a reference to chaos theory; he informs us that “Calvino did not live to see the full emergence of chaos theory from its roots in thermodynamics and cybernetics, but he was part of the cultural milieu that grappled with the paradigm crisis.”<sup>125</sup> Calvino’s death in 1985 pre-dates the publication of Gleick’s *New Science* in 1987 and the explosion of popular interest in chaos theory, but Calvino was one of the first writers to examine the tremendous discursive possibilities of chaos theory. Sbragia establishes that Calvino was not only aware of the science of chaos theory around the time of the writing of *If on a Winter’s Night a Traveler*, but that he was actively interested in the literary implications of this new science. Calvino’s *If on a Winter’s Night a Traveler* is a striking example of how fictional texts contribute to the literary interpretation of chaos theory.

The strange attractor principle is evident within *If on a Winter’s Night a Traveler*. In *Leadership and the New Science* Wheatley appropriates the concept of the strange attractor to define human and social systems. Wheatley hypothesises that meaning is the

<sup>121</sup> Sbragia, “Italo Calvino’s Ordering of Chaos,” p. 287. See Calvino, “Cybernetics and Ghosts,” in *The Uses of Literature*, translated by Patrick Creagh, San Diego: Harcourt Brace Jovanovich, 1986, pp. 3-27, p. 8.

<sup>122</sup> Calvino, *Six Memos for the Next Millennium*, p. 70.

<sup>123</sup> Sbragia, “Italo Calvino’s Ordering of Chaos,” p. 288. See Calvino, “No, non saremo soli,” in *La Repubblica*, May 3, 1980.

<sup>124</sup> Sbragia, “Italo Calvino’s Ordering of Chaos,” p. 284.

<sup>125</sup> *Ibid.*, p. 301.

strange attractor that governs such human systems as relationships, histories, and narratives.<sup>126</sup> Attractors determine the behaviour of open systems; strange attractors are the chaotic determinants of nonlinear dynamical systems. Whereas in physical systems attractors take the form of physical properties or concepts, like water surface tension or gravity, in human systems attractors manifest themselves as immaterial properties or concepts. The strange attractors of human systems include physiological properties, but more commonly take the form of psychological desires, emotional impulses, and abstract ideas. The strange attractor of meaning strongly determines human behaviour. We look for meaning in the world, and make decisions according to what does, and what does not, possess meaning for us. The search for strange attractors represents the search for meaning.<sup>127</sup>

The search for the strange attractor of meaning is an important theme in *If on a Winter's Night a Traveler*. To give an example of the idea that meaning itself is a strange attractor that determines the lives of the characters in *If on a Winter's Night a Traveler*, it is necessary to focus on the desire of the Reader to read a single narrative, and to obtain meaning from this narrative. Because it remains unobtainable, this narrative is invested with great potential meaning by the Reader and Other Reader. The elusive nature of the texts read by the Reader and Other Reader suggests that meaning may be present, but that the nature of this meaning is indeterminate. By introducing ambivalence and ambiguity into the order/disorder dichotomy, deterministic chaos blurs the difference between information and meaning. This blurring of information and meaning creates problems for the characters in *If on a Winter's Night a Traveler*, and it is a significant influencing factor on their behaviour. The Reader and Other Reader make decisions about their lives, about where they go and what they do, based on their search for the strange attractor of meaning.<sup>128</sup>

<sup>126</sup> Margaret J. Wheatley, *Leadership and the New Science: Learning about Organization from an Orderly Universe*, San Francisco: Berrett-Koehler, 1992, pp. 134-6.

<sup>127</sup> This is an idea that will be further examined in the following chapter.

<sup>128</sup> In this situation, the Reader and Other Reader are simultaneously participants in the systems they are attempting to observe and study. Whereas in science the observer is generally considered extraneous to the system being studied, in these circumstances the observers cannot remain separated from the events they are examining. The idea, taken from quantum theory, that systems cannot be observed without being influenced or effected in some way is also a significant feature of *If on a Winter's Night a Traveler*. I must thank Professor John A. McCarthy for his comments in relation to this issue. McCarthy, personal

Sbragia argues that Calvino's characters suffer from an acute sensitivity to disorder.<sup>129</sup> This sensitivity to disorder may be one of the effects of strange attractors. The Reader, for example, appears particularly sensitive to unexpected events in his own life, as his desperate search for the original narrative intensifies. Other characters are also sensitive to disorder. Some appear implicitly aware of deviations in the plans of others, while others become aware that their own plans are never fulfilled. In the bar at the railway station in the opening chapter "If on a winter's night a traveler," someone says that "Chief Gorin is arriving later than all predictions tonight" as the police chief enters the bar (23). The second-person narrator of "Chapter two" informs us that "[t]he thing that most exasperates you is to find yourself at the mercy of the fortuitous, the aleatory, the random, in things and in human actions" (26). In another instance, a character in the chapter "Leaning from the steep slope" works for a short period of time reading meteorological equipment. He declares that "only the checking of the meteorological instruments enabled me to master the forces of the universe and recognize an order in it" (56). This passage makes clear the relationship between chaos and order, power and powerlessness, in relation to the character in *If on a Winter's Night a Traveler*. Calvino's characters are subsumed by their chaotic environments, and it is only in brief moments that they feel they have overcome this chaos.

The recurrence of first chapters in *If on a Winter's Night a Traveler* is an example of recursive symmetry, for each new chapter contains features of the previous chapter while also being different to it. "Professor Uzzi-Tuzii" of the department of "Bothno-Ugaric Languages and Literatures" explains that the first chapter of *Outside the town of Malbork* by Tazio Bazakbal is also the first chapter of the Cimmerian novel *Leaning from the steep slope* by Ukko Ahti (46). The characters and settings in *Leaning from the steep slope* have the same names as those in *Outside the town of Malbork*. There is further evidence of recursive symmetry in the confusion about the real versus fake editions of the "Latest Best Seller by Silas Flannery," *In a network of lines that enlase* and *In a network of lines that intersect* (127). Sbragia argues that the trope *mise en abyme*, the "the mirror-like reproduction of a figure or text within itself," is a meaningful

correspondance, August 1998.

<sup>129</sup> Sbragia, "Italo Calvino's Ordering of Chaos," p. 292.

feature of *If on a Winter's Night a Traveler*.<sup>130</sup> Although he does not elaborate on the similarities between *mise en abyme* and recursive symmetry, Sbragia uses it to describe textual recurrence. If the concept of recursive symmetry is substituted for the trope of *mise en abyme*, Sbragia's reading of *If on a Winter's Night a Traveler* remains valid.<sup>131</sup>

The bifurcation principle effectively explains how *If on a Winter's Night a Traveler* changes from one chapter to another. At the end of each first chapter, the text bifurcates into a new chapter. Bifurcations points mark a change in complex open systems and signify the operation of eternal return. In these conditions, the text bifurcates into a new form which nonetheless has similarities to its past form. Each new chapter continues themes from the preceding chapter. For example, *Leaning from the steep slope* develops ideas established in *Outside the town of Malbork*. The Reader and Ludmilla determine that “*Without fear of wind or vertigo* is not *Leaning from the steep slope*, which, in turn, is not *Outside the town of Malbork*, which is quite different from *If on a winter's night a traveler*” (75). The Reader and Ludmilla notice that each new chapter is different in style from the one that precedes it, but they also notice that each new chapter has links to its predecessor. In each change, the new narrative retains recognisable, though rearranged and reorganised, features, characteristics, and signs of the previous narrative.

Calvino references the principle of the butterfly effect or the ‘sensitive dependence on initial conditions’ in *If on a Winter's Night a Traveler* in at least two locations. Firstly, the first person narrator of the chapter “If on a winter's night a traveler” tells us that he “would like to swim against the stream of time: I would like to erase the consequences of certain events and restore an initial condition” (18). Chaos theory informs us that such a desire is impossible: once the initial conditions of a system are set, they cannot be changed. Secondly, the chapter “If on a winter's night a traveler” provides a summary of the eventual behaviour of the Reader as he responds to the numerous narratives in the text:

<sup>130</sup> *Ibid.*, p. 297.

<sup>131</sup> This substitution indicates that although the recurrence in *If on a Winter's Night a Traveler* has already been examined, it has not previously been considered evidence of Calvino's interest in chaos theory.

every moment of my life brings with it an accumulation of new facts, and each of these new facts brings with it consequences; so the more I seek to return to the zero moment from which I set out, the further I move away from it: though all my actions are bent on erasing the consequences of previous actions and though I manage to achieve appreciable results in this erasure, enough to open my heart to hopes of immediate relief, I must, however, bear in mind that my every move to erase previous events provokes a rain of new events, which complicate the situation worse than before and which I will then, in turn, have to try to erase (18).

Characters desire to turn back time in *If on a Winter's Night a Traveler*, to return to earlier times in order to avoid making mistakes, to prevent events from happening, or to determine that other events will happen.

Reader and Ludmilla agree that none of the narratives they have started to read are the original narrative. Consequently, they attempt to restore the initial conditions of the narrative they want to read. In their first attempt to restore the initial conditions of the narrative, they return to the bookshop where they purchased *If on a Winter's Night a Traveler*, but this action only serves to further complicate their search. Ludmilla concludes that “[t]he only thing we can do is go to the source of all this confusion”(75), and she persuades the Reader to visit the publisher of *If on a Winter's Night a Traveler*. The Reader consequently visits the publishing company, and speaks to Mr. Cavedagna, who appears to be involved in all aspects of the company’s operations. Cavedagna uses a metaphor based on the bifurcation principle and the concept of the butterfly effect to describe the fragile complexity of the publishing process, and the ease with which it is corrupted by entropic information: he tells the Reader that “[a] publishing house is a fragile organism... If at any point something goes askew, then the disorder spreads, chaos opens beneath our feet” (80). Cavedagna echoes Prigogine and Stengers, who argue in *Order out of Chaos* that the “existence of an instability may be viewed as the result of a fluctuation that is first localized in a small part of the system and then spreads and leads to a new macroscopic state.”<sup>132</sup> In other words, “[l]ocal events have repercussions throughout the whole system.”<sup>133</sup> This concept is clearly represented in *If on a Winter's Night a Traveler*.

Finally, Calvino refers to Shannon’s information theory in *If on a Winter's Night a Traveler*. In “Chapter two” we discover that *If on a winter's night a traveler* by ‘Italo

<sup>132</sup> Prigogine and Stengers, *Order out of Chaos*, p. 178.

<sup>133</sup> *Ibid.*, p. 180.

Calvino' actually contains multiple copies of the first signature of *Outside the town of Malbork* by Tazio Bazakbal (27). The narrative voice in "Chapter two" tells us that the text is "degraded into a swirling entropy," it is so "shaken by redundancies and noises" that it is "reduced" into "information" (26). The potential meaning of the text is obscured by the disordered arrangement of its information. With reference to Sbragia's trope of *mise en abyme*, the reader becomes aware that *If on a Winter's Night a Traveler* is complexly ordered, and that the interconnections between its chapters destabilise the possible meanings of the text. Sbragia achieves two important objectives in "Italo Calvino's Ordering of Chaos." Firstly, he provides firm evidence to support his hypothesis that Calvino was well acquainted with the principles of chaos theory, and that this familiarity could have only been the product of Calvino's direct reading of scientific texts. Secondly, he demonstrates that a literary appreciation of chaos theory can result in the formation of new readings of Calvino's fictions and other novels. This reading of *If on a Winter's Night a Traveler* indicates that an effective method for examining novels which represent and embody deterministic chaos is to employ a literary criticism specifically informed by chaos theory.

## SUMMARY

In *Six Memos for the Next Millennium* Calvino asks: "[i]s it legitimate to turn to scientific discourse to find an image of the world that suits my view?"<sup>134</sup> This question similarly concerns other literary interpreters of chaos theory; is the appropriation of chaos theory a legitimate endeavour, and how can it be substantiated? Calvino responds in the affirmative to his own rhetorical question by suggesting that the scientific worldview to which he refers is itself a reflection of a much older worldview that is represented in the poetry of Lucretius.<sup>135</sup> Calvino affirms the epistemological legitimacy of the cultural use of chaos theory by demonstrating that the values of chaos theory do not belong entirely to science: they also possess philosophical and literary origins. By

<sup>134</sup> Calvino, *Six Memos for the Next Millennium*, p. 8.

<sup>135</sup> *Ibid.*, p. 8. Calvino's reference to Lucretius alludes to his earlier reading of *Order out of Chaos*; Prigogine and Stengers discuss Lucretius and his concept of the 'clinamen' in *Order out of Chaos*, pp.

combining scientific principles and philosophical values, *If on a Winter's Night a Traveler* and *The Unbearable Lightness of Being* embody the convergence of chaos theory and postmodernism. In exploring this convergence through contemporary novels, critics draw attention to the symbiotic relationship between entropy and existence envisioned by Nietzsche. Shannon's declaration that information and entropy are "identical" rather than "opposites" is particularly important, for it indicates that entropy is not only a measure of disorder but also of information.<sup>136</sup>

This chapter has indicated that interpretations based on the principles of chaos theory is well suited to making sense out of the multiplicitous complexity of contemporary novels, and that the Second Law and Shannon's information theory provide fundamental structures from which new hypotheses about the nature of open narrative systems may be developed. One of the fundamental principles of chaos theory is that information is abundant yet obtuse: the behaviour of open systems is so complex and chaotic that it often cannot be understood. Chaologists are concerned with elucidating the coherence of chaotic systems: Prigogine and Stengers comment in *Order out of Chaos* that "[o]ne of the most interesting aspects of dissipative systems is their coherence,"<sup>137</sup> and John H. Holland argues in *Hidden Order: How Adaption Builds Complexity* (1995) that "complex systems show coherence in the face of change."<sup>138</sup>

Critics are also fascinated by the paradoxical coexistence of chaos and coherence in many contemporary novels, and suggest that analysing their structures may reveal how chaos and order coexist. At the heart of the application of chaos theory to literary criticism is the idea that information behaves like energy: information flows through culture and narratives in the same way that energy flows through open systems. Kundera postulates in *Immortality* that we need an "existential mathematics" (253) to make sense of our experience of flux and uncertainty, to measure and map the flow of energy through human systems. The literary use of chaos theory in both fictional and critical guises provides surprising and exciting evaluations about the symmetry and order within

141, 303.

<sup>136</sup> Hayles, *Chaos Bound*, p. 49.

<sup>137</sup> Prigogine and Stengers, *Order out of Chaos*, p. 171.

<sup>138</sup> John H. Holland, *Hidden Order: How Adaption Builds Complexity*, New York: Addison-Wesley, 1995, p. 4.



social systems, and furnishes contemporary critical discourse with something that approximates Kundera's existential mathematics.