UNIVERSITI PUTRA MALAYSIA

RECAPTURING THE TIMELESS PAST IN SELECTED SCIENCE-BASED POSTMODERN BRITISH PLAYS THROUGH LENS OF CHAOS THEORY

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By

KHALID AHMAD YAS

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

To my brother Muhammad

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

RECAPTURING THE TIMELESS PAST IN SELECTED SCIENCE-BASED POSTMODERN BRITISH PLAYS THROUGH LENS OF CHAOS THEORY

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July 2018

Chairman : Associate Professor Arbaayah Ali Termizi, PhD
Faculty : Modern Languages and Communications

Recapturing the past is a marked feature of postmodern science plays. McBurney, Wertenbaker, and Stephenson established themselves vigorously in historical representations to trace both the root and the fruit of a scientific phenomenon. Unlike traditional plays; where the events are chronologically and spatially fitted into a linear causal process, contemporary science dramas created by the dynamic interaction of all theatrical elements and governed by an internal logic simulate the structure and behaviour of a chaotic system. Due to this similarity, the study utilises the key-facets of chaos theory, i.e., The Butterfly Effect, Strange Attractors and Recursive Symmetries, as a theoretical and methodological framework to investigate how timeless past can secure a better understanding of the fragmented reality, and how the science of chaos and the selected science plays are interrelated in providing answers to the main characters' most pressing questions about the origin, purpose, and end of life. It also endeavours to examine how chaos key-facets can help in identifying the inciting events that trigger conflict, recognizing thematic concepts that control and guide the behaviour of the characters, and exposing order amid fragmentation and formlessness of the selected texts, which in turn can elucidate the significance of a cross-discipline approach, chaos theory, in reading the chosen science dramas. While *Mnemonic* and *A Disappearing Number* appropriated the physiological process of remembering and mathematical patterns to tackle concepts like identity and eternity, *After Darwin* and *An Experiment with an Air Pump* employed biological and social Darwinism, cadavers and genetics to address issues related to the post-Darwinian world and the danger of extending the natural selection to society. The double frame of a story from the past interwoven with another one from the present is used deliberately to allow each period to comment on the other. However, at the end of each drama, time and place disappeared, the personal turned into collective, and the fragmented, intertwined stories are combined to present a universal image. While Alice of *Mnemonic* abandons her personal quest for identity

to embrace a bigger one, the whole humanity, Al of *A Disappearing Number* realises that a full union with a beloved is possible, but only in the world of infinity. Lawrence *of After Darwin* presents adaptation as a solution to survive the post-Darwinian world. Instead of resisting evolution, one has to be adaptable. Endowed with brains work independently, humankind is the only species qualified enough to turn the table against the brutality of natural selection and establish its own values. Whether to understand or change the world, Fenwick and Ellen of *An Experiment with an Air Pump* state openly that science is not entirely morally-free, and heart should come first sometimes. Instead of being a tool of liberation, science in a market-driven culture could be turned into a weapon of oppression and discrimination. By interweaving past with the present, the playwrights reveal not only the level of determinism, but also how chaos works in the universe. It occurs when human desires disrupt the natural sequence of order and spark a chain reaction. Such an act operates like the butterfly effect, where reversing the process or predicting the consequences becomes so difficult. Briefly, the achievement made by the selected dramas lies not only in presenting hard science in an accessible way or challenging the old axiom that art and science cannot coexist, but also in merging universal humanism with contemporary science to reveal that Man is not only affected by the chaotic inclination of the world, but he is also a fundamental part of it. He can create as much disorder as order and can affect change within a system through his own choice. The study can be further developed to cover some more aspects. A survey study can be conducted to trace the evolution of science play from *Dr. Faustus* until the present time as the current research focuses on the last stage of this development. The study also can be taken as a springboard to compare between American and British science dramas. Due to its rich language and method, chaos theory can also be extended to include classical literature; Shakespearean tragedies are one possible area.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGLAHIRAN SEMULA MASA LAMPAU ABADI DALAM DRAMA INGGERIS BERDASARKAN SAINS MELALUI LENSA TEORI HURU-HARA

Oleh

KHALID AHMAD YAS

Julai 2018

Pengerusi : Profesor Madya Arbaayah Ali Termizi, PhD
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Pengwujudan semula kala lampau merupakan ciri penandaan bagi drama Sains pascamoden. McBurney, Wertenbaker dan Stephenson memantapkan kedudukan mereka dengan gigihnya dalam representasi sejarah bagi mengesan kedua-dua punca dan hasil sesuatu fenomena saintifik. Bukan seperti drama tradisional; iaitu acara adalah secara kronologi dan spatial dimuatkan ke dalam proses kausal linear, drama Sains kontemporari digubah melalui interaksi dinamik bagi semua elemen teatrikal dan ditunjangi oleh logik internal yang mensimulasikan struktur dan tingkah laku sesuatu sistem kekacauan. Hal tersebut mungkin eratik bagi pemerhati yang biasa, tetapi hal tersebut mempunyai struktur dalaman mereka sendiri. Disebabkan kesamaan tersebut, kajian ini menggunakan faset kunci teori huru-hara, iaitu Kesan Kupu-Kupu, Tarikan Pelik dan Simetri Rekursif, sebagai kerangka teoritikal dan metodologikal bagi analisis; untuk memperlihatkan susunan yang tampaknya tidak tersusun, dan menerokai peranan lampau dalam pemahaman masa hadapan. Ia juga mengkaji kaedah dramaturgikal dan struktural dan menyelidiki ke dalam tema cinta, persahabatan, kepercayaan, dan kemahuan sendiri di samping berbincang tentang persoalan yang berkaitan dengan asal, tujuan dan kesudahan kehidupan. Manakala *Mnemonic* dan *A Disappearing Number* memetik pola dan pendapat dari neurologi dan matematik, *After Darwin* dan *An Experiment with an Air Pump* memetik dari evolusi dan genetik. Bagi dua yang pertama bersesuaian dengan proses fisiologikal pengingatan dan siri matematik bagi menangani konsep seperti identiti dan eterniti,manakala yang dua lainnya menggunakan biologikal dan sosial Darwinan, kadaver dan genetik bagi memperkatakan isu yang berkaitan dengan dunia pascaDarwinan dan bahaya memperkembangkan pemilihan natural kepada masyarakat. Dwikerangka cerita dari lampau terjalin antara satu sama lain dari masa ini secara sengaja digunakan bagi membenarkan setiap zaman memberikan komen

terhadap mereka. Walau bagaimanapun, pada penghujung setiap drama, masa dan tempat ditiadakan, aspek personal bertukar menjadi kolektif, dan cerita yang dipecahkan , terjalin telah disatukan untuk menggambarkan imej universal. Manakala Alice dalam *Mnemonic* mengetepikan hasrat personalnya untuk memberikan yang lebih besar, keseluruhan komuniti, Al of *A Disappearing Number* merasai bahawa penyatuan keseluruhannya dengan yang tersayang adalah pasti, tetapi hanya dalam dunia infiniti. Lawrence dalam *After Darwin* mempersembahkan pengadaptasian sebagai suatu penyelesaian bagi kelangsungan dunia pascaDarwinan. Daripada menentang evolusi, Manusia haruslah dapat mengadaptasi. Dengan dianugerahi minda yang dapat bekerja secara independen, hanya manusia merupakan spesis yang amat layak menukar keadaan daripada kekejaman pemilihan semula jadi dan mewujudkan nilai mereka sendiri. Sama ada untuk memahami atau mengubah dunia, Fenwick dan Ellen dalam *An Experiment with an Air Pump* menyatakan secara terbuka bahawa Sains bukan sepenuhnya tanpa moral dan hati kadang-kadang harus datang dahulu. Daripada menjadi alat pembebasan, Sains dalam budaya berpandukan pasaran dapat ditukar kepada senjata penindasan dan diskriminasi. Dengan penjalinan lampau dengan masa hadapan, pengarang lakon memperlihatkan bukan sahaja tahap determinasi, tetapi juga bagaimana huru-hara terjadi dalam alam semesta. Ia terjadi apabila keinginan manusia merosakkan urutan semula jadi sesuatu aturan dan mencetuskan reaksi jaringan. Tindakan tersebut beroperasi seperti kesan kupu-kupu ,ketika menterbalikkan proses tersebut atau meramalkan akibat menjadi sangat sukar, dan di sini datangnya peranan pemilihan manusia. Ia masih merupakan proses yang penting. Ringkasnya, pencapaian yang diperoleh oleh drama terpilih bergantung bukan sahaja pada mempersembahkan Sains tulen dalam cara yang dapat diakses atau mencabar aksiom lama bahawa seni dan Sains tidak boleh wujud bersama, tetapi juga dalam menggabungkan humanisma sejagat dengan Sains kontemporari bagi memperlihatkan bahawa Manusia bukan sahaja terjejas oleh kecenderungan huru-hara dunia, tetapi juga merupakan bahagian asas. Dia boleh mencipta begitu banyak kecelaruan sebagai urutan dan boleh menyebabkan perubahan dalam sesuatu sistem melalui pilihannya sendiri.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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Declaration by graduate student

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
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CHAPTER 1

INTRODUCTION

"*Deep in the human consciousness is a pervasive need for a logical universe that makes sense. But the real universe is always one step beyond logic.*" Frank Herbert

1.1 Background of the Study

The drastic move in viewing the world from Newtonian to chaotic worldview has questioned not only solid scientific facts, but also the way we perceive reality. The Newtonian clockwork model is replaced by the waterfall model of chaos (Hayles, 1991). The world is closer to a great thought than a gigantic machine ruled by the immutable laws of cause and effect (Rosenblum and Kuttner, 2006). Such a shift in western thinking has affected all branches of knowledge, broken all borders that divide different disciplines, presented a new methodology and articulated a new vision of the world. Chaos theory, as Kellert (1994) explains, does not present "predictions of quantitative detail, but of qualitative features." It does not expose "causal processes [rather] display geometric mechanisms, and it does not yield law-like necessity but reveals patterns" (p. 96).

In fact, the unprecedented zeal for chaos can be measured by the ever-broadening range of its applications. It is utilised in a variety of disciplines: astronomy employs it to the motion of comets, stars, and satellites, physics applies it to the movement of atoms and electrons, mathematics to address problems never tried before, biology to examine the populations of birds and insects and meteorology to forecast the weather. Apart from hard science, chaos has also been applied to market, management, psychology, education, family system, and finally to football matches (O'Hare, 1996).

Chaos theory has also stirred the artistic imagination that looks for new tools and fresh methodology. Literary criticism has considerably expanded its terminology to include terms like the butterfly effect, strange attractors, tipping points, open systems, self-organisation, etc. In the process, it has also gained more than new vocabulary: it has appropriated a new perspective as well (Wilcox, 1996). Theorist N. Katherine Hayles in *Chaos Bound* (1990) has utilised this new paradigm in interpreting contemporary literature. She exploited aspects of chaos theory to reveal the interconnectedness between literature, science, and culture. Holding BSc in Chemistry and Ph.D. in English, Hayles scrutinises the correspondences between chaos, post-structuralism and the works of Italo Calvino, Stanislaw Lem, Henry Adams and others. Following Hayles' steps, critic Harriett Hawkins in her book *Strange Attractors* (1995) expanded the application of chaos theory to cover a period ranging from 17th-century to 20th- century. She examined the relation between the

metaphors of chaos and early writers like Milton and Shakespeare as well as some contemporary ones.

Conversely, William W. Demastes has discussed in his book *Theatre of Chaos* (2005) contemporary theatre from the perspective of quantum physics and chaos theory. Michael Patrick Gillespie in *The Aesthetics of Chaos* (2008) recognised a severe drawback in most literary criticism: it is linear and governed by cause and effect logic. He applied the new science as a new approach to literature as it promotes diversity and nonlinearity. He covers a wide range and different genres from the *Book of Job* to *Harry Potter*.

As for theatre, it has moved to a new territory, hard science. The latter, according to Barr (2008), can provide theatre with the conflict, tragic hero and above all the ethical dilemmas, the crux of the drama. Drama is not only a text performed on stage rather a life recreated vividly through performance. And this double function is what enables it to bridge the gap between science and literature where the unspoken implications of scientific theories can be benefitted from much on stage. To Demastes (1994): "the chaos model may very well be an essential tool for future research into modern and postmodern drama (or all contemporary literature?)" (p. 252).

As a manifestation of chaos and fragmentation, contemporary British play in general and science play, in particular, are not an exception to this alteration. Their method of depicting the world has been changed into a process where the audience, actors, props, and space interact collectively to experience different kinds of reality. It is ruled by an internal logic and guided by hidden patterns created by the interplay of all theatrical elements. By utilising unfinished narratives, imagistic and fragmented stories, and blending different cultures and ages within a nonlinear timeline, postmodern science drama seeks to break the habitual ways of perceiving reality, and to push the audience to experience various levels of awareness and ultimately form their own (Barr, 2006).

Viewed in both performance and textual form, conventional texts have a predetermined narrative structure in which dialogue, characters, and plot are fit forcibly. To States (1985), it is like "a closed field of force" in which every single detail is "temporally and spatially linked:" in sum, it is "a world permeated with causality" (p. 135). Postmodern texts, on the other hand, are a series of events, guided by a dynamic, internal framework. Like any chaotic system, they appear outwardly erratic; but, inwardly, they are governed by internal logic. While classical texts are predictable and compact, postmodern ones are expandable and unpredictable. They prosper on the disorder and expansion. The difference between the two modes is similar to the difference between a predetermined linear trajectory and a nonlinear chaotic one in which no one can expect what will happen next. In the former a flap of a butterfly's wings means nothing, but in the latter, such insignificant event will be magnified and repeated until it becomes a motif upon

which the whole structure is based. In a nutshell, while one system pursues an apparent pattern exists independently of the literary work, the other depends on the interaction of all elements to create a pattern.

The selected plays are *Mnemonic* (1999), *A Disappearing Number* (2007) conceived and devised by Simon McBurney, Complicité, and *After Darwin* (1998), *An Experiment with an Air Pump* (1998) by Timberlake Wertenbaker and Shelagh Stephenson. The first two dramas quoted ideas and patterns from neurology and mathematics to approach the intangible and the invisible. They belong to Theatre de Complicité, whose style is highly physical, stunningly visual and structurally fragmented combining modern technology as a tool facilitating storytelling. Chapter two, section 2.2 secures an adequate background for this kind of theatre as understanding it helps much in comprehending the selected texts. Quoting ideas and patterns from evolution and genetics, the second two dramas address issues related to Darwin's legacy, the challenges face this theory and the ideology it engendered. Chapter three, section 3.2.4 secures a sufficient background as the emergence of chaos theory as a new paradigm shift in science and the discovery of the double helix or DNA structure occurred concurrently. While the first helps in presenting a different interpretation of evolution, the second softens the earth to the appearance of the science of genetics.

All the selected dramas are science-based postmodern British dramas authored within the period of the boom of chaos theory. They all tackle stories quoted from science, i.e., biochemistry, mathematics, evolution, and genetics. The playwrights incorporated these sciences into the very texture of structure, performance, and thematic content. Science is utilised not only as a new language, but also an impetus for experimentation in performance. In short, it is integrated into both form and content where images, metaphors, and patterns quoted from science are translated into scenography and dramaturgy.

Structurally, they all are meta-texts based on the technique of a play within a play where a fictional story from the present is interwoven with true one from the past. The picture of the present is the reflection of the one taken from the past. Hence, recapturing the past is a recurring theme in these plays. It is a marked feature of postmodern science plays since the 1990s. They root themselves vigorously in historical representations to trace both the roots and the fruit of the scientific phenomenon, and also, to back the artistic discourse by science's authority. Sometimes haunting but always transformative, the past is no longer used as a metaphor for the present rather has its own autonomy. It is connected to but separated from the present. The double time frame here is used deliberately to help build multilayered dramas and facilitates a profound philosophical debate with reflection on both periods.

1.2 The Statement of the Problem

Reviewing relevant literature, one is struck by the paucity of studies dedicated to the applied aspect of chaos theory. Previous studies related to the theory fall into three categories. They either trace the evolution and the first germ of chaos theory as the case with Scott's *Chaos and the Microcosm* (2009) and Miyuki's study *The Silver Lining of Literature and Science* (2014) or focus on the sociocultural impact and the literary interest in this epistemological transition from Newtonian to chaotic worldview, e.g. Ward's dissertation *The Literary Appropriation of Chaos Theory* (1998), Varela's *Vortex to Virus, Myth to Meme* (2004), Aarnio's *Rhetoric and Representation* (2008) and Polvinen's *Reading the Texture of Reality* (2008). The third group is that of researchers who tried to espouse chaos theory with other theories, e.g. postmodernism as the case with Manzoor's dissertation *Chaos Theory and Robert Wilson* (2003), psychoanalysis, e.g. Benzon's study *A Poetics of Chaos: Schizoanalysis and Postmodern American Fiction* (2006) or quantum physics as Pritzker did in her thesis *Tom Stoppard: Humanizing Chaos* (2011).

Texts selected, on the other hand, have not been well-explored notably through the lens of chaos theory. Previous studies conducted were mainly in the form articles or extensive research papers. Though there are few studies, they either tackle plays chosen theatrically, i.e. scenography, physicality, the role of the director, as the case with Hunter's study *Theatrical Wonder* (2005), Hickie's *Scenography as Process in British Devised and Post-dramatic Theatre* (2008) and Sidiropoulou's *The Theatre of the Director—Auteur* (2009) or thematically, i. e. the development of science play or gender as the case with Niekerk's *Theatre and Science* (2002), Malinowska's *Staging the Scientist* (2014) and Rosier's *Gender and Performance in Contemporary Plays by Women* (2000).

As less attention is paid to the applied aspect of chaos theory and researchers were not that enthusiastic: they only tackled one aspect and hardly touched another within a literary work analysed. Also, it is quite difficult to find a study that examines both the structural and thematic aspects of texts selected within a clear framework, in particular, through the lens of chaos theory. Thus, this interdisciplinary study intends to fill this gap through the application of key-concepts of chaos theory, i.e. the Butterfly Effect, Strange Attractors and Recursive Symmetries as an intellectual and methodological framework to analyse plays selected thematically and structurally to probe the fragmented world of these dramas in order to look into the hidden order underlying the apparent chaos, and also to examine how recourse to the past can assist in comprehending the fragmented picture of the present. Through a chaotic nonlinear reading, the study will scrutinise the dramaturgical and structural methods and delve into themes of love, friendship, faith and free will while arguing within questions related to the origin, purpose, and end of life.

The research also brings fresh insight into the discourse of drama and science interconnectedness. Though different in approaches, they are naturally interrelated in their quest for answering Man's most pressing questions about the origin, purpose or end of life in a world that inclines naturally towards uncertainty and unpredictability. To Hawking (2011), Barr (2006) and Shaffer (1998), science in the contemporary world has seized the place of both philosophy and religion. The collapse of rational philosophy and religious myth as a source of meaning and the radical shift from a Newtonian to chaotic worldview made people turn to science for answers.

Hence, this study arose from the need to tackle plays selected from an alternative perspective. Nonetheless, it does not mean in any way to eclipse other interpretations, but rather offering a different one owing in part to the similarity between contemporary scientific inquiry and performance techniques and in part to the tremendous impact of scientific theories that makes science a compelling subject for theatre and the scientist a surrogate for clerics and armchair thinkers. In short, chaos theory can lend theatre criticism a different perspective, mindset and analytical tools to probe texts lie beyond the territory of traditional criticism as both are deeply rooted in postmodern existence and can exemplify a zeitgeist for the era.

Plays chosen interwove science into the very fabric of their structure, performance and thematic content. While *Mnemonic* (1999) and *A Disappearing Number* (2007) quoted patterns and ideas from neurology and mathematics, *After Darwin* (1998) and *An Experiment with an Air Pump* (1998) quoted from evolution and genetics. Whereas the first two dramas appropriated the physiological process of remembering and mathematical patterns to tackle concepts like identity and eternity, the other two utilised biological Darwinism vs social Darwinism and cadaver vs genetics to address issues related to the post-Darwinian world and the danger of extending the natural selection to society. Interweaving a story from the past with another one from the present helped not only each period to comment on the other, but also to reveal how chaos works and the level of determinism prevailed in the universe.

1.3 Research Objectives

The drastic shift from a linear, predictable Newtonian worldview to a nonlinear, unpredictable chaotic one has questioned not only the solid scientific facts, but also challenged Man's most cherished beliefs. It has reshaped our thinking, re-cast the systems we used to be part of, and above all the way we used to view the world. As a mode of presenting reality through performance, the drama is not an exception from this alteration. Its method of depicting the world has been changed into a process where audience, actors, props and space interact collectively to experience different kinds of reality. By utilising unfinished narratives, imagistic and fragmented stories, and blending different cultures and ages within a nonlinear timeline, postmodern science drama seeks to break the habitual ways of perceiving reality and to push the audience to experience various levels of awareness and ultimately form their own.

Based on the statement of the problem, the interrelated research objectives are set as follows:

- To investigate how the timeless past can secure a window to achieve a better understanding of the fragmented reality of the selected science dramas.
- To explore how the science of chaos and the selected science plays are interrelated in providing answers to the main characters' most pressing questions about the origin, purpose, and end of life.
- To examine how the key-facets of chaos theory can assist in identifying inciting events that trigger conflict, recognizing thematic concepts that attract and guide the behaviour of the main characters, and exposing order amid fragmentation and formlessness of the selected texts.
- To elucidate the significance of a cross-discipline approach of chaos theory in analysing the selected science dramas.

1.4 Research Questions

The study targets at providing answers to the questions below:

- How can timeless past secure a better understanding of the fragmented reality of the chosen science plays?
- To what extent are the science of chaos and the selected science plays are interconnected in providing answers to characters' most urgent questions about origin, purpose, and end of life?
- How can the key-facets of chaos theory assist in the analysis of the selected science dramas?
- How important is it to promote a cross-discipline method to read the selected science plays?

1.5 The Significance and Contribution of the Study

As humanity, now, is experiencing a tremendous transformation from the machine age to the information age, from matter and motion to energy and knowledge and from a Newtonian-Laplacean deterministic worldview to a quantum, relativistic and chaotic worldview: in sum, from the absolutes to the probabilities, it is quite crucial to adopt another perspective to read literature. Since the mid-1980s, chaos theory has provided such an impetus to read literature and to leave behind a set of methods affected deeply by the Newtonian clockwork model of the universe. A Holistic, dynamic view of chaos is quite necessary since the world is not a clock, a vast machine or a bunch of straight lines.

Conversely, the study is not merely promoting a method of utilising a scientific theory and applies it to certain selected texts rather than presenting a mindset appears to affect different branches of knowledge, including contemporary literature, which is also preoccupied with the breakdown of order and fragmentation. It is quite appropriate here to quote Galatzer-Levy (2016) who states that: "a worldview is not a group of statements about a subject matter, but rather a method approach to thinking about the subject." To him, it "is not a theory per se but rather an approach to building theories" (p. 410).

This study is particularly prominent and a significant contribution to reading postmodern science drama for the following reasons:

- It provides the reader with an avenue of escape from the mechanistic view of the world that dominates most of the critical approaches to literature by presenting a dynamic approach associated with the science of chaos to establish an intellectual method to comprehend and evaluate the worldwide qualities of postmodern science drama.
- The study also endeavours to add and contribute to the discourse on the importance of promoting a sort of a third culture in which science and literature work as allies, not enemies, in particular in the postmodern age where scientists have occupied the place once filled by clerics and armchair thinkers.
- The study is also significant in revealing the importance of chaos in creating new levels of understanding, and in freeing us from fixed patterns of feeling, thought, and behaviour as a stable system is a dead system.
- The paucity of such a kind of practical studies has pushed the researcher to enrich the library with more material and to give a fresh impetus for communicating across disciplines as the study has the potential to become a template for future speculations on the science of chaos and literature.

1.6 The Scope and Limitations of the Study

1.6.1 The Scope

Plays chosen for this study are *After Darwin* (1998) by Timberlake Wertenbaker, *An Experiment with an Air Pump* (1998) by Shelagh Stephenson, *Mnemonic* (1999) and *A Disappearing Number* (2007) by Simon McBurney, Complicité. The selection is confined to the criteria that all the plays under examination are in part making compelling dramas, and in part integrating science efficiently in the art form. They all are postmodern British science-based plays written within the period of the boom of chaos theory. Moreover, they all are structurally similar and to some extent thematically as well. They all tackle stories and ideas taken from science. They are all meta-texts built with the technique of a play within a play where a true story from the past is superimposed on a fictional one from the present.

Stoppard's *Arcadia* (1993) and Frayn's *Copenhagen* (1998), the most celebrated science plays, are not included in this study. Academically, they are studied and scrutinised by many researchers. Though utilises chaos theory, *Arcadia*, thematically speaking, focuses on the transitional period that witnessed the shift in western mind and mood from a Newtonian to a chaotic worldview which does not suit the objective designated for this study, i.e. the applied aspect of chaos theory. On the other hand, *Copenhagen*, one of the best science plays ever written, is not included as well because it tackles quantum physics, not chaos theory.

Chaos theory is believed to be the best choice to examine plays chosen thematically and structurally. Thematically, it copes with the postmodern spirit that is quite obsessed with issues of uncertainty and unpredictability on various levels. To Wilcox (1996) and Hayles (1991), chaos theory and postmodern theatre practice represent the zeitgeist of the postmodern era. They are deeply rooted in postmodern existence. Structurally, broken narrative, episodic structure, intertwined stories, different times, and backgrounds, telegraphic sentences between characters that practice double roles and change places continuously necessitate adopting this theory since it concentrates on studying the behaviour of the nonlinear, the dynamic, and the uncertain.

Moreover, chaos theory is deemed to be the best choice among other gigantic modern scientific theories as it "connects us to our historical, rationalist longings… [and it is highly] relevant to human activity" (Demastes, 2005, p. 19). While relativity theory is more concerned with 'celestial objects', quantum theory is more specialized in tackling atomic and subatomic worlds and Newton's rationalism and linearity are highly questioned, chaos theory has approved to be the most appropriate choice as it does not focus on the large-scale universe as relativity theory does or small-scale universe as the case with quantum physics, but it works in between, i.e. our world.

Facets of the theory selected are butterfly effect, strange attractors and recursive symmetries. The reason is that they meet and fit in with the primary object of the study, which is to examine plays chosen thematically and structurally. While the butterfly effect works on inciting events that start the conflict and strange attractors on the thematic level, the recursive symmetries can decode and construe how the structure is built and operates.

However, this does not mean that some other ideas, i. e., the edge of chaos or self-organisation will not be availed of. They will be explained and referred to as needed. Furthermore, issues like; two-culture debate, factors promoted science to become the new territory for drama, the unprecedented influx of science plays, theatre of chaos and linear and nonlinear approaches to literature will be tackled in literature review chapter and hinted at within the study when it is necessary as the primary object of this research is the applied aspect of chaos theory as an alternative perspective to approach science drama.

1.6.2 The Limitations

The study is limited to chaos theory only. Although it is a continuation to relativity and quantum theories and a direct reaction to Newton's theory, the study will not discuss them as the primary object of the study is the applied aspect not to trace the evolution of chaos theory.

The study is limited only to the number of plays mentioned above. Technically, they work best with the theory and aspects chosen. They are all built around the same technique and share the same interest, science. Also, they belong to the same period, postmodernity, and they are all British as the researcher does not intend to make it a comparative study.

Conversely, the study has nothing to do with postmodernism as a literary movement. It only focuses on chaos theory as the scientific product of postmodern age and only on aspects aforementioned. Musicals, operas, comedies and fantasy science plays are beyond the scope of the study as the primary focus is on hard science and the way it is integrated with the drama.

1.7 Conceptual Framework

As the principal objective of the study is to analyse the selected texts thematically and structurally utilising key-aspects of chaos theory as a theoretical and methodological framework, it is quite imperative to cast some light on the theory proposed and the aspects chosen.

1.7.1 Chaos Theory

Since the dawn of civilisation, people tended to embrace order and decline disorder as something undesirable and evil. From Hesiod to Aristotle through the concept of the Great Chain of Being to which medieval Christianity added the element of love to Newton until the 20th-century, humanity was shackled by reductionism and metaphysical dualism: to dissect and consider things in simple dichotomies. Anything cannot be classified according to this linear reductive logic is ignored and labelled as chaos or random. Such a mechanistic view presents a clock-like world ruled by the immutable laws of cause and effect. Once we managed to break the code, future events would be at hand. This deterministic view gave Man a sort of control over nature, but it robbed free will and independent action and choice. It made the world predictable and ultimately controllable. To Hansen (1994), it gives "a comforting picture of the universe." (p. 76).

Chaos theory, instead, promotes a holistic, dynamic view of the world. It preaches that things in the universe are deeply linked than we could ever imagine, and the world is less predictable and less manageable than we thought. However, it does not abolish order; but it preaches, like order, the disorder has a profound patterned structure, too. It is only the erratic behaviour that makes it look random to the observer. It promotes a world that combines both order and disorder in which human being is neither entirely free nor totally bound. It teaches that chaos is part if not the whole reality. It should not be looked at as a dustbin into which we toss things we cannot comprehend. Chaos, as depicted by Hayles (1990), is "the womb of life, not its tomb" (p. 100).

As a concept, chaos is not new. It is as old as humanity. It can be traced back to mythology when the gods created the world out of the fathomless and formless void. Nevertheless, its modern scientific version started and developed during the 1960s and 1970s at the hands of Lorenz, Li and Yorke (Chau and Wang, 2011). It was recognised and penetrated non-scientific population during the late 1980s and early 1990s, in particular with the publication of Gleick's groundbreaking book *Chaos: Making a New Science* (1987) where the principles of chaos had become so entangled with postmodern culture. Hayles in *Chaos Bound* (1990) defines this meeting "as two mingled voices within… postmodern culture" (p. 208). With the social and political turmoil of the twentieth century, disorder, indeterminacy and uncertainty have crept into almost every aspect of life. As a method to measure society temperature, literature embraced these new ideas enthusiastically. People of literature were in dire need for fresh ideas to explore this disturbing reality.

In closing, understanding chaos is to understand life as it is in reality. What was considered mere noise in the past might have its own laws now. The middle ground chaos theory secures between order and disorder, and the dynamic, qualitative and holistic view it presents have all helped to form a bridge between various branches of knowledge and to find applications in different fields. It is a science of global nature managed to redeem the crisis of too many specialisations and combine them under one umbrella. Scientists believe that the natural world is profoundly unpredictable, but the very same thing makes it unpredictable allows it to create patterned structures (Wheatley, 2006).

To exhibit how a chaotic system has a hidden patterned structure, chaologists who consider the butterfly effect also utilise strange attractors and recursive symmetries as tools to reveal the order in chaos. Defining and clarifying these three fundamental tenets of chaos is the subject of the next three sections.

1.7.2 The Butterfly Effect

It is a term coined by the American meteorologist Edward Lorenz in his most-quoted article on predictability in 1972 (Lorenz, 1995). It is the fundamental cause and the most powerful and evocative image of chaos. To Hastings et al. (1993), it is the most intuitive and effortless definition of chaos: how minute changes in a massive system can produce dramatic results. It is highly connected with an example of a butterfly beats its wings somewhere in South America could influence the behaviour of the weather some thousands of miles away. As no one can be precise about the initial conditions of a system, the butterfly effect is associated with the notions of nonlinearity, uncertainty and unpredictability. Chaologists conceive it as an example of how chaos works, how much of it is inherent in the fabric of nature and how Man's ability to predict is limited.

To Bishop (2008), the butterfly effect raises a tantalising philosophical question and triggers a free will vs. determinism debate. It could be both a curse and a blessing. Pavlopoulos in his article *The Terrible Turn of Events: Literature and the butterfly effect* (2013) comments on Man's attempt to take hold of godlike predictive power, and he also discusses the issue of free will vs. determinism. He concludes that both sides of the coin have its own pros and cons. While determinism clears Man from responsibility and leads to indolence and carefree life, the freewill viewpoint presents a world works like dominoes in which minute simple events could lead to chain reaction ended with catastrophic results.

Crutchfield et al. in their seminal article titled *Chaos* (1986) look more optimistic about the philosophy of chaos. To them, it reveals how creativity is an innate part of Man. Our subconscious has its own version of chaos where selectively choose to magnify tiny individual variations and cast them into forms of decisions or thoughts. And in this way chaos can provide a sort of mechanism that permits free will to work from within in a world governed by chaotic deterministic laws. Briggs and Peat (1990) are optimistic, too. They believe that chaos "may hold comfort" for those who feel their place in the world is insignificant as tiny things "can have a huge effect in a nonlinear universe" (p. 75).

In fact, the scientific approval of this phenomenon provides a solid ground for writers as well. The butterfly effect has become an essential feature in many literary works and the favourite subject in many contemporary literary circles. To Kellert (1994) and Alonso (1990), the appropriateness of this notion to social and literary contexts is entirely as valid as to scientific ones. Porush (1991), on the other hand, asserts: without the scientific recognition of the vital role this concept plays, virtually every single great writer, including Shakespeare, ''would have been out of business'' (p. 382). The study conducted is going to utilise this notion to expound how inciting events that start the conflict work: how a small, inconsequential event can have an enormous impact on the lives of fictional characters.

1.7.3 Strange Attractors

Since the order in chaotic systems is invisible to the naked eye, scientists are in need of new mathematics: the mathematics of visual shapes, not formulae. Strange attractors and recursive symmetries are the best examples of this new mathematics. As they are simulated on a computer screen, they are able to reveal the order in seeming disorder. So, what are they? This section and the next will secure the answer. First, let us start with strange attractors. What are they?

Strange Attractor is simply any point within a system that attracts the system or the system eventually settles down to it. It is the other side of the coin. While the butterfly effect is associated with the unpredictable part of the chaos, strange attractors are identified with stable one. In this sense, as Stewart (2002) conceives, chaos is both "a strange and beautiful combination of stability and unpredictability" (p. 130). A strange attractor is called so because it cannot settle like a point on a graph or a limit cycle, but it creates a trajectory with a fractal shape as shown below.

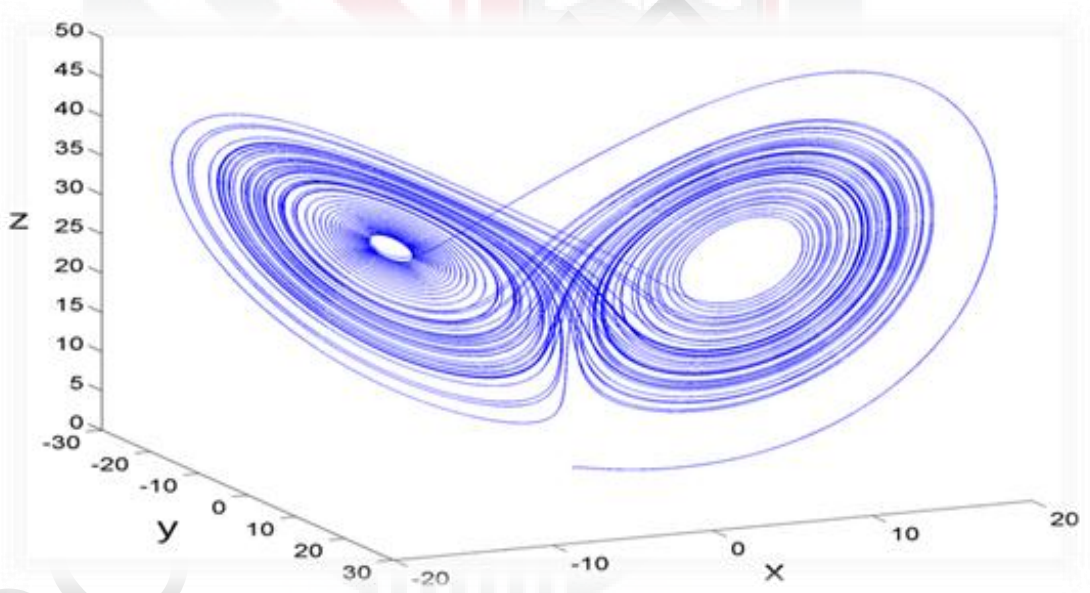

Figure 1 : A Strange Attractor

Actually, there are four kinds of attractors: quasi-periodic, periodic, point and strange. The first three are linear and predictable. The fourth, the strange attractor, is chaotic, unpredictable and it occurs only in nonlinear systems where each system has at least one attractor (Koperski, 2001). Hence, to understand the behaviour of a chaotic system, one has to identify its attractor first.

Strange attractor, in fact, has the ability to restrict the behaviour of a system in a particular area in phase space and bound it to follow endless but non- repeating paths in this space. Phase space is a sort of abstract space that turns numbers into images, and allows things to stretch, fold and move freely into any dimension. In short, a strange attractor in a chaotic system enjoys three qualities. First, it works as a key through which one can see the behaviour of a chaotic system. Second, it functions as a magnet that attracts the system to it. Third, it operates as a driving force that compels the system to follow paths it chooses.

In literature, strange attractor works as a kind of thematic concept that holds structure, plot and meaning together as it can function as a key for interpretation, a magnet to pull plot threads together or a driving force that compels events to follow a particular direction. A strange attractor also functions as a tool that brings the physical world within the scope of human thought, i.e. setting the boundaries of meaning out of a plurality of them. It works as a vital aid in comprehending the pattern and the purpose of a character's life. Yet, it does not operate as fate rather offering infinite paths within a restricted area, providing characters with various ways of forming their identity and reshaping their lives.

Looking for meaning in life is what organisational theorist M. J. Wheatley tried to present in *Leadership and the New Science* (2006). As chaologists look for strange attractors to determine the behaviour of the chaotic system, she proposes meaning as the attractor that governs the human relationship. These attractors manifest themselves as abstract concepts taking the form of desires, dreams or emotional impulses. To Demastes (2005) these emotions are the attractors of "human dynamics" (p. 101). Every single individual is looking for meaning in his/her life and acts or reacts accordingly. So, the quest for an attractor corresponds to the search for meaning in someone's life. It is quite vital in defining the goal and pattern in someone's life and determines his/her behaviour. In sum, an abstract idea, a lost memory or a passion for something can function as an attractor around which action evolves, the plot develops and meaning unfolds.

1.7.4 Recursive Symmetries

It is a term used by scientists to describe the iterative behaviour of a natural system. Changing of the seasons is one example and a form of recursive symmetry. On August 12 in KL, Malaysia, for instance, the weather is hot because it is summer. From year to year, the temperature recorded on August 12 varies, sometimes considerably. This variation is an example of recursion: systems return close to their original behaviour, but not exactly. David Ruelle (1991) proposes that they are in "a certain state, at a certain time… will return arbitrarily near the same state at a later time" (p. 86). Hayles (1990) emphasises this concept, arguing that it is a key-feature to understand and recognise a system as chaotic: when symmetries are there in a system, so too is chaos. As one can notice, a chaotic system is disordered in a sense

it is unpredictable, but it is ordered in a sense that it has recursive symmetries that are closely, not exactly, replicate themselves over time.

This underlying pattern, recursive symmetry or self-similarities as called by chaologists, works as a sort of specs allow scientists to trace these patterns and map out the order within chaos. Mitchell Feigenbaum is believed to be the first to pin down this phenomenon, stating that "the rate at which the recursion occurred quickly approached a limit that proved to be a universal constant" (Hayles, 1991, p. 10). According to Hayles (1990), Feigenbaum was the first to deem that chaos has a structure as rigorous and consistent as the order. In sum, employing recursion as a source of information has changed our view of chaos from a mere noise devoid of order to a swirling stream of information, and subsequently, it saves the universe from barren repetition.

More pertinently, as chaotic systems rich with information, strange attractors and recursive symmetry are in fact indispensable tools to make sense of this information. But strange attractors deal only with specific points in a system and do not show how these patterns emerge, and here lies the importance of recursive symmetries. Whereas the former deals with certain points in a system, the latter covers the general form of the system by tracing the way these symmetries iterate on various levels. Harriet Hawkins (1995) sums it up by referring to recursive symmetry as an underlying pattern that repeats itself in a referential way where "the behaviour of one function is guided by the behaviour of another" (p. 102).

The plot structure of the selected plays relies mainly on butterfly effect, strange attractors, recursive symmetry, and characters' action for their progress and development. Past and present are not only juxtaposed for the sake of drama but also to excavate the complexities of human nature and human responses to a world that is less controllable and less predictable. In such a world, characters become proxies of order and disorder, and through their actions, the plot is recurring itself.

However, within this recursion, one can notice, there is still room for human choice and action as people are not only affected by chaos, but they also are an essential part of it. So, as strange attractors help in recognising themes and motives, recursive symmetries are going to work on the plot to reveal the order in seeming disorder. To come up with the overall picture, one has to imitate chaologists by determining these self-similarities permeated throughout the overlapped fragmented structure of these plays.

1.8 Methodology

The classical model of science which affects all disciplines including literature is both reductionistic and mechanistic. Chaos theory, as a new paradigm shift in science, presents a holistic, dynamic model. It emphasises that the world, in essence,

is chaotic. It involves, according to Galatzer-Levy (1995), "a qualitative as opposed to the quantitative view of nature, and addresses questions in a wholly different fashion from a traditional physical science investigation" (p. 1110). Its capacity to tackle the intricacies of chaotic systems makes it a promising candidate. The primary reason for this interaction between scholars and the science of chaos, as Wilcox (1996) explains, is the methodology which looks for overriding patterns and shifts our focus away from simple reductive models towards complex systems of interaction. Such reductive models, according to Gillespie (2008), are "too narrow to accommodate the full potential of literary expression" (p. 3). They prevent any sort of diversity and categorise anything that does not go with the mainstream of investigation as an irregularity.

The current study is a qualitative and textual-analytic one. It is based on library and online research as a means for providing the material needed to support concepts and findings. Since the study is an analytic and qualitative one, the selected texts are analysed using the textual interpretation of the chosen plays through the lens of chaos theory. Employing textual-analysis methodology in the light of chaos theory will enable the researcher to analyse the dramaturgical and structural methods, extract themes and motives, and to excavate the complexities of human nature, choice and action as chaos theory with its holistic, dynamic view can be one possible help in understanding what these dramas are up to as creative works.

As mentioned in the statement of the problem and clarified in objectives section, the study aims to analyse selected science-based, postmodern British dramas thematically and structurally examining the fragmented world of these plays and how interspersing past and present assist in understanding the core of such a world. It also endeavours to probe devices and techniques that make this goal achievable. Expounded in conceptual framework section, the approach chosen for this study as a method of analysis is chaos theory, more precisely the key-concepts of this theory: the butterfly effect, strange attractors and recursive symmetry. They tackle inciting events that start the conflict, theme and plot structure respectively to map out the order in seeming chaotic, fragmented construct as these plays are not built in a traditional linear storyline in which events are put next to each other in a unified fashion.

The butterfly effect illustrates how a small and apparently irrelevant change in one part of a system can cause a considerable impact on the other parts of the system. How a little incident, a short meeting or even inadvertent words could turn Man's life upside down and lead to irredeemable consequences. In a nutshell, whether they occur in weather, computer or happens to a man, these tiny, insignificant perturbations indiscernible at the moment they take place could initiate a sort of chain reaction that ultimately gives rise to irreversible damage or unexpected results (Hawkins, 1995). In *A Disappearing Number* (2007), a letter from a self-taught math genius from India to a professor at Cambridge University in 1913 led eventually to the discovery of String Theory in the modern age. An old painting about a scientific experiment inspired Shelagh Stephenson to write her remarkable play *An Experiment*

with an Air Pump (1998). A trip to uncharted waters as in *After Darwin* (1998) gave rise to a theory that is still playing a significant role in formulating man's response to origin be it executed by natural or supernatural force.

In a chaotic system, a strange attractor possesses unique qualities. It is used to predict the behaviour of the system, to attract the system to a particular point, and also it has the ability to restrict the system to follow the course it chooses without repeating a path or return to the same point. It performs a triple-function: a key, a magnet and a driving force. In *A Disappearing Number* (2007), intellectual curiosity worked as an attractor that bridged the gap between two periods of time despite ideological and racial differences. These knowledge-seekers shared the same goal; to unearth order in the seemingly disordered world and to find out overarching patterns that could provide purpose and meaning to the universe. Discovering personal roots in *Mnemonic* (1999) and tracing the footsteps of a brilliant mind in *A Disappearing Number* (2007) led the heroines to travel as far as possible to find answers.

Recursive symmetry is the repetitive behaviour of a chaotic activity. It is a method chaologists use to map out pockets of order in chaotic systems via determining self-similarities and the way they iterate on various scales. The plot in the selected texts is built in the form of recursive symmetries continually emphasising the central concepts texts meant to discuss. A true story from the past is interwoven with fictional one from the present. They are presented in a disordered fashion; therefore, they appear chaotic to the casual observer. The action does not move linearly rather bouncing back and forth between past and present, while physical reality remains the same. Props and characters are in continuous motion throughout the whole performance to secure this chaotic background. Through recurring situations and images from past and present, the playwrights reveal the inescapable level of determinism prevail in the world and cast light on what happens when human actions and desires disturb the natural order. They will act like the butterfly effect in a complex system where predicting the consequences or calculating the results becomes so difficult. Thus, to come up with the overall picture, one has to imitate chaologists by tracing these self-similarities or recurring images spread throughout the overlapped fragmented structure of these plays.

In conclusion, while the butterfly effect will work on the inciting events that trigger the conflict, and attractors will tackle thematic concepts that drive and guide characters' behaviour, recursive symmetries will be utilised to trace self-similarities and recurring images in both intertwined, fragmented stories from past and present to secure an overall picture of the chaotic, fragmented structure of the selected plays.

1.9 Definition of Terms

- **Chaos theory:** it is the study of orderly disorder. It investigates the behaviour of a dynamic system, focusing on the moment of transition from order to disorder.
- **The Butterfly Effect:** it is the cause of chaos; how minute changes in a massive system can produce dramatic results. It is identified with the example of a butterfly beats its wings in Asia could ultimately tip the balance of weather in America.
- **Strange Attractor:** it is the heart of chaos. It is defined as any point within a system that attracts the whole system to it and compels it to follow a particular direction.
- **Recursive Symmetry:** it is the repetitive behaviour of chaotic activity. It is utilised by scientists to map out the order within chaos by tracing self-similarities on different levels of observation.
- **Phase Space:** it is a sort of abstract space that turns numbers into images, and allows things to stretch, fold and move freely into any dimension.
- **Pastiche:** a mixture of different styles and genres borrowed from other works.
- **Faction:** a technique of dramatizing actual, real historical events or figures.
- **Nonlinear Timeline:** a technique used to create a new narrative voice, blur the line between fact and fiction and enable the playwrights to jump backward and forward in time.

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