

The Butterfly Effect Hits Complicité: A Chaotic Reading of *Mnemonic* and *A Disappearing Number*

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ABSTRACT

The middle ground chaos theory secures among other gigantic scientific theories to describe the world has brought it to the fore lately. It neither declines the Newtonian clockwork model completely nor promotes the quantum indeterministic model entirely. It preaches that the world is both ordered and disordered, and man is both bound and free. Unlike relativity and quantum physics, it is neither busy with massive objects nor preoccupied with tiny ones, the atoms. It simply works in between, our world. Thus, it spreads and is widely utilised in a variety of disciplines, including literary and cultural domains. Conversely, Theatre de Complicité promotes nonlinearity and fragmentation for structure, and physicality and visual imagery for performance. It does not prefer pre-written texts rather favours devising its own through a lengthy process of improvising and rehearsing. It believes that the world is no longer a world of a single story. It cannot be encompassed within one philosophy or viewpoint. Mnemonic and A Disappearing Number suggest human body within the context of origin as a collective identity, and math within the context of infinity as a path for eternity. Hence, chaos theory is deemed to be the appropriate choice for analysis as it can provide an avenue of escape from the soul-crushing mechanical view of the world dominated most critical approaches for decades and can also furnish an alternative language and scope for literary interpretation.

Keywords: chaos theory; butterfly effect; strange attractors; recursive symmetry; nonlinearity and fragmentation

INTRODUCTION

Chaos was the law of nature; order was the dream of man. H. B. Adams

For centuries, things Man cannot comprehend or classify according to his linear, reductive and deterministic logic, inherited from Aristotle and later from Newton, are simply dismissed as something random or disordered. Both promote a world ruled by causality and reject chaos as something undesirable impeding human progress (Gillespie 2008). This mechanistic and deterministic worldview presents a clock-like universe governed by immutable laws of cause and effect. It makes the world predictable and eventually controllable. It permeates to all aspects of life and becomes a cult. Sir Isaac Newton, as Prigogine and Stengers (1984) explained, was “the new Moses who had been shown the tables of the law” (p. 27).

Alternatively, chaos theory preaches that there is an order in seeming disorder. Chaotic systems are rich with order. It is their irregular behaviour what makes them seem

disordered to the casual observer (Briggs and Peat 1990). Chaos is the study of what Hayles (1991) beautifully describes the “orderly disorder” (p. 1). To Gleick (1987), it is “a science of process ... of becoming rather than being” (p. 5). With its holistic view, it spreads and is widely utilised in a variety of disciplines including literary and cultural domains. Chaos theory does not decline order: it simply promotes a world that combines both order and disorder. It teaches that chaos is no longer a dustbin into which we toss things we cannot comprehend. It is a part –if not the whole—reality. To Hayles (1990), chaos is “the womb” not the tomb of life (p. 100). It is everywhere: in every dripping faucet, in every puff of smoke, in every swirl of water and above all it is over there in Wordsworth’s lonely cloud.

ASPECTS OF CHAOS

THE BUTTERFLY EFFECT

You can stay at home and be happily introspective or you can make a choice, step out, and be the Butterfly that begins the tempest that changes the world. John Sanford

The Butterfly effect is the essence of chaos theory. It was first conceived by Henry Poincare and rediscovered later by Edward Lorenz in 1962 due to the advent of the computer. He gave it this poetic name in his most quoted seminar on predictability in 1972 (Lorenz 1995). It tells that the slightest apparently non-related changes in the input could lead to dramatic consequences in the output. It is highly associated with the example of a butterfly beating its wings somewhere in Asia which could ultimately influence weather somewhere in North America. Such phenomenon reveals how chaos works, how much of it is inherent in the universe and how man’s predictability is limited.

Ignored by Newtonianism, it becomes the principal subject in most contemporary literary circles. It is no longer restricted to weather-forecasting as all dynamic systems including human beings reveal such sensitivity to minute changes in their initial conditions. Before the advent of chaos theory, it was “dismissed as pertinent only to the realm of accident, coincidence, kismet, and messy human affairs” (Porush 1991, p. 382). Chaos preaches it is part of reality. To Porush (1991), without the scientific 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” (p. 382). Kellert (1994) and Alonso (1990) state openly that its appropriateness to literary and social contexts is entirely similar to scientific ones.

Hawkins (1995) makes an argument with those single-minded critics and moralists who behold things in terms of vices and virtues or black and white. Human behaviour cannot be looked at as a linear process. She expounds how some tragic results are simply an outcome of some innocent morally neutral slips. Arons and Richards (2014) assert that man is not “a static thing.” He is “a process in motion” (p. 169). People might change the moment they see somebody smiles or hear him talks. An innocent simple ‘Hello!’ from a person can change another’s life forever.

However, to map out order in chaotic systems, chaologists generally focus on two tools: strange attractors and recursive symmetry (Hayles 1991).

STRANGE ATTRACTORS

You’ve never heard of chaos theory? Nonlinear equations? Strange attractors? Ms. Sattler, I refuse to believe you’re not familiar with the concept of attraction. Michael Crichton

Strange Attractor is defined as any point within a system that pulls or attracts the system to it. While butterfly effect is linked to the unpredictable part of the chaos, it is associated with the stable one. To Stewart, (2002) chaos is “a strange and beautiful combination of stability and unpredictability” (p. 130). It is called ‘strange’ because it cannot settle on certain geometric shapes like ellipse or circle but creates its own fractal trajectory, and it is called ‘attractor’ because it attracts the whole system to a certain point in phase space and compels it to follow endless non-repeating paths. According to Cambel (1993), phase space is a sort of virtual space that has the ability to turn equations and numbers into images. It also allows these attractors to fold, stretch and move into any dimension freely. Briefly, attractors act like a magnet as they have the ability to attract, restrict and guide a system through courses it chooses within set boundaries. Hence, to understand the behaviour of a chaotic system, one has to identify its attractor first.

While in the physical realm it takes the form of physical properties, in the human domain it takes the form of desires, emotions, and dreams where the meaning of these attractors can strongly determine human behaviour which is not purely random but complexly ordered. It is the result of myriad conditions of a chaotic psyche and unspecified environmental factors. While Rossi (1989) deems obsessive thoughts as an expression of strange attractors, Argyros (1991) regards them as the best conceptualization of ideas. The same goes with Svyantek and DeShon (1993) who notice that personality may sometimes operate in a manner similar to an attractor. Conversely, M. J. Wheatley (1992) suggests attractors as an expression of meaning in somebody’s life. So, the search for attractor is similar to the search for meaning. Thelen (2014) finds attractors a quite useful tool as they can reduce the number of behavioural patterns because they work within set boundaries. Yet, attractors do not act like fate rather they offer infinite paths to reshape someone’s life within restricted area physicists call it phase space and people call it life.

Yet, a problem might float to the surface. Strange attractors can deal with specific points. They cannot display how these pockets or patterns of order emerge. Here, recursive symmetry can stretch a hand for help. It can secure a general form or an overall picture of a system and the way it iterates among different levels.

RECURSIVE SYMMETRY

Repetition is the reality and the seriousness of life. Kierkegaard

It is the repetitive behaviour of chaotic systems where they revert closely not exactly to their original behaviour recurrently. The best example is changing seasons where temperature recorded varies from year to year. It approaches the original, but no two temperatures are alike. This variation is a good example of recursion in chaotic systems. Such a behaviour changes our view about chaos from a mere noise in nature into influx of information needed to be tracked carefully. To Ruelle (1991), at a certain time in a particular state, chaotic systems “will return arbitrarily near the same state at a later time”. They consistently “come back again and again to near the same situations,” but never replicate them (p. 86).

Mitchell Feigenbaum was the first to notice that “the rate at which the recursions occurred quickly approached the limit that proved the universal constant” (Hayles 1991, p. 10). Feigenbaum notices that bifurcations are not only “coming faster and faster,” but they are “coming faster and faster at a constant rate” (Gleick 1987, p.172). This constant, as Hayles (1991) believes, expresses clearly “orderliness amidst the unpredictability” by revealing how “large-scale features relate to small-scale ones in a predictable way” (p. 10). Kenneth G. Wilson’s studies on dynamic motion of turbulent flow made a tremendous progress in studying chaos. His approach, called renormalization, presented a “shift from following individual molecules” into tracing “symmetries between different scales”. As he

espoused it “with the idea of a mathematical group”, he came up with “a method whereby this factor could be defined and calculated” (Hayles 1990, pp. 155-156).

Robert Wright (1988) believes that despite its complexity, the whole universe is just a massive recursive algorithm. To deem such a universe, one needs to look for overriding patterns, and such a method is well-secured by tracing recursive symmetries on various levels. Complex systems, Galatzer-Levy (1995) suggests, “often involve structures that repeat basic features on several different levels of observation” (p. 1085). Interestingly, recursion shows also that chaotic systems have continuity. The original order is carried throughout all levels in the form of recursive symmetries. Thus, any change will quickly be communicated through the entire system. Loye and Eisler (1987) assert that chaos generates its “own new forms from inner guidelines rather than the imposition of form from outside” (p. 56). Chaos in this sense totally opposes Newtonianism that preaches a view of a world governed by immutable laws. Instead, it presents a holistic vision: to trace similarities throughout various scales, not individual units. Otherwise, the information one gets from reductionism will be quite misleading.

METHOD AND JUSTIFICATION OF THE CHOSEN THEORY

This paper intends to utilise key facets of chaos theory as a theoretical and methodological framework to analyse selected plays thematically and structurally. The paper does not suggest that other readings for these remarkable science dramas are false rather, attempts to tackle the subject from another perspective. It aims at exposing patterns of order underlying the apparently chaotic and fragmented structure of the selected dramas. The impetus stems from the realisation that conventional methods, affected by the Newtonian clockwork model of the world, have a limited capacity to absorb the nonlinear, dynamic and kaleidoscopic structure of these dramas. This narrow view of analysis that dominates most of the critical approaches to literature for centuries has aborted any attempt for diversity. It focuses mainly, as Gillespie (2008) describes; “on a central idea, weighing the evidence, and balancing opposing views to arrive at a conclusion” (p. 5). Thus, seeking an alternative approach is quite crucial as it will be shown throughout analysis section.

The choice of chaos theory as an approach for text-analysis is based on some crucial elements. Firstly, Theatre de Complicité has a style that is structurally nonlinear, stunningly visual, and highly physical (Hickie 2008, Hunter 2005). Secondly, the plays selected are not built around traditional storylines or structures where things are put adjacent to each other in a unified plan: a series of events governed by causality. They hardly have plots. Both are made up of bits and pieces: uneven consecutive scenes without any intervals or act division. They do not move linearly rather they cross different places and times where action shuttles back and forth. Thirdly, science in these two dramas is not peripheral to the narrative. It is integrated into theme, structure and performance. Hence, seeking a method stems from science is a quite appropriate choice. To Liliame Campos (2014), the company was quite enthusiastic to adopt other forms to tell stories, i.e. neurology for *Mnemonic* and mathematics for *A Disappearing Number*. Briefly, the style of theatre, the structure of the plays, the universality of themes posed as well as the scientific ideas they intend to stage make it necessary to adopt another dynamic and holistic approach for reading.

Conversely, the butterfly effect is no longer limited to weather-forecasting. All dynamic systems including human beings reveal sensitivity to minute changes in initial conditions. Moreover, minor events can no longer be ascribed to accident, kismet or muddled human affairs. They are a part of this world, part of its reality. Insignificant details within a text should not be overlooked no matter how irrelevant they might appear. Thus, the butterfly

effect is going to deal with these inciting events that start the conflict and work as catalysts for action to start. With its ability to attract and constrain chaotic system to a certain point, strange attractors can work on thematic concepts that bound drama's other elements to follow a certain direction. It works as a road-map that minimises the zone of search. Recursive symmetry, on the other hand, can trace patterns of order within an apparent chaotic structure of plays by outlining self-similarities in both dramaturgy and scenography.

MNEMONIC (1999) AND *A DISAPPEARING NUMBER* (2007):
IDENTITY AND ETERNITY

Both dramas were conceived by Simon McBurney and devised by Complicité. The plays achieved a stunningly critical success. They were widely celebrated and highly garlanded with awards. The reason for this great success was the integration of science into structure and performance. Science was not peripheral to the story. McBurney was quite zealous to adopt other forms to tell stories: Neurology for *Mnemonic* and mathematics for *A Disappearing Number*. In *Mnemonic*, the biochemistry of memory is used to reveal the act of remembering and the role of imagination in formulating a memory, and also to ponder over origin within the context of identity. Inspired by Hardy's premise "A mathematician, like a painter or a poet, is a maker of patterns," McBurney in *A Disappearing Number* aims at utilizing mathematical concepts like infinite series, partitions and infinity to create patterns on stage able to describe life, death, beauty and immortality (Hardy 1967, p. 84).

In both sagas, the drama is opened with a lecture that softens the earth for two intertwining stories; a true one from past and a fictional one from the present. They both eventually meet in the final scene to unfold a theme that starts personally but ends universally. In *Mnemonic*, the personal quest of a Welsh-Lithuanian girl for identity is espoused with a collective inquiry of archaeologists for the origin of a 5000-mummified body found in the Alps. Likewise, in *A Disappearing Number*, the story of the remarkable collaboration between math professor G.H. Hardy of Cambridge and self-taught math genius Srinivasa Ramanujan of Madras is interwoven with a fictional modern love story between math don from Brunel University, Ruth, and an American businessman of Indian origin, Al. Both sagas frame present and the past as a window to tackle crucial issues: of origin within the context of identity; who we are, and of infinity within the context of eternity; where we will go! While the first suggests the human body as a collective identity for humanity, the second proposes infinity as a path to eternity.

Before setting a sail, it is quite essential to scrutinise the opening scenes of both dramas as they set the context and outline the scientific ideas that provide overarching structuring images for the plot. These images, i.e. biochemistry of memory and mathematical series are well-supported by an ingenious use of scenography and dramaturgy. The two opening scenes were in the form of lectures. To soften didactic elements and to dispel the feeling of being lectured, Complicité mixed them with some comedy through joking and swearing.

In *Mnemonic*, McBurney (1999) describes the act of remembering and the role of imagination in this process. Remembering is not "an act of retrieval but a creative thing...an act...of imagination." When we remember, we don't retrieve from a store of fixed memories rather we create. He depicts memory as "chaotic map," and as the weather; it is highly fickle and "completely unpredictable." Every time one remembers he comes up with something different because his brain takes "a different route" than the one it should be (p. 4). Thus, remembering is an act of creation not retrieving, and this is why no two memories are alike. To shift from theory to practice, McBurney invites the audience to wear eyeshades and catch

a leaf attached to their seats. He asks them to feel and imagine leaf's veins as their lines of ancestors. He asks them to travel through genealogy using nothing but imagination. The result is that everybody eventually is related to everybody else in the auditorium (p. 7).

McBurney here has appropriated this physiological process in the brain as a model for the form of the play: it is a nonlinear chaotic, fragmented one. How the brain works as we remember is acted on the stage. Leaf's experiment conducted by audience reveals that past memories are horribly chaotic and irretrievable. Such a concept is supported by Virgil as he introduces chaos theory to a friend: "the pattern on the leaf is chaotic. ... The further back we go, the more chaotic our interrelationships become" (McBurney 1999, p. 11). He admits "it's chaos, and we don't know why or how chaos occurs, but there is a pattern to it (p. 13).

Like *Mnemonic*, *A Disappearing Number* is also opened with a lecture. Ruth a professor of math appears on stage accompanied by blackboard filled with weird equations. The baffling one, developed by Ramanujan, is " $1 + 2 + 3 + 4 \dots \infty = -1/12$ " (p. 22). It is important not only because it persuades Hardy that he has a new Newton, but also because it asserts to McBurney that math is like art has "a method by which the invisible, the intangible, and the absent can be approached" (Stone 2008, p. 489).

To dispel the feeling of being lectured, the math scene is interrupted by a man named Aninda Rao. In Brechtian style accompanied by an Indian accent, he tells the audience that he is an actor and the don is an actress as well. What they have already watched is not the whole show! Suddenly, he started dismantling the whole set: "This door doesn't lead anywhere! I can push these walls right off". Then he added that the only real thing is math; "It's terrifying, but it's real" (p. 23). Actually, the focal point this scene wants to assert is that math is the only real thing in existence. It "wears less with time" because its "patterns are made with ideas" (Hardy 1967, pp. 84-85). It also alludes that, although it is fragmented, the play is based on patterns as well.

Action starts when our butterfly beats its wings. In *Mnemonic*, it hits two places in two different continents and in two different times: a tiny flat in London and the vast Sahara in North Africa. During the funeral of her mum in 1998, Alice, Virgil's girlfriend, has discovered that she has a living father somewhere in Eastern Europe. She has found his broken Russian watch in a drawer. This little broken machine triggered Alice's quest for identity. The second has led to the most important archaeological discovery in the 20th century, Otzi, the Iceman. The frozen body is discovered accidentally by two tourists in the Alps, half-buried in the ice. But, how could that happen and what is the role of the butterfly effect?

Virgil explains through voiceover how all things on earth are connected; a "movement of a camel" could have been stirred the sand. It might have been carried by "southerly air current between the fifth and the eighth of March 1991" and covered the Alps with a yellow layer of dust. So, instead of reflecting, the ice has "absorbed the radiation and accelerated the disappearing of snow." It is quite clear to Virgil that "All movements of the earth contribute to the chaotic movement of the weather" (p. 16). Through voice-over, he was heard concluding: "So the man emerging out of the glacier was as a direct result of a sandstorm in North Africa" (p. 27).

Likewise, the butterfly in *A Disappearing Number* hits one place this time but in two different periods, England, more precisely: Trinity College 1913 and Brunel University 2007. G. H. Hardy, a brilliant math professor, used to receive weird letters about pyramids, Bacon's cryptograms or on the subject of the Elders of Zion. Yet, this time was entirely different. The letter was from India, and it had odd theorems on infinity and prime numbers. The author was a young man from Madras called Srinivasa Ramanujan. He tried to prove that " $1+2+3+4$ and so on to infinity is equal to minus one twelve" (p. 26). Hesitated for a while and discussed it with some Cantabrigian colleagues, Hardy realised that he had a prodigy on the order of

Gauss or Newton, not some crank (pp. 45-46). He invited him to join Cambridge circle. This simple letter, actually, triggered a collaboration that lasted for seven years from 1913 to 1919 and laid the basis for modern string theory. Equations Ramanujan came up with were “the holy grail of physics” as they secured a kind of “a unified vision of the universe” (p. 86). Indeed, Ramanujan’s legacy has reshaped modern mathematics to the extent still felt today.

The second incident took place in the present day. An Indian-American businessman called Al attended a conference at Brunel University. He accidentally stepped into a lecture hall where a math don called Ruth was doing a seminar on Ramanujan’s theorems. He instantly was smitten by her passion, eloquence, and the infinite joy she found in prime numbers. They chatted a little bit after the lecture about mathematical series, infinity and prime numbers. However, the only number Al cared about was the don’s phone number; a number of considerable importance for both, but for different reasons.

In his two seminal articles on chaos, Michael R. Butz’s (1992, 1993) presents an anxiety as a metaphor to explain people’s response to chaos. Like any chaotic system highly sensitive to minute changes in its initial conditions, any incident regardless how big or small it is can profoundly change one’s behaviour. Butz’s trope of chaos through an anxiety assists much in grasping characters’ responses. Knowing of a living father or the real age of mummified body in *Mnemonic* activates the process of anxiety to know the origin. Likewise, realising the importance of Ramanujan’s theorem as a re-discovery of the Riemann-Zeta function or the enthusiasm this woman has for prime numbers in *A Disappearing Number* triggers such process of anxiety in Hardy and Al. Al is quite eager to know the secret behind this passion. Why is it for abstract not for a real thing like him?

Like Al who was doing his best to grasp Ruth’s passion for math, Virgil of *Mnemonic* was pondering over his girlfriend’s sudden disappearance. She left nothing but a short text message containing two contradictory words; “wait and follow.” As fluids become hard to predict as they pass tipping points, it is the same with Alice because human emotion is “essentially fluid” (p. 15). The question to Virgil is not whether chaos has patterns or not, but how to live with these patterns that are extremely unpredictable. Briefly, these minor incidents in both dramas like; finding a broken watch in some drawer, a camel movement somewhere in North Africa, a letter from India found on doorsteps or stepping into the wrong room, worked as catalysts that started action to pass it on later to strange attractors.

As explained above, to figure out the behaviour of chaotic systems, one has to determine their attractors first as they have the capability of attracting, constraining and guiding the behaviour of these systems. They act as determinants help chaologists to discern patterns of order in seeming disorder. While in a physical realm, attractors reveal themselves through physical properties, in a human domain; they take the form of subconscious desires and emotional impulses. To Wheatley (1992), looking for meaning in human world corresponds to looking for an attractor in a physical one. Looking for origin in *Mnemonic* and eternity in *A Disappearing Number* are the attractors that lead characters’ behaviour across continents and centuries. Ramanujan, Ruth, Al and Alice are consumed by and restricted to their attractors, but how?

Armed with a broken watch, Alice of *Mnemonic* starts her quest of looking for a long-lost father. She is motivated by unquenchable desire to find her roots. Her attractor, identity, led her to scour many cities and places across Europe. She even left behind a dear boyfriend ruminating their last meeting hoping to find a reason for her sudden disappearance. She chased trails of rumours and anecdotes from west to east. She stumbled across different stories of different people: a Greek taxi driver; Simonides and his wife a German hotel maid, and the BBC correspondent. Simonides left his country for a better life in Germany but ended up as a taxi-driver. He and his wife advised Alice to relinquish the past and look at the future

because in the past people “always arrive too late” (p. 46). Actually, they are not better than Alice. They are only attached to a different attractor, the future.

Alice went on her journey because being cut off an attractor means a loss in boundless space. Luckily, she met a sister-in-law who gave her more belongings of her dad: a pair of shoes, a lighter and a tallith or a prayer shawl. These priceless possessions provided her with invaluable hints of her father’s personality, profession and origin. They were examined carefully by the BBC man who told Alice that: her father is a smoker, a motorbiker and a devout Jew (pp. 51-52). Being a motor-biker means travelling a lot which is another characteristic of strange attractors. To Bishop (2008) attractors are in a continual move, but they never repeat a course or visit the same point twice.

Eventually, she succeeded in finding her father. He was sleeping in an apple orchard in a small village in Poland (p. 73). Suddenly, she abandoned the idea of meeting him and just walked away. Nothing would restore childhood memories. He was not there anyway. Being a part of a Jewish family who fled the Nazis, carrying a 5000-year history of migration and displacement did not work that much on Alice as she, during her journey, had come across similar tragedies. She was deep inside looking for a bigger connection, a bigger attractor. As her Dantean journey set an anchor in Bolzano Museum, Italy, Alice was face to face with Iceman body. She realised that she had to leave her personal attractor and embrace a bigger one, the entire humanity. To chaotic systems, it is quite natural to switch attractors during the process. It is an essential part of their entity. Casado-Gual (2012) states that Alice has eventually realised that “her identity is part of an even larger network of entangled memories.” This mysterious stranger, Otzi, can secure “the enigmatic answer to her quest” (p. 185).

In parallel, the Iceman became a centre of gravity where scientists from all over Europe rushed into the site between Italian-Austrian borders. They had a team led by archaeologist Konrad Spindler to examine this naked body from the past. They scrutinised every bit of him: tools, weapons, clothes and even his guts since he could provide them with an unparalleled opportunity to have a look at the daily life of Stone Age people. To Helen Freshwater (2001), the autopsy unveils man’s deep pressing “desire to recuperate meaning and to discover origins” (p. 214). It becomes the symbol and the mnemonic device to our connection with the past.

Questions about possession and later about commercial value of Otzi are ended by questions about origin. Everybody wants to know who he is, where he comes from, and the reason behind his death in the Alps. X-ray images of some broken ribs reveal that Otzi was a victim of violence. He struggled to survive. Reference made to a nearby village from Stone Age witnessed genocide makes the picture clearer (p. 71). The drama here provides parallel images of prehistoric and contemporary pogroms. In sum, the odyssey *Mnemonic* presents, that spans vast time and place from the Neolithic period to the 20th century and from London streets to the tops of the Alps, has managed to provide an attractor of interconnectedness and empathy to all of us. Yet, the play does not succeed in getting definite answers from the past. While archaeologists were caught up in never-ending speculations, Alice’s quest was culminated by “I can’t remember” (p. 73). To Freshwater (2001), such “incompletion is the only faithful way to depict the vagaries of memory” (p. 215). The instability of memory makes recapturing past more problematic than informative.

Conversely, *A Disappearing Number* also presented attractors that started personal and ended universal revealed through an Indian self-taught math genius Ramanujan, British math don Ruth and her husband Al, an Indian-American businessman. Ramanujan and Ruth were consumed by their love for math. Similarly, Al is quite eager to know the secret of his wife’s attraction to such an abstract subject. The first time we heard of Ramanujan was via voiceover introducing himself to Hardy as a poor clerk from India came up with some

theorems on prime number hoping to win Hardy's favour (p. 26). Recognising a prodigy, Hardy set all necessary arrangements to bring him to Cambridge.

Ramanujan had to face many challenges: religious, social and also the issue of acclimatisation. As a Brahmin, he was not allowed to travel abroad; however, a vision seen by his mother saved the situation (pp. 51-53). To Rao, the vision was not everything; "it was the mathematics that lured him" (p. 54). His love for math was the attractor that pushed him to chase his dream. As a genius worked by instincts, it was so hard to adapt with formalist Cantabrigian people addicted to proof. Moreover, it was also difficult for a man of faith attributed all his visions to Namagiri to justify himself before a committed atheist as Hardy (Haynes 2014).

Overall, Ramanujan was a complete alien. He was a poor Indian among the English, a dark brown among whites, a vegetarian Brahmin among Christian meat-eaters, intuitive among highly formalists, self-taught among educated and finally a young among the old. Cold weather, prejudicial treatment, strange dietary habits and long hours of work made him so dejected with suicidal tendencies (p. 78). In 1920 and after contracted TB, he returned to India to die a year later (pp. 75-76).

However, our poor hero from Tamil Nadu left a legacy still felt today. He left behind about "4000 formulas on 400 pages filling three volumes of notes" (p. 68). His modular forms and theta function have become key concepts in string theory. Truly, his theorems postulate a link that gives our universe its continuous expansion. Hardy deeply mourned his friend. He later described the seven years of collaboration as the most romantic experience in his life (p. 44).

Ruth, on the other hand, was very obsessed with Ramanujan's works. As she felt her biological and professional clock ticking harshly, she decided to travel to Ramanujan's hometown looking for inspiration. The play makes it very conspicuous regarding the transient nature of human life and the necessity to redefine one's self (Achachelooei, 2016). The solace might, as Hardy (1976) suggests, lie in math immutable nature: "immortality may be a silly word, but probably a mathematician has the best chance of whatever it may mean" (p. 81). To Hardy, physical reality and mathematical reality are totally different. While the first is transient, the second is everlasting. It is a pre-existing truth even before creation.

Mathematical infinity is the shortest way to eternity. To Al, infinity is the place where people go when they die. To Ruth, there are lots of them, "infinity of infinities." She explains to Al: between 1 and 2 and within, and between 3 and 4 and within up to infinity, there is a never-ending series of sub-numbers. She explains beautifully to Al—as he comes to ask her if she desires children—when "one plus a half plus a quarter plus an eighth plus a sixteenth" will become two. They "get closer and closer" but can never be a finite number, only at infinity (p. 49).

As the story unfolds, Ruth marries Al, becomes pregnant and unfortunately miscarries the baby. She dies of a brain aneurysm on a train heading to Ramanujan's village. The mathematical message is carried out through Ruth's agony. It is the sole reality, the only immutable one. Her response to math is similar to ours towards poetry. She sees in it: beauty, peace and harmony. It is chased by all but got by the very few. Despite their tragic death, Ramanujan and Ruth's saga is tied by Al, as seen scattering Ruth's books in the Cauvery River near Ramanujan's village. He succeeds in making peace not only with his beloved but also between her and Ramanujan. Similar to fractions draw near two, union with beloved ones can only be achieved at infinity where Ramanujan, Ruth and Al's attractor will drop anchor.

Concerning structure, the plot in both dramas is structured in the form of recursive symmetries or self-similarities constantly emphasising vagaries of memory and origin within the context of identity as in *Mnemonic*, or love, beauty and infinity within the context of

immortality as in *A Disappearing Number*. Stories in both dramas are told in a disordered mode. Thus, they appear untraceable and chaotic to the casual observer: a collage of images, sounds, conceits, ideas, and shards of narratives. Yet, they have order as they have attractors and recursive symmetries. Both dramas are made up of bits and pieces: disproportionate successive scenes without any intervals or act division. The plays do not move linearly rather they bounce between different places and times where action shuttles back and forth. Props and characters are in a continuous motion and transformation to provide a fragmented and chaotic background for narratives.

Dramas are devised in this way: a prologue in the form of a lecture sets the context by outlining the scientific idea that provides an overriding thematic and structuring image. Then it is followed by two narratives run in parallel: a fictional story from the present is interwoven with a real one from past. Both stories are met in the final scene to deliver play's message which starts personally but ends universally. The link between the two narratives is secured through chosen characters. In *Mnemonic*, it is Virgil who links the search story from the present with the archaeology story from the past via cellphone and TV-set. He is Alice's boyfriend and a great admirer of Iceman discovery. Likewise, in *A Disappearing Number*, the link is secured through two characters: Al; Ruth's husband and a non-mathematical person, and Rao; an expert in string theory and Ramanujan's math. Both are of an Indian origin, and both are brought up and educated in the West. In fact, most events are filtered through them.

However, to come up with these results, one has to imitate chaologists who track recurring symmetries or self-similarities to map out order in seemingly disordered as these symmetries can provide an overall picture. Thus, we are going to focus on these recurring images and similarities in both dramaturgy and scenography. As mentioned earlier, science is not only a subject matter or "a new language"; it is also "a stimulus for formal experimentation in drama and performance". Structural patterns, metaphors or images taken from science, as Campos (2013) explains, are translated clearly into both "dramaturgy and scenography" (p. 302).

Dramaturgically speaking, Alice's search story for personal identity in *Mnemonic* alternates with Otzi's archaeology story: a search for collective identity. Both Alice and Otzi are looking for shelter, be it physical or spiritual. Armed with scraps, they both fled a pogrom. Although Otzi lived it literally, Alice had to suffer the consequences. She is a rootless woman. While the former's remainders are scrutinised by archaeologists, the latter's observed by a keen eye of a correspondent (p. 37, 51). The remainders of both tell some but not the whole story. As she scours different European cities, she comes across many stories especially that of Simonides, the Greek taxi-driver. Unlike Alice, he chooses forgetfulness and sets future not past as an attractor. While he is heading west, she is heading east. In short, heading west or east, chasing future or tracking past, adopting forgetfulness or choosing remembrance, the collective recurring image drawn by *Complicite* is that of displacement and exile. The play, as Casado-Gual (2012) conceives, is alluding within "to violent episodes of European history, such as the Greco-Turkish war or the disintegration of Yugoslavia, and to the disturbingly massive wound of the Holocaust" (pp. 184-185).

Both Simon and Spindler, head of the archaeological team, launched into a long monologue. While Simon armed with a rock and a chair talked theoretically about the mutability of memory, armed with artefacts of Otzi Spindler proved such difficulty practically. While Simon provided the audience with leaves and eyeshades asking them to bring back some personal memories, Spindler, displaying scraps belongs to the Iceman, pushes the audience to ponder over collective ones. And while Simon invited the audience to watch a contemporary fictional story, the latter revealed a true one from past. Yet, in both cases, Simon and Spindler encouraged spectators to reassemble fragments utilising nothing but their imagination. In sum, while the artist revealed how memory is mutable, the scientist

proved it is so! Thus and despite all sophisticated technology, the past is still an issue of speculation and future is still an issue of prediction.

Conversely, both stories in *A Disappearing Number* are mirroring each other: recurring images are the technique the company adopts. In contemporary London, a loving husband is trying his best to figure out his wife's passion for abstract math. In Bangalore, his wife collapses as she chases the shadows of Ramanujan, her Indian inspiration. In the 1910s Cambridge, a math professor is doing his best to absorb jumbled theorems sent from India. In Madras, a prodigy is struggling with religion and caste taboos to follow his dream.

In both narratives, though nationalities are reversed, recursiveness is quite apparent. In emotional romance, the fiancé is non-mathematical of Indian origin; the fiancée is British math don. In intellectual romance, both persons are mathematicians; however, they are totally different in characters. Ramanujan is intuitive and follows his instinct. Hardy is an ardent formalist who adores proof. Both Ruth and Ramanujan travelled in opposite directions. Ruth headed east; from England to India. Ramanujan headed west. The passage to India is totally reversed and updated. In both narratives, mathematical facts of convergence, decomposition and infinity parallel love, death and immortality metaphorically speaking.

Al struggles badly with feelings of loss after his beloved's death. This is reality: life is finite. Yet, he finds a sort of solace as he remembers her words: "there are no gaps between the numbers, like there are no gaps in time or space; they are continuous. And if time is continuous, then we are linked to the past and future. And if space is continuous we are linked to the absent" (p. 30). Namely, everything is connected with everything else. It is what Ramanujan's theorems try to preach, and what chaos theory works to confirm. Actually, premature deaths of Ruth and Ramanujan foreshadowed how vulnerable we are in the face of chaos.

Scenographically speaking, the dramas are not only about narratives but also about inanimate objects that define them. To Barr (2006), *Complicite* relies mainly on two things: "the expressive powers of the body and the transforming capacity of inanimate objects" (p. 202). In both dramas, the scenery is quite economical and simple. Yet, the secret is that: it is constantly transforming. Actors are continuously in motion because it is not the word but the body is the medium for expression.

In *Mnemonic*, there is a sort of harmony between the spoken word, scenography and the body. As Virgil talked about chaos theory, the chair collapsed (p.13). It is changed throughout the play from McBurney's grandfather into Iceman's naked body under inspection and exhibition (p. 5, 26). To Campos (2014), McBurney possesses a special relation with chairs. He admires their ability to signify human body. The museum where Otzi's body kept is invoked through a picture-frame. Such frame is used to change perspectives and angles (p. 75). Soundscapes of Eurostar help audience to travel across Europe (p.19, 21, 30, 36). As archaeologists start describing tattoos on Otzi's body, projection immediately displays them on Virgil's nude body (p. 75). To reveal how it is hard to bring a true memory, stories are usually accompanied by noises of ringing cell phones, traffics, trains or jargon of different foreign languages.

Conversely, the lighting scheme, involving fans, haze and projections, is quite functional. It adds a lot to the tone and emotion of scenes. It does not only display images on walls, but also on actors' torsos. Sound design; ranges from voiceovers to collage of sounds, is really haunting and adds much to the general impact. Casado-Gual (2012) sums it up that these devices work "as an artistic compass" for audience "by providing them with scientific knots that form networks of theories; with cultural patterns that reveal maps of identities; with individual stories that re-present aspects of ...history" and above all they secure "dramaturgical strategies that reconstruct human empathy on the stage and which foster emotional bonds with the audience" (pp. 187-188).

Scenography along with dramaturgy in *A Disappearing Number* has worked jointly. It is revealed through recurring visual images. Sounds, music and videos; live and recorded, are utilised to evoke times, places, mathematical concept or to lay emphasis on present and past intersection. Immediately after the opening scene, audiences are showered by an amalgam of images: a young woman with her family on a boat ready to leave India, Ruth on a train, professor Hardy welcomed by a conference convener, Chamberlain proclaiming war against Germany and Churchill announcing India an independent nation (p. 31).

While OHP is exploited to display Ramanujan's letter to the audience (p. 46, 54), chairs are used to depict lounges in airports, cars, trains or even partners in dancing. Instead of classical blue cloth, the Cauvery River is projected on the screen. It alludes that modern technology is able to produce the same effect if it is used properly (Hamdan, 2011). Movable walls are not only used as a projection screen for city scenes but also to allow audience watching what is going on at the front or back of the stage simultaneously (p. 30, 33). A blackboard filled with theorems is utilised as a door through which people step to infinity.

As a cultural reference, the Tabla is also used to accompany complex ideas. As Ramanujan is engaged with numbers; voices, music and dances are accumulated to give rapid quick notes to simulate numerical progression. As things gradually become more energetic, papers begin to fly, and numbers start falling like snow everywhere on stage (p. 70). Faced by disjointed pieces, audiences are pushed to look for patterns. It is what mathematicians do, and it is what Complicite did to create this piece: a long process of improvising and rehearsing. And here lies the similarity between art and math: both are a creative process.

In both dramas, time begins decreasing as narratives move towards the climax. In *Mnemonic*, the final scene presents an answer to the repeated question about the meaning of nakedness. Actors start a sequence of rolling, one by one replacing Otzi on the table. Their movement suddenly accelerates to become an image for successive generations of humankind (p. 75). This metaphor summarises all fragmented stories of exile and displacement. Amid this phantasmagoric and panoramic image, the naked body indicates unity among people or as expressed by Reinelt (2001) "a family of man" (p. 376). McBurney, actually, spent like a quarter of the play stark naked. The reason is that nakedness is a pivotal theme in the play. The human body is not only flesh and blood, but the whole history is there! The whole biography is recorded on our bodies: gender, race, suffering and happiness. Otzi's unsolved mystery and Alice's open-end story propose the impossibility of restoring past in its entirety. Here *Mnemonic* actually performs honestly what it preaches. Remember is not an act of retrieving rather it is an act of creation. One day, we become part of ashes of history; partly might be recognised but impossible to be recovered wholly. Yet, the solution lies in going on telling stories because without them, our past dies, and what makes us unique with it.

In *A Disappearing Number*, Al and Rao appear on stage. They both stand by the river near Ramanujan's village. As Rao begins scattering his aunt's ashes, Al starts to throw his wife's math books into the sacred river. Through this epiphany, the two men, who come to pay tribute to their beloved ones, tie both narratives together. The scene is concluded by Ruth's hand stretches to rest on Al's shoulder. She begins relating in a sad voice magnificent lines about the image of entangled bones of lovers in death which is highly connected to math. According to Rao; "prime numbers are the bones of mathematics" (p. 72). The decomposition of numbers into their primes is quite similar to that of dead bodies into bones. As suggested by Gritzner (2011), this powerful image reconnects audience with play's central idea of "the beauty of abstract thought and the intractability of love" (p. 105). The final image implicit in Ruth's poetic speech emphasises what explained mathematically earlier that fully union between lovers might be possible, but only in the world of infinity. A fact Al partly grasps but solemnly accepts.

CONCLUSION

The two plays hold successfully all Complicite features: fragmented narratives, nonlinear plots, and vast span of time and space flavoured with innovative multi-media and expressive physical movements. This merge of scenography, dramaturgy and choreography succeed in integrating the complicated discourse of science into theme, structure and performance.

Epic in scope, the two dramas cross all borders, be it cultural, geographical or chronological, and challenge man's linear perception of time and space. They even question our concept of theatre performance. Science is utilised not only as a source for narrative but also as a source for structure. Outlined in the opening scene, the scientific idea secures a kind of overarching framework to the fragmented text. The interlocking narratives are told backwards and forward and sometimes cut from the middle. The traditional plot-structure of putting things next to each other in a linear unified plan no longer works. *Mnemonic* and *A Disappearing Number* hardly possess plots. The conventional method of a writer writes, a director stages and an actor performs is no longer applicable. Complicite creates its own dramas collectively through a lengthy process of improvising and rehearsing as our world cannot be embraced within a single story.

Chaos theory helped much in providing an all-encompassing framework for analysis. It assisted in catching loose threads in narratives and in figuring out patterns of order amid this formlessness and fragmentation. The butterfly effect shed light on these little events and inconsequential details that triggered action in both dramas. Strange attractors, on the other hand, were utilised to identify thematic concepts governed characters movements, i.e. mutability of memory and origin within the context of identity in *Mnemonic* or intellectual curiosity and eternity within the context of infinity in *A Disappearing Number*. Characters were consumed by unquenchable desire to find answers. Recursive symmetry succeeded in mapping out order in apparently chaotic plots by tracking self-similarities in dramaturgy and scenography.

Complicite in both plays set universality as a collective attractor embracing all humanity regardless geography, culture or race. While naked human body in *Mnemonic* is chosen as a universal symbol of unity among mankind, mathematics is selected as a means of communication in *A Disappearing Number*. The abstract math is humanised to depict the entanglement of human relations. The company succeeds in presenting boundless utopia able to accommodate us all with the human body as an identity and math as a language and path for eternity.

REFERENCES

- Achacheloeei, E. M. (2016). The God-Human Relationship in Octavia Butler's "The Book of Martha." *GEMA Online[®] Journal of Language Studies*. Vol. 16(3), 129-143.
- Alonso, M. (1990). *Organisation and Change in Complex Systems*. New York: Paragon House.
- Argyros, A (1991). *A Blessed Rage for Order: Deconstruction, Evolution, and Chaos*. University of Michigan Press.
- Arons, M., Richards, R. & Bugental, J. F. T. (2014). Two Noble Insurgencies: Creativity and Humanistic Psychology. In Kirk J. Schneider, J. Fraser Pierson and James F. T. Bugental. (Eds.), *The Handbook of Humanistic Psychology: Theory, Research, and Practice*. (pp. 161-176). London: SAGE Publications.
- Barr, K. S. (2006). *Science on Stage: From Doctor Faustus to Copenhagen*. Princeton University Press.
- Bishop, R. C. (2008). What Could Be Worse than the Butterfly Effect? *Canadian Journal of Philosophy*. Vol. 38(4), 519-547.
- Briggs, J. & Peat, F. D. (1990). *Turbulent Mirror: An Illustrated Guide to Chaos Theory and the Science of Wholeness*. New York: Harper & Row.
- Butz, M. R. (1993). Practical Applications from Chaos Theory to the Psychotherapeutic Process, a Basic Consideration of Dynamics. *Psychological Reports*. Vol. 73(2), 543-554.
- . (1992). Chaos, an Omen of Transcendence in the Psychotherapeutic Process. *Psychological Reports PR*. Vol. 71(7), 827-843.

- Cambel, A. B. (1993). *Applied Chaos Theory: A Paradigm for Complexity*. New York: Academic Press, Inc.
- Campos, L. (2014). This Is Not a Chair: Complicite's Master and Margarita. *New Theatre Quarterly*. Vol. 30(2), 175-182.
- . (2013). Science in Contemporary British Theatre: A Conceptual Approach. *Interdisciplinary Science Reviews*. Vol. 38(4), 295-305.
- Casado-Gual, N. (2012). Pre-dicting the Past, Re-remembering the Present: Theorizing Memory in Complicite's *Mnemonic*. *New Theatre Quarterly*. Vol. 28(2), 182-188.
- Freshwater, Helen. (2001). The Ethics of Indeterminacy: Theatre De Complicite's 'Mnemonic'. *New Theatre Quarterly*. Vol. 17(3), 212-218.
- Galatzer-Levy, R. M. (1995). Psychoanalysis and Dynamical Systems Theory: Prediction and Self Similarity. *Journal of the American Psychoanalytic Association*. Vol. 43(4), 1085-1114.
- Gillespie, M. P. (2008). *The Aesthetics of Chaos: Nonlinear Thinking and Contemporary Literary Criticism*. University of Florida Press.
- Gleick, J. (1987). *Chaos: Making of a New Science*. New York: Penguin Group.
- Gritzner, K. (2011). Spirit to Ashes, Performance to Dust: Derrida, Theatre De Complicite, and the Question of a "Holy Theatre." *Performance and Spirituality*. Vol. 2(1), 85-110.
- Hamdan, S. A. (2011). Human Subjectivity and Technology in Richard Morgan's Altered Carbon. *3L: Language, Linguistics, Literature*. Vol. 17(Special Issue), 121-132.
- Hardy, G. H. (1967). *A Mathematician's Apology*. Cambridge University Press.
- Hawkins, H. (1995). *Strange Attractors: Literature, Culture and Chaos Theory*. New York: Prentice Hall.
- Hayles, N. K. (1991). Complex Dynamics in Literature and Science. In N.k. Hayles (Ed.), *Chaos and Order: Complex Dynamics in Literature and Science*. (pp.1-33). Chicago: The University of Chicago Press.
- . (1990). *Chaos Bound: Orderly Disorder in Contemporary Literature and Science*. Ithaca: Cornell University Press.
- Haynes, R. D. (2014). Whatever Happened to the 'Mad, Bad' Scientist? Overturning the Stereotype." *SAGE Journals*. Vol. 1(45), 1-14.
- Hickie, R. J. (2008). *Scenography as Process in British Devised and Postdramatic Theatre*. (Doctoral Dissertation). Retrieved from <https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/12660>
- Hunter, M. (2005). *Theatrical Wonder*. (Doctoral Dissertation). Retrieved from <https://repositories.lib.utexas.edu/handle/2152/1578>
- Kellert, S. H. (1994). *In the Wake of Chaos: Unpredictable Order in Dynamical Systems*. The University of Chicago Press.
- Lorenz, E. N. (1995). *The Essence of Chaos*. U.K: UCL Press Limited.
- Loye, D., & Eisler, R. (1987). Chaos and Transformation: Implications of Nonequilibrium Theory for Social Science and Society. *Behavioral Science*. Vol. 32(1), 53-65.
- Porush, D. (1991). Prigogine, Chaos, and Contemporary Science Fiction. *Science Fiction Studies*. Vol. 18(3), 367-86.
- Prigogine, L. & Stengers, I. (1984). *Order Out of Chaos: Man's New Dialogue with Nature*. Bantam Books.
- Reinelt, J. (2001). Performing Europe: Identity Formation for a "New" Europe. *Theatre Journal*. Vol. 53(3), 365-387.
- Rossi, E. L. (1989). Archetypes as Strange Attractors. *Psychological Perspectives: A Quarterly Journal of Jungian Thought*. Vol. 20(1), 4-15.
- Ruelle, D. (1991). *Chance and Chaos*. Princeton: Princeton University Press.
- Stewart, I. (2002). *Does God Play Dice? The New Mathematics of Chaos*. USA: Blackwell Publishing Ltd.
- Stone, R. (2008). A Disappearing Number (Review). *Theatre Journal*. Vol. 60(3), 489-491.
- Svyantek, D. J. & DeShon, R. P. (1993). Organisational Attractors: A Chaos Theory Explanation of Why Cultural Change Efforts often Fail. *Public Administration Quarterly*. Vol. 17(3), 339-355.
- Theatre de Complicite. (2007). *A Disappearing Number*. London: Oberon Book.
- . *Mnemonic*. (1999). GB: Methuen Drama.
- Thelen, E. (2014). Self-Organisation in Developmental Processes: Can Systems Approaches Work? In Megan R. Gunnar & Esther Thelen (Eds.), *Systems and Development: The Minnesota Symposia on Child Psychology Vol.22*. (pp. 77-117). New York: Psychology Press.
- Wheatley, M. J. (1992). *Leadership and the New Science: Learning about Organisation from an Orderly Universe*. San Francisco: Berrett-Koehler.
- Wright, R. (1988). Did the Universe Just Happen? *The Atlantic Monthly*. Vol. 261(4), 29-44.