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# Synthesizing Dichotomies in Tom Stoppard's Play *Arcadia*

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***Abstract*— *The research paper connects thematic complexities in Tom Stoppard's play Arcadia (1993) with paradigm shifts in science. A remarkable illustration of science as a metaphor for human behaviour, Arcadia alternates between the early 1800s and 1993, interlinking the scientific pursuits of characters across time periods. Stoppard dexterously introduces Chaos Theory into the play through a young girl, Thomasina Coverly, who intuitively anticipates Fractals in the early nineteenth century. The playwright takes his readers through a world first ruled by Newton's laws, then one where those laws are revised by the laws of Thermodynamics, and then one where they are revised yet again by Chaos Theory. The paper brings out a series of dichotomies latent in the plot structure of the play - Classicism versus Romanticism, Science versus Humanities and Newtonian Determinism versus the Second Law of Thermodynamics, which signify the presence of order and purpose amid the apparent randomness and disorder in the universe. Arcadia is an apt exemplification of how order arises from chaos.*

***Keywords*— *Arcadia*, dichotomies, Newtonian determinism, order and chaos, Second Law of Thermodynamics**

## I. INTRODUCTION

This is the way the world ends,
This is the way the world ends,
This is the way the world ends,
Not with a bang, but with a whimper!

-T.S.Eliot

The renowned British playwright and screenwriter Tom Stoppard (b.1937) is widely celebrated for his wit, intellect and innovative use of language. *Arcadia*, a remarkable exemplification of the impact of the Second Law of Thermodynamics on the human psyche, refers to a wide array of subjects, including mathematics, physics, thermodynamics, computer algorithms, fractals, population dynamics and Chaos Theory. The play earned the prestigious Olivier Award for Best Play in London, and in America, it received the New York Drama Critics Circle Award.

Stoppard challenges the readers to decode the mysteries of existence and limitations of human understanding with a captivating delineation of modern scholars' struggle to interpret the clues left by past scholars.

The paper uncovers latent thematic dichotomies in Stoppard's *Arcadia* through which the plot unfolds, bringing the intersection of science, literature and human relationships to the fore.

## II. *ARCADIA*: A BRIEF THEMATIC OVERVIEW

*Arcadia* unfolds at Sidley Park, an aristocratic estate in Derbyshire, England. The plot of the play alternates between two distinct periods separated by nearly two hundred years, remarkably portraying the scientific pursuits of the modern characters with the intellectual initiatives of the past characters. The first half of the play depicts the early 1800s (1809-1812), presenting an engaging conversation between an intelligent teenage girl, Thomasina Coverly and her tutor, Septimus Hodge. Thomasina's understanding of science is much ahead of her time. The action in the second half of the play takes place in 1993, with a group of modern scholars, Hannah

Jarvis, Bernard Nightingale and Valentine Coverly, who probe the house's history and its inhabitants.

Though Chaos Theory is still nearly two hundred years away from being developed, Stoppard works it into the plot of the play through a thirteen-year-old math genius, Thomasina Coverly, who manages to invent fractal geometry and comprehend two central principles of Chaos Theory - entropy and its irreversibility. Thomasina's discoveries are explained in the present-day setting of *Arcadia* by her descendant, Valentine Coverly, a mathematician, who is deeply engaged in studying the historical records and documents related to the estate's past, mainly the early nineteenth century. He concentrates on the work of his ancestor, Thomasina Coverley. Stoppard explains the workings of chaos theory through Valentine's research on the grouse population.

*Arcadia* revolves around the interplay between past and present, order and disorder, depicting the nature of truth and knowledge. Stoppard takes his readers through a world first ruled by Newton's laws, then one where the laws of Thermodynamics revise those laws, and then one where they are revised yet again by Chaos Theory. Elisabeth Angel-Perezon writes:

> With *Arcadia* Stoppard suggests that post-modernism, fragmentation and chaos are reclaimed if not by order, at least by determinism. In Chaos theory, Stoppard finds the oxymoronic and paradoxical vision of a world which becomes disorganised as a system but organised as chaos. The Stoppardian new problem play elects complexity as its thesis and conveys a message which is both conservative and iconoclastic.

## III. SHIFTING PERSPECTIVES IN SCIENCE: A GLANCE

Classical Physics, primarily developed by Sir Isaac Newton(1643-1727), posits a deterministic universe operating as a machine governed by cause and effect. Predictability extends to human choice and action in this framework, making free will and autonomy subject to the deterministic system.

The arrival of the Second Law of Thermodynamics shook the Newtonian world with the realisation that the level of disorder is constantly rising in the universe, and the amount of potential energy is steadily depleting. In *Great Ideas in Physics* (1992), Alan Lightman explicates:

> The second law says that some processes in nature are one–way arrows, never going backwards, never returning the world to its initial condition. The machines are running down. The universe, on average, is dissipating itself. (61)

The emergence of Quantum Theory sent shock waves through the Newtonian world, shattering the clockwork model and destabilising notions of certainty. At the end of the nineteenth century, Max Planck (1858-1947), a leading German physicist, argued that light was not merely a wave (as previously believed) but made up of "quanta" or discrete packets of energy. Albert Einstein (1875-1955) extended Planck's discovery in 1905 with his theory that light does not always behave like a wave but sometimes behaves like a particle. This 'wave-particle duality' forms the basis of Quantum Theory and is still one of the greatest enigmas of the quantum world. In 1926, Ervin Schrodinger(1881-1961) also developed his famous Schrodinger equation, the fundamental equation in Quantum Physics.

With the current social, political, and moral upheavals, uncertainty has crept into almost every facet of the world. Chaos theory, a mathematical sub-discipline also known as the Science of Chaos, is based on discovering that highly chaotic systems are rich in information and often exhibit some underlying pattern. Nature is highly complex and mysterious, and Chaos Theory examines its extraordinary unpredictability.

## IV. EXPLORING DICHOTOMIES IN ARCADIA

A close analysis of *Arcadia* reveals that the plot progresses with interesting thematic dichotomies : Order and Chaos, Classical Newtonian Determinism and the Second Law of Thermodynamics, Regular Euclidean Geometry and Irregular Geometry (fractals), and Humanities and Science.

The argument between Lady Croom and Mr Noakes over the changes being made in the Sidley garden aptly illustrates the clash between the tidiness and order of the Classical style and the rugged, gothic appearance of the Romantic. Hannah passionately exclaims to Bernard:

> The whole Romantic sham, Bernard! It's what happened to the Enlightenment, isn't it? A century of intellectual rigour turned in on itself. A mind in chaos suspected of genius...The decline from thinking to feeling. (39)

Further, Stoppard presents this dichotomy through the characters of Septimus and Thomasina. Even though Thomasina lacked sufficient mathematical background, through her intuition, she could understand the Second Law of Thermodynamics, contradict Classical-Newtonian

Determinism, and discover the foundations of Chaos Theory and irregular geometry (fractals). Septimus, a strong advocate of classical Newtonian science, discards her discoveries as mere whimsical stories until he understands the implications of her discoveries. Later, after her death, as a hermit at Sidley Park, he spends his entire life proving these discoveries through English Algebra.

In the modern context, Stoppard depicts the dichotomy between Classicism and Romanticism through Hannah Jarvis and Bernard Nightingale. Hannah embodies classical temperament with her classical reserve and objective approach, which she demonstrates while investigating the mystery surrounding the nineteenth-century hermit at Sidley Park. She did not draw hasty conclusions based on her intuition but rather strove for evidence to prove that the hermit was none other than Septimus Hodge, Thomasina's tutor, whose love was shattered with her premature accidental death. Hodge devoted the remainder of his life to proving her theories using English Algebra.

On the other hand, the character of Bernard Nightingale represents the Romantic temperament. He relies more on the methods of subjective investigation in developing his theory. Without evidence, he believed Lord Byron had killed Mr Ezra Chater in a duel at Sidley Park in 1810. Later, when Hannah proves him wrong, he immediately leaves Sidley Park embarrassed and devastated. His character depicts recklessness, predominance of emotions over rational thinking, arrogance, greed, pomp and biased research. He values literature and personalities more than scientific progress.

The dichotomy between Science and Humanities forms an important part of *Arcadia*. Valentine Coverly's background in science, mathematics, and Chaos Theory helps him understand Thomasina's discoveries. Through Valentine, the playwright explains the major shifts in science and reveals the relevance of past scientific discoveries in the present time.

The argument between Valentine and Bernard brings out the dichotomy between science and humanities. In scene five, Valentine and Hannah do not accept Bernard's belief that Lord Byron killed Mr Ezra Chater in a duel over his wife due to a lack of objectivity and concrete evidence. In the arguments that follow, Valentine stresses the importance of scientific advancement and asserts:

> The questions you are asking don't matter, you see, It is like arguing who got there first with the calculus. The English say, Newton, the Germans say Leibnitz. But it doesn't matter. Personalities. What matters is the calculus. Scientific progress. Knowledge.(82-83)

The character of Bernard stands for the superiority of art and humanities. He holds the view that artistic genius exceeds scientific understanding. For him, literature and philosophy are more important than science and its progress. He says:

> Oh, you're going to zap me with penicillin and pesticides. Spare me that and I'll spare you the bomb and aerosols. But don't confuse progress with perfectibility. A great poet is always timely. A great philosopher is an urgent need. There is no rush for Isaac Newton. We were quite happy with Aristotle's cosmos. Personally, I preferred it. Fifty-five crystal sphere geared to God's crankshaft is my idea of a satisfying universe. I can't think of anything more trivial than the speed of light. Quarks, quasars- big bangs, black holes – (83)

Another significant dichotomy fundamental to the play is between Classical Newtonian Determinism and the Second Law of Thermodynamics. In the Age of Enlightenment, scientists compared the universe to a mechanical clock, which works as a perfect machine with its gears governed by Newton's laws of physics, making every aspect of the system perfectly predictable. They believed that events within this universe are bound by causality in such a way that any state of an object or an event is completely determined by its initial state. They believed that since prediction is possible in the deterministic world, free will, autonomous human choice and action become subject to the same predictable system. This is generally referred to as Classical Newtonian Determinism.

Stoppard delineates this dichotomy through the characters of Septimus and Thomasina, Even though Thomasina lacked sufficient mathematical background, through her intuition, she could understand the Second Law of Thermodynamics, contradict Classical-Newtonian Determinism, and discover the foundations of Chaos Theory and irregular geometry (fractals). Septimus, a strong advocate of classical Newtonian science, discards her discoveries as mere whimsical stories until he understands the implications of her discoveries. Later, after her death, as a hermit at Sidley Park, he spends his entire life proving these discoveries through English Algebra.

Thermodynamics has originated from the study of engines. Most early engines built in the Enlightenment era were slow and clumsy, converting only 2% to 3% of the fuel into useful work as they used heat conduction between bodies at different temperatures. Nicolas Leonard Sadi Carnot(1796-1832), a French mechanical engineer who is regarded as the father of Thermodynamics, mentioned in his book *Reflections on the Motive Power of Fire* (1824) that the conduction of heat between bodies at different temperatures is a wasteful and irreversible process, which must be eliminated if the heat engine is to achieve maximum efficiency. His notion formed the early version of the Second Law of Thermodynamics. Later, Emile Clapeyron (1799-1864), a French engineer and physicist, further developed the work of Sadi Carnot, which was further elaborated by Clausius and Kelvin, who developed the concept of 'entropy' and the Second Law of Thermodynamics.

Entropy is a thermodynamic property. The second law states that all processes go only in one direction, which is the direction of greater and greater degradation of energy, in other words, to a state of higher and higher entropy. This implies that thermal energy always flows spontaneously from regions of higher temperature to regions of lower temperature, and the process reduces the state of order of the initial system. Therefore, entropy is an expression of disorder or randomness. In the play's very first scene, Thomasina understands the concept of entropy and discusses this topic by putting forth her rice pudding example. She enquires about the reasons underlying this:

> Thomasina: When you stir your rice pudding, Septimus, the spoonful of jam spreads itself round making red trails like the picture of a meteor in my astronomical atlas. But if you need to stir backwards, the jam will not come together again. Indeed, the pudding does not notice and continues to turn pink just as before. Do you think this is odd?
>
> Septimus: *No.*
>
> Thomasina: Well, I do. You cannot stir things apart. (8)

The problem of rice pudding is a direct consequence of the Second Law of Thermodynamics, which states all processes go only in one direction, which is the direction of a greater and greater degradation of energy, in other words, to a state of higher and higher entropy. The rice pudding problem not only indicates the irreversibility of time but also points to the irreversibility of the process, which answers her puzzle and makes Thomasina doubt Newtonian determinism. We all know that time flows in a specific fixed and irreversible direction.

In scene seven, Septimus gives an essay from the Scientific Academy in Paris to Thomasina in which the scientist much like Thomasina finds a contradiction in Newton's Theory of Determinism. She exclaims with joy seeing the French Scientist's results in line with her intuitive ideas:

> Septimus: He demonstrates the equation of propagation of heat in a solid body. But in doing so he has discovered heresy- a natural contradiction of Sir Isaac Newton.
>
> Thomasina: Oh! He contradicts determinism?
>
> Septimus: No!... Well perhaps He shows that the atoms do not go according to Newton.
>
> Thomasina: Well ! Just as I said! Newton's machine which would knock our atoms from cradle to grave by the laws of motion is incomplete! Determinism leaves the road at every corner, as I knew all along, and the cause is very likely hidden in this gentleman's observation.
>
> Lady Croom: Of what?
>
> Thomasina: The action of bodies in heat. (114)

In the seventh scene, Thomasina, due to her intuitive understanding of entropy and the Second Law of Thermodynamics, could perceive deficiency in Mr Noake's model of the steam engine. She expresses her ideas about the same in the form of a diagram (known as a Heat Exchange diagram today) and gives it to Mr Noakes. When a confused Septimus asks her to explain the meaning of her observation, she explains as follows:

> Thomasina: Oh…yes. Newton's equations go forwards and backwards, they do not care which way. But the heat equation cares

very much, it goes only one way. That is the reason Mr Noakes's engine cannot give the power to drive Mr Noakes's engine. (118-119)

On being warned by Septimus that everybody knows about the inefficiency of a steam engine, her sarcastic remark, "They know it about engines!" clearly shows her confidence in the universality of her intuitive ideas, which were later discovered and established as entropy and the Second law of Thermodynamics. The idea of the heat death also stems from the Second Law of Thermodynamics. According to this, the mechanical movement of the universe will run down as work gets converted to heat in time, finally, leading to heat death.

Towards the end of the play, in the seventh scene, when Septimus begins to understand Thomasina's intuitive ideas regarding the Second Law of Thermodynamics, entropy and the heat death of the universe, he exclaims, "So, we are all doomed!" to which Thomasina cheerfully replies "yes". Septimus shows his understanding of Thomasina's theory and says, "So the Improved Newtonian Universe must cease and grow cold. Dear me." (128)

The dichotomy between regular geometry and irregular geometry reinforces the dichotomy between classicism and romanticism, with regular geometry representing classicism and irregular geometry representing romanticism. In the third scene, Thomasina expresses her displeasure over the equations formulated by Septimus, which, according to her, are limited to commonplace manufactured forms. She wants to create the kind of equations that make the unpredictable nature. Through deterministic chaos, Thomasina intuits that irregularity triggers the emergence of life. The conversation between Thomasina and Septimus is interesting:

> Thomasina: God's truth, Septimus, if there is an equation for a curve like a bell, there must be an equation for a curve like a bell, there must be an equation for one like bluebell, and if a bluebell, why not a rose? Do we believe nature is written in numbers?
>
> Septimus: He (God) has mastery of equations which lead into infinities where we cannot follow. (52)

In the same scene, Thomasina tells Septimus :

> Mountains are not pyramids and trees are not cones. God must love gunnery and architecture if Euclid is his only geometry. There is another geometry which I am engaged in discovering by trial and error, am I not, Septimus? (114)

In Scene four, Hannah and Valentine come across Thomasina's Mathematics Primer through which they come to know of Thomasina's discoveries. They see the following written in the book :

> I, Thomasina Coverly, have found a truly wonderful method whereby all the forms of nature must give up their numerical secrets and draw themselves through numbers alone. This margin being too mean for my purpose, the reader must look elsewhere for the New Geometry of Irregular Forms discovered by Thomasina Coverly (58)

Hannah and Valentine discover that the pages of Thomasina's book are filled with iterated equations or equations that feed solutions of one equation into the next step/iteration. Valentine explains to Hannah:

> What she is doing is, every time she works out a value for y, she's using that as her next value for x. And so on. Like a feedback. She's feeding the solution back into the equation, and then solving it again. (61)

Valentine relates his technique, which he is using in his grouse numbers research work in the twentieth century, to Thomasina's method developed almost two hundred years ago. He further explains that what Thomasina discovered years ago is now called Fractals. He tells Hannah that the unpredictable results of iteration are like the unpredictability of nature. Valentine elucidates:

> If you knew the algorithm and feed it back say ten thousand times, each time there'd be a dot somewhere on the screen. You'd never know where to expect the next dot. But gradually you'd start to see this shape, because every dot will be inside the shape of this shape, because every dot will be inside the shape of this leaf. It wouldn't be a leaf, it would be a mathematical object. But yes. The unpredictable and the predetermined unfold together to make everything the way it is. It is how nature creates itself, on every scale, the snowflakes and the

> snowstorm. It makes me so happy. To be at the beginning again, knowing almost nothing. (64)

Valentine iteratively plots the beautiful "Coverly set" on his computer screen using Thomasina's equations and tells Hannah:

> In an ocean of ashes, islands of order. Patterns making themselves out of nothing. I can't show you how deep it goes. Each picture is a detailed of the previous one, blown up. And so on. Forever. Pretty nice, eh?" (103)

In *Arcadia,* the passions for love and intellectual pursuits are shown to be in constant conflict throughout. The playwright offers a solution through the proposition of marriage and the philosophical justification for sex. The play touches upon the theme of love versus intellect through Thomasina's character. Sexual knowledge gets in the way of Thomasina's maths lesson. She also discusses the conflict between emotion and intellect during her history lesson. Thomasina applauds Queen Elizabeth, who did not give away land or power, succumbing to the passion of love. In the modern context, the great Hannah Jarvis is like Thomasina's Queen Elizabeth, unswayed by romantic passions. She believes, as did Thomasina that romantic inclinations would destroy or distract her from her work. Hannah refuses warmth or emotion: she refuses a kiss, denies Bernard's propositions, laughs at Valentine's proposal, and brushes off Gus's flirtation.

Nonetheless, Hannah, unlike Thomasina, towards the end of the play, could not resist her emotion for the bashful Gus all waltz. The conflict between emotion and intellect is resolved with Hannah's realisation that the two are inseparable. Hannah unconsciously understands this interconnection between the two and is driven by the mystery of both.

The dichotomy between 'Order and Chaos' is predominant throughout. The scenes in the play keep bouncing from the past to the present in a non-linear manner and finally, in the last scene the juxtaposition of the past and present reflects the chaotic structure of the play and showcases how everything is gradually dispersing into a state of chaos and entropy, and yet within that chaos, order is to be found. Valentine summarises this idea: "In an ocean of ashes, islands of order. Patterns making themselves out of nothing." (103). Even though the characters constantly attempt to define the order in the world through their ideas and theories, they are continually overturned. Even the table which collects props from both periods is a strong example of the dichotomy between order and chaos. In "Science in Hapgood and Arcadia" (2001), Paul Edwards explains:

> At the end of the play, the table has accumulated a variety of objects that, if one saw them without having seen the play, would seem completely random and disordered. Entropy is high. But if one has seen the play, one has full information about the objects and the hidden 'order' of their arrangement, brought about by the performance itself.(174)

## V. CONCLUSION

*Arcadia* dexterously portrays how contradictory phenomena can coexist paradoxically at the same time and in space. According to John Fleming, Stoppard "shows an acceptance of uncertainty and instability as being the central component of the world; however, his plays also embrace order, logic and those things that provide stability in an uncertain world"(22). The ultimate message is nature is unpredictable and random, the universe is moving towards disorder and "the paths of glory lead but to grave", yet, there is order in this disorder. Seeing order in disorder refers to seeing the purpose of our life amid the baffling diversity and complexity of the universe. In the long march of history, humankind has always been driven by purpose, which makes order emerge from chaos.

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