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INTERDISCIPLINARY CONNECTIONS BETWEEN SCIENCE & THEATRE

Jessica N. Dotson

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A thesis submitted in partial fulfillment of the requirements of the degree of Master of Fine Arts at Virginia Commonwealth University.

by

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Abstract

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In the 1990s, astronomer Peter Usher was searching for new ways to teach his introductory astronomy class at Pennsylvania State University. He began to engage his students by searching for astronomical connections from other disciplines. His focus was turned to the arts, especially the works of William Shakespeare. Usher found, while searching through the canon of Shakespeare's work, astronomical references that explored the “new astronomy” of the Elizabethan age (Falk 171). This thesis will explore the writings of Usher, in regard to the astronomy of *Hamlet*, along with the interdisciplinary connections between art and science in and outside the classroom and museum theatre. From interdisciplinary classroom methods, to arts and scientists collaborating together for the betterment of man-kind, the use of theatre is a way of rediscovering the humanity of human history. The collaboration between the disciplines serves as one of theatre's greatest purposes, to educate and represent a living history of man.

PREFACE

Upon coming to graduate school, I never knew museum theatre was something one could do; the concept of museum theatre had at no time entered my mind. In my first week of school, I was introduced to Larry Gard, who would have a great impact on the next two years of my education. I have always had a fascination with science, and though I never pursued this interest in my studies, I still read and explored these subjects on my own. The appeal of science was not discovered until I was in my twenties and by then I thought it was too late to pursue any type of degree in the field. My life in between my undergraduate education and my graduate education was full of encounters with both scientific and artistic minds. Together my friends and I were a group of individuals who would discuss recent books we read, make bad philosophy jokes to one another and, on clear nights, sit outside and watch meteor showers; it was a truly inspiring environment. I spent years with this group, which included musicians who now study biology, a chef who explored new recipes with the aid of *The Science of Cooking*, and people with backgrounds in theatre who would, for fun, constructed theories through math. During this time in my life, I began to look at science with an artistic lens and began to find beauty in the sciences that I'd never seen before.

Art was in mathematics, both in an aesthetic quality, but also in its communicative aspects; it was in the structure of the human body, and of course in the beauty of the night sky. I was lucky enough to grow up in rural Virginia seeing the bright stars each night, along with

shooting stars and eclipses that filled the sky. When I looked up, I found comfort in these objects, they gave me a sense of security and allowed me to explore the limitless possibilities of the night. The stars have been an inspiration in all of my artistic attempts such as painting, sculpting, poetry, craft-making, but never in theatre. The connection between science and theatre would not come until the fall of 2013, with that first meeting with Larry, when I began to explore science and museum theatre.

One of the reasons I was compelled to study theatre was because I saw it as one of the only subjects that covered every area of academia. For someone who wants to explore various fields, this was an area of that would allow me to pursue all those interests. I perceive the study of theatre to be equal to the study of man-kind's story throughout history, for theatre and the arts are ways of exhibiting publicly a moment in time, displaying examples of knowledge and ideology of the current human state; science is no exclusion. Theatre is the opportune place for a cross-disciplinary education to take place in both a classroom setting and in its professional environment. However, being introduced to museum theatre gave me a new avenue of theatre to explore, but at the time I still was preparing myself for a career as a theatre educator. The entire reason for my pursuit of my graduate degree was to teach, but I had still yet to realize that there was more than one way to educate.

I spent that first year in a conflicted state, questioning my abilities as an educator and wondering if teaching in a university setting was the right fit for me. I enjoyed discussing texts with students, listening to their ideas on how they'd explore its meanings, or hearing of the discoveries they made through a play that connected with them on a personal level. The days where I felt the most accomplished were when the class constructed their own vignettes from the

reading, or through reenactments in different styles, playing with the text's possibilities. Overall, I was struggling with my confidence as an educator, always wondering if I was conveying the information correctly or if what I was saying even made any sense. I wanted to teach, but I began to come to terms with my ability and skill to do so. Even in arts education we sometimes forget about the artistic aspect of the material we are studying, especially in regards to more academic based subjects. I realized the way I was teaching was not how I'd run a classroom of my own, for I was following the teaching structure of those around me, hindering my own abilities. I wanted to explore the text more with its association to the events that were occurring simultaneously while these productions were being written and performed. I wanted students to play a creative part in their learning through hands-on experiences of performance and technical projects, where the information goes beyond facts and dates to applicable knowledge they can infuse with their own art; however, at the rate the course material was taught it allowed very little time for such exploration to take place.

As my first year of school came to an end, I realized my passion and desire to teach in an educational environment was waning, and I struggled to find what it was that I wanted to do. I had enjoyed my work in museum theatre, but there were no courses offered that would allow me to explore this new curiosity further. In my next semester I would enroll in a course through the museum studies department; I have always enjoyed and valued art, but an art historian I was not. “Museums and Communities” was my first step in engaging in interdisciplinary studies. Though much of the material involved the art museum, I began to find hidden connections to my other areas of interest, for the world of the museum is a fascinating environment with a rich history. My involvement in the class led me to realize that the concept of the museum was similar to a

giant classroom whose history is on display. Never would I have imagined that I would be able to combine science, theatre and education, or that this would even be an avenue of exploration as my goal as an educator. Through museum studies I found a multitude of ways in which theatre and the museum combine. The exhibits done by curators are similar to the work done by a dramaturge in a lobby display. The narration and construction of the art also had a story to tell by what each piece was saying or the discourse that could take place when artifacts were juxtaposed against one another. This was the moment of time I realized that all art shares a central quality in some form, for in each of their own aspects all visual, performing, and literary artists are storytellers.

INTRODUCTION

Without knowing it, I discovered my thesis topic in my first week of graduate school. In the fall of 2013, during my initial visit to the Science Museum of Virginia, I saw Grant Mudge's *Shakespeare and Galileo* performed by the Carpenter Science Theatre Company. This was a twenty-minute play with the intended audience of children in elementary and junior high school. During the performance, I was amazed of the array of connections between the writings of William Shakespeare's *Hamlet*, to the astronomy of the Renaissance proposed by Galileo in the production. By placing these two high profile figures beside one another, I was easily able to connect components of Shakespeare's work to the cosmic ideology of the Renaissance; leading me to question of playwright's knowledge of astronomy. For myself, this was both an entertaining, yet educational experience and was presented in a venue that appealed to me both as an artist and an educator.

Science plays became my next pursuit in my studies. I wanted to explore how theatre was infused with scientific theories, concepts and discoveries and how these attempts began to play on stage. I knew that I wanted to incorporate these elements into my own education, for once I began researching I was enthralled by the connection, and the artistic aspects found in the field of science itself. While reading *Science on Stage*, by Kirsten Shepherd-Barr, I discovered a multitude of plays based on scientific themes. I had heard of and even had read a few of them, but overall this was a new genre of theatre which I did not realize existed. Presenting the beauty

behind science in a theatrical setting involves storytelling. Telling the story of the discovery of the planet Uranus could easily sound like a lecture, but telling the story of William Herschel, the man who made the discovery, allows for the use of theatrical elements. These elements allow the audience to relate to a person rather than an event, idea or concept; making the performance both educational and entertaining. As I read over these plays, deciding what scientific element my focus would be, I always keep going back to astronomy. My infatuation with the night sky is based on its aesthetic appeal and the infinite possibilities of what exists beyond our solar system. The sky has served an inspiration for literary and visual artists since the dawn of human existence. I decided I would do a survey of theatrical texts, beginning with the ancient Greeks to the present day, to find how our knowledge and understanding of the night sky has changed and how it has been reflected on our stages. From this initial idea, I began to narrow my scope to the dramatic texts of the Renaissance.

With Shakespeare as the prominent dramatist of the era, it was no surprise that I first turned my attention to his works. I was still uncertain of what exactly it was that I was looking for, for the playwright infused Greek mythology, whose origins are based on the movements of the heavens, to references of comets, eclipses, meteors and actual celestial happenings during his life. I realized I could not find the astronomy if I did not know about its functions during this era,and began to read texts about the history of astronomy and its development during the Renaissance. After I realized I was putting the cart before the horse, I stumbled across an article by astronomer Peter Usher, which would end up being the key source that would inspire the rest of my research, while also making a connection to museum theatre and interdisciplinary learning through arts education. The article was focused on Shakespeare's *Hamlet* as an allegory for the

Copernican revolution. While reading the article, I was remembering that first performance I had seen of *Shakespeare and Galileo*. Much of what Usher was describing about Shakespeare's knowledge of astronomy was presented in that production which initially brought my attention to the connections between science and theatre connection.

Through the exploration of science theatre, I also found myself examining how educators have implemented theatrical elements in their course material. The entire inspiration behind Usher's research and connections of Shakespeare and Renaissance astronomy was to find new ways of teaching his introductory to astronomy course. Over the past fifteen years, public education has been through some drastic changes that have affected the ways teachers are able to explore their course material and what can be taught based on the school's funding. With the No Child Left Behind Act of 2001, the American education system was to be reformed with a stronger focus on math and science; however, in this new structure, the arts would be taking a major cut in funding. This act left many educators wondering how to incorporate an arts curriculum back into the classroom, and many have found that utilizing drama in their science and technology classes had led to more interactive learning, while also engaging their students. With a government focus on standardize testing and a decreasing emphasis on the humanities, many in the education field are still growing concerned about where their students will gain the interpersonal, critical-thinking and creative skills needed for these future scientists, technicians and mathematicians to thrive in their field.

Museums are beginning to supplement their displays, text panels and docent talks with a higher emphasis on art education. Many ways in which museums are integrating these new aspects into their environments are through theatre. Companies such as the Carpenter Science

Theatre are infusing their creativity and storytelling abilities to create a different approach to the learning environment of museums. These programs are reaching their audience by displaying the face of humanity behind the science presented in the museum, which engages the visitor in a participatory fashion that leaves them, hopefully, to explore the knowledge they have been introduced to during their visit.

From science classrooms to museum tours, theatre is being embraced as a device that connects our past with our future, infusing creativity with academic learning, allowing for interdisciplinary education across all fields. By the arts and sciences embracing one another new discoveries are taking place in the lab, the classroom and on the stage. The future of both fields depends upon their collaboration as we are constantly approaching new waves of technology, medical and scientific advancements. This paper surveys examples of the discoveries that happen when the arts and sciences combine. I will discuss a case study on the discoveries one can make when looking through a text with a astronomical lens, the use of drama in the classroom to increase retention rates in learning, the interactions between arts and science as an exploration for collaboration, and museum theatre as an interdisciplinary tool for education and entertainment.

CHAPTER 1: INTRODUCTION TO ASTRONOMY

> We were all descended from astronomers, our survival depended on knowing how to read the stars in order to predict the coming of winter, and the migration of the wild herds, our ancestors learned how to shape their environment...To our ancestors the sky was their storybook...cultures all overs the planet looked up at the same stars and found different pictures there. (*Cosmos: A Spacetime Odyssey* 2014)

To understand the astronomy of Shakespeare's time we must first acquaint ourselves with those that made the preliminary observations and contributions to this area of study. These observations of the celestial patterns against the night sky helped in shaping and civilizing mankind, along with the creation of changing ideology throughout human history. “Early nomads, herders and farmers found that nature was unpredictable, and correlated their success and disasters with clouds, eclipses and other celestial events” (Sarma 157). The rising and setting sun, along with the waxing and waning moon, provided our ancestors with a reliable calendar that correlated with their hunter-gatherer occupations. The history of astronomy can be traced to the birth of recorded history in Babylonia and China. The study of the stars began in Babylonia, as far back as 2000 B.C.E., when astronomy and astrology began to spread throughout Egypt, “astrolatry,” the worship of the stars, began to take shape. All ancient astronomy was based upon the stars, eclipses and comets observable by the naked eye, which became the foundation for the development of a geocentric universe, with Earth being placed at the center of everything (Dicks 10).

Mythology, a collection of creation stories belonging to a religion or culture, found foundation in the stars. Records of constellations can be found among the writings of the Egyptians, Japanese, Chinese, Babylonians, Incas, Native Americans and also in those of the Greeks and Romans (Falkner 9). The acceleration of myths in these ancient civilizations created the origins of religion in prehistoric astronomy, especially in accordance with the rising and setting sun. Sun worship became popular with many of our archaic ancestors; the early Egyptians worshiped the sun god Re, a predecessor to an earlier deity, Atum. Re was eventually renamed Re-Atum, and his offspring were the gods of the air. There were also beliefs based upon the interactions with the behavior of the Nile and its correlation with the star Sirius, the brightest star in the sky. The tides of the Nile marked the three seasons relating to the helical rising from the river, which led toward the creation of the Sirius/Sothis Festival and marked the start of a new year. The Egyptians did not fully formalize their observations, for they were more intrigued by reading the legends that appeared against the sky rather than the mathematics of the stars (Norton 8-17).

As with Egypt, most of the Babylonian gods were cosmic in origin; unlike the Egyptians' worship of the sun; the Babylonians worshiped the stars. They, like the ancient Greeks, believed the motion among the stars and planets held the explanations of man-kind's fate; through this belief system, the Zodiac was created, which led to the birth of the horoscope. The idea behind the horoscope was a belief that stemmed from the soul coming down from the heavens, where it then takes its place among the rotation of the stars, until the soul is united with a mortal form, which continues to be influenced by the movements of the stars and planets. Not only did these beliefs influence man-kind's behavior, but the study of the sun, moon and the planetary positions

of the Zodiac were also used as interpretations that concerned climate, war, famine, disease, along with foretelling the fate of kings and nations (Norton 23-41).

As our knowledge about the world progressed, so did the way in which we studied the night sky. While the Assyrian and Babylonian cultures used their knowledge of the sky to track the concerns and welfare of daily life, based on divination and the "Zorastrian," star worship, the teachings of Plato and Aristotle began to lay the foundation of a changing mode of observation. Beginning around the 3rd century, B.C.E., Hipparchus, the "Father of Astronomy," was the first to make systematic observations of the stars. He created a catalog of 1026 stars and tracked the motion of the Earth's axis in relation to them. He also identified the revolution of the sun, along with the known five planets: Mercury, Venus, Mars, Jupiter and Saturn (McCormick-Goodheart 492). Whereas divination from the stars focused upon the public's well-being and man-kind's fate, the Greeks, "applied the art in large measure of the life of the individual" (Norton 121-122). Those who studied the stars in the late antiquity thought they were interpreting the movements of the gods (Norton 121-122).

However, as pagan practices began to decline, and Christianity was on the rise, the ideology of the stars controlling man's fate became less of a common belief. Even so, from these ancient rituals festivals had grown, such as the winter and summer solstice, based on the patterns of the stars and planetary orbits. It has been often considered that the festivals and celebrations of the Christian church stem from these older pagan traditions. The Christian faith had divided concerns about the pursuit of astronomy as a science, even though the practice and study of it was vital to the church; for astronomy's examination led toward the creation of time-keeping of the hours and days, along with the development of the calendar. St. Augustine cautioned that

astrologers could enslave the idea of free-will, if their predictions of the stars came true and if their work was done either by chance or devils. He also believed in God's foreknowledge, and the idea of celestial influence presented him with a dilemma: “How could humans be free, if all was foreordained that is either by God – who can only know what is to come if indeed it is to come – or by the influence of utterly predictable planetary motions?” (qtd. in Norton 123).

The centuries-long study of the sun has also aided in our knowledge and understanding of the night sky. Claudius Ptolemy, in his book *Almagest*, states: “I know that I am mortal by nature, and ephemeral; but when I trace at my pleasure the wingdings to and fro of the heavenly bodies I no longer touch the Earth with my feet: I stand in the presence of Zeus himself and take my fill of ambrosia...food of the gods...” (qtd. in Grinerich 4). Ptolemy is famed for positing the Earth-centered, geocentric, world view of our universe. His goal was to calculate the position of the planets in relation to the sun's circular route through the Zodiac. Ptolemy believed that the Earth was not just the center of our solar system, but of the entire universe, and assumed that each planet moved on a small sphere known as an epicycle, which moved on a longer sphere known as a deferent. Ptolemy believed that the stars moved into their own sphere around the epicycle and deferent of the planets as well. The reasoning behind this study of planetary motions was based on Ptolemy's assurance in tracing and predicting planetary phenomena, such as comets and eclipses.

The geocentric theory, based upon Ptolemy's theory of a stable and motionless Earth, dominated the ancient and medieval science of the universe. One of the assumptions for the motionless Earth was based upon the fact that when an object falls, it falls towards Earth, which was on of the foundations of the geocentric theory, and was also in accordance with the

theocentric (god-centered) world view. The orbits of the celestial bodies were considered to be perfect circular paths, for the circle was seen as the most flawless geometrical figure, which made it only appropriate to be the figure of heavenly movement. There were patterns in the orbits of the sun, moon and planets that were not consistent with Ptolemy's theory; for the rising and setting sun varied month to month, along with the changing patterns of the constellations across the night sky. Ptolemy believed that this was easily explained by the rate of rotation of the objects against the sky around the Earth (*Science Encyclopedia*).

The moon, sun, planets and fixed stars were placed in a definite order that allowed each to approach and recede from the Earth, and each object had a range of motion that preserved the order; ignoring any complications to explain any anomalies of their motion deferent around the Earth; such as the retrograde motion of Mars. Ptolemy believed that this was based on the linear distance from the objects in motion, and the determination of their radius was based on his required ordering of the planets and stars, creating an Earth that was insignificantly smaller than what we now know it to be. However, Ptolemy and his work were not challenged for nearly 1300 years (Cole 477).

Medieval & Renaissance Astronomy

"Since the dawn of human thought, the universe was believed to have been made for us. The larger the universe became, the harder it became to sustain the belief" (Falk 47). The Renaissance saw a tremendous change as new scientific thought began to transform the world. One of the most epoch-making of these transitions was Copernicanism, which moved humanity away from an Earth-centered universe, to one with the sun as its center. While the Ptolemaic

system placed man at the center of all stellar happenings and events, Nicolas Copernicus suggested a replacement for the geocentric theory, where man would no longer reside at the center of it all. In his book *On the Revolution of the Celestial Spheres*, Copernicus set out to explain a heliocentric theory that could more easily explain the movements of the heavens. In his great work published in 1543, Copernicus states:

> In the center of all resides the Sun. For this most beautiful temple, who would place this lamp in another or better place than that from which it can illuminate the whole at one and the same time? As a matter of fact, not inappropriately do some call it the lantern of the universe; others, it mind; and others still its ruler...And thus the Sun, as if seated on a kingly throne, governs the family of planets that wheel around it. (qtd in. *Cambridge* 97)

What Copernicus accomplished, and what Ptolemy could not easily explain, was "retrograde motion," the moving of the planets westward instead of their continuing eastward drift in orbit. The heliocentric model of the universe, along with a new planetary alignment (the one in which we still recognize as true) could more effortlessly explain this change in motion "as an appearance arising from the various movements of Earth and planets as they orbit the sun" (Usher, *Advances in the Hamlet Allegory*).

The field of astronomy grew out of what the ancient cultures referred to as astrology. Astrology concerns the belief in the influences of the heavens on human life and fate, along with the omens of war, famine and the rise and fall of those deemed divine, such as kings and queens, and can be traced back to the Egyptians and Babylonians along with their practice of "astrolatry," which still continues today. In spite of the spread of Christianity, the superstitious aspects of astrology were, however, a vital part of medieval and Renaissance Europe in both their literature and their daily lives; for supernatural phenomena in the sky was seen as harbingers of disaster,

even to the most well-educated. Astrology gave man foreknowledge of what was yet to come, and this belief began to be the antagonist of the Christian doctrine.

Astrology in medieval times was divided into two branches: Astrologia Naturalis (natural astrology) and Astrologia Judicalis (judicial astrology). Natural astrology was referred to as the theory and practice of prophecy relating to the influences of the heavens on all corporeal matter, both living and decaying, on Earth. This branch of astrology was considered a physical branch of study that gave scientific explanations of phenomena such as the weather and the physical matter of the atmosphere on the Earth's surface. Natural astrology was more akin to conventional astronomy, with its focus on tracking and predicting planetary and celestial movements. Judicial astrology was quite the opposite, its theory related to the prophecy of the influences of the heavens on human destiny, much closer related to what we consider astrology today, in the attempt to link celestial happenings to earthly affairs. This theory collided with religious doctrines, especially the ecclesiastical doctrine of free-will, which was based upon the dogma of original sin and redemption through the birth and death of Christ (Sondheim 245-246).

Astrology's practice, although not accepted by the church, continued to thrive during the medieval period. Those who were studying the atmosphere outside of Earth were still considered to be grouped with those who practiced astrology. The divide between the two disciplines did not appear until the discoveries of Kepler and Galileo, giving way to the study of the night sky as its own area of knowledge. During this age of superstition, the life of an astronomer was not without its dangers, as in the case that happened in the English Royal house in 1441. The Duchess of Gloucester, Eleanor Cobham, was accused along with two clerks and a woman Margery

Jourdemayne, known as the Witch of Eye, of conspiring to cause the death of King Henry VI. They were all accused of necromancy and of practicing the black arts, and while Margery was burned for being a witch, the two clerks were prosecuted, but not sentenced to death (Norton 269-270).

During the Medieval Ages and well into the Renaissance, events from the night sky had an impact on human affairs. The plague was frequent in Renaissance England and in 1593, an outbreak occurred. Despite the poor hygiene and overcrowded streets, the plague was considered a reaction to Saturn passing through the outermost parts of Cancer, just as it had done fifty years prior during a previous outbreak. However, the stars were never the sole explanation for misfortune on man-kind: disaster was also attributed as punishment by God for moral infringement. Most people believed that the movements of the heavens, along with the appearance of comets and meteors were considered portents of events to come. “People watched the sky with the same jumpy intensity of Wall Street analysts watching economic indicators; a bad omen could cause public confidence to plummet” (Falk 218).

The Renaissance was an age of discovery, full of men who became the pioneers for the modern age of scientific and medical theory and practice. The transition from the Ptolemaic theory to the Copernican theory began a new revolution of thought of not only the universe, but man's place in it.“They went from seeing themselves at center stage of the universe to realizing they were very much on the sidelines” (Condie). During the reign of Queen Elizabeth, male literacy doubled from five to ten percent, to almost twenty, and female literacy went from one out of one hundred, to one out of ten. Thanks to such inventions as the printing press people began reading in their own vernacular language, unlike the Latin and Greek in which many

previous works were published.

Most Elizabethans were still holding onto the geocentric notions, by still placing man at the center of the universe, which puts Earth at the focal point in God's design. Many believed that God moved the universe and Earth, along with the rest of the planets, and was perfect. The practice of astrology during this time straddled a fine line between magic and science. Queen Elizabeth, along with other distinguished nobility, were known for consulting astrologers, such as John Dee. Dee was considered a traditional figure in astrology and was part mystic, part scientist and an accomplished mathematician (Cartwright-Baker 40). Even with the evolving ideology of the times many maintained their belief in a direct correlation between celestial happenings and their effects on human affairs. Astrology to many was still perceived as magic.

CHAPTER 2: SHAKESPEARE: POET OR SCIENTIST

William Shakespeare is considered one of the world's greatest playwrights; his works have stood the test of time across the centuries, still providing and sparking universality in his themes. What made Shakespeare such a visionary was his use of language, creating a verbal landscape for his audience. Like many artists who came before and after him, the great poet and dramatist found inspiration from the night sky. William Shakespeare was born in 1564, the same year as Galileo, and his references represented many popular ideas and assumptions of astronomy/astrology of his day. Throughout Shakespeare's works the word “star” appears in every play but four, and references to the sun appear some two-hundred times; the moon is referenced close to one-hundred and twenty times. Never once though does the poet mention or refer to any astronomer, and his use of celestial imagery can be more easily seen as metaphors than astronomical observations. Many who debunk the notion that Shakespeare may have had knowledge, or even a background in astronomy/astrology, believed the poet saw the heavens as a source of dramatic inspiration; something that was distinct from everyday life (McCormick-Goodheart 450-451).

Even if Shakespeare was unfamiliar with the discoveries about the world around him, he did not completely forego the astrology of his day. In 1599, Shakespeare's company, the Lord Chamberlain's Men, consulted astrologer John Dee, it is assumed, to help decide on the best day to open The Globe. The day the chosen was June 12th, which also coincided with the summer

solstice and the new moon. So, even as Shakespeare was not a practicing astronomer, he knew and understood traditional symbolism associated with the heavens; the sun was linked to masculinity and kingship; the moon was connected with femininity and madness (lunacy) (Falk 222). When The Globe opened, the audience was surrounded by cosmic emblems; the extended canopy over the stage depicted the sun, moon and other planets. "The Globe audience would have been encouraged by the name (Globe) to see in the rectangular projecting stage surrounded by a circular wall with familiar images of the circularized square, and of the squared circle (an emblem of the timeless and infinite)" (McAlindon 3).

Shakespeare's characters say much about the stars and believed in their influence over human destiny. It is hard to determine what Shakespeare's own stance on astrology was. There is no example of judicial astrology in any of his works; in none of his plays is the resolution of conflict determined by the stars, even when his characters believe they are being guided by these celestial objects. Many of the dramatist's themes and characters are stories and myths borrowed from Greek and Roman archetypes, but Shakespeare's characters always remained men of the English Renaissance (Sondheim 243-251). Throughout his career, Shakespeare made references to astronomical discoveries, but none were made in his works after 1604, and this small piece of evidence has been a key factor in the debate about who the real author of the works is behind the alleged Shakespeare. Despite who the "real" author was behind the works of the great dramatist, there is one thing for certain, the poet knew how to integrate the celestial landscape of the night sky to intermingle with his text and themes, using the heavens as literary devices.

CHAPTER 3: THE COSMIC ALLEGORY OF *HAMLET*

In the 1990s, Peter Usher, an astronomer and educator at Pennsylvania State University, was looking for a fresh way to teach his introduction to astronomy class and turned his attention to the arts. While looking through the canon of Shakespeare, Usher found references to the new astronomy of the era, especially in *Hamlet*. Usher's moment of revelation was contained in the name Claudius; the uncle of Hamlet, who happened to share the same name as the ancient astronomer Claudius Ptolemy. After further analysis of the text, with an astronomical lens, Usher found that *Hamlet* could be perceived as an allegory of the competing cosmological theories of the era. Usher found connections in the text that directly corresponded with the history and current scientific theories and discoveries of the time. Many of the connections were based upon the location of events in the text, the names of the characters and the references made by the playwright about actual celestial events of the Renaissance, such as the supernova of 1572. One of the many similarities Usher describes are the locations and the prominence given to Wittenberg, Germany. He also strengthens his connection of *Hamlet* as an allegory for the changing cosmological view through his examination of the characters Rosencrantz and Guilderstern, and their connection to Danish astronomer Tycho Brahe. Usher notes that the character Hamlet personifies Thomas Digges and his heliocentric view, while Claudius personifies Ptolemy and his geocentric view. Usher also uses the words of the playwright to back up his theory of the competing world views by having Hamlet mention returning to school in

Wittenberg and Claudius' use of the word retrograde.

Usher believed that Shakespeare was on the side of science: “My thesis is the he [Shakespeare] was a powerful supporter of the new world view [heliocentric]...it struck me as odd, at the same time Shakespeare could be alive as the Copernican Revolution began to take hold and not have mentioned it. A man of that caliber could not fail to have taken notice of what was going on around him” (qtd. in Condie). Usher believes that Shakespeare was a champion of the Copernican view of the heavens and believes *Hamlet* represents this theory best for its hidden views and connections to the changing world order of the era.

The Origins of Hamlet

The history of the origin of *Hamlet* can be traced back to Saxo the Grammarian's, 12th century *Historia Danicca, Amleth*. Aspects of *Amleth's* characters have characteristics of Roman archetypes that also appear in Shakespeare's *Hamlet*. *Amleth* begins with the death of Horwendil, the King of Denmark, who was murdered by his brother Feng, who then marries Queen Gerutha and becomes king, depriving Amleth of his throne. After the murder of his father, Amleth feigns madness to avoid suspicion, which gives him more time to exact his revenge upon his father's killer. Feng is very doubtful about Amleth's madness and sends a woman to seduce him, trying to attract Amleth's attention away from himself. After Feng's unsuccessful attempts to rid himself of the prince, he sends Amleth to England in the company of two retainers who are carrying commands to have Amleth killed. Amleth convinces the King of England that the letter concerned the two retainers and not his own life and returns to Denmark, where the court believes him to be dead. After Amleth's return to Denmark, he recalls his journey to the courtiers

while they fill themselves up with alcohol. After the court has become intoxicated, Amleth pulls the tapestries from the wall and ties the courtiers in them and sets them on fire. Amleth then goes into the king's chambers and confronts and kills Feng with the king's own sword (Hunt 3-15). Peter Usher believes that for Hamlet, as well as Amleth, that madness is merely a tool in the acquisition of knowledge. For Usher, it seems appropriate that Shakespeare would choose Book 3 of Saxo Grammaticus' *Historia Danicca* as the foundation of his play because the events within the story suited his dramatic purpose (Usher, *Hamlet's Transformation* 53-56).

Usher's Allegory

If we examine the text of the play *Hamlet* and its sources in the Amleth legend of Saxo Grammaticus, we see parallels between the events throughout the play and the development and competition among four chief world models extant at the turn of the 17th century. Usher suggests that *Hamlet* contains a cosmic allegory. In the plot of the text, there is a stability in politics that manifests itself through a king, who allegorically speaking, is positioned at the center of a hierarchy of planets; including the sun, whose position is threatened by the prince, the legitimate heir to the throne; the rightful sun and center of the universe (Usher, *Shakespeare's Support for the New Astronomy* 3). Hamlet is the only character in the text who straddles between common man and court, much like the sun in many of the cosmic theories. Usher defines many aspects of the playwright's text upon his configuration of *Hamlet* as an allegory for the acceptance of the Copernican system (Usher, *Advances in the Hamlet Cosmic Allegory*).

Usher's theory can be broken down into key points by the characters in the text.

- Claudius kills the king of Denmark and usurps the throne

- Claudius personifies the bounded geocentric model perfected by his namesake
- Rosencrantz and Guildenstern represent Tycho Brahe's hybrid system of the universe
- Prince Hamlet champions the new model of the universe as represented by Thomas Digges

"To cut a long story short, Hamlet disposes of the courtiers before killing the false king, thereby knocking from contention the false models of the universe" (Usher, *Shakespeare and the Elizabethan Telescopy*). As the allegory continues, Hamlet says, "seems madam? Nay, it is. I know not 'seems.'" (*Hamlet* 1.2.76), here Hamlet is addressing the issue of appearance versus reality. This distinction in the text represents the difficulty in the development of world views; either celestial or terrestrial, physical or metaphysical. Hamlet's use 'seems' instead of 'is,' becomes fundamental to how one may interpret the world. "The allegory recounts the struggle to distinguish physical reality from appearances, a struggle well-known to astronomers as they strive to convert images of the sky to the reality of the third and fourth dimensional space" (Marchitello 80). Hamlet was intended for contemporary audiences of Shakespeare's time, though the evidence Usher describes that the dramatist also had an outline of a rich body of knowledge of astronomy, and through this, the characters and plot reflect a comprehension of the night sky of the playwright's world (Levy 48).

What's in a Name

In the *Hamlet* allegory, almost every male character in the text can be perceived as a 'stand-in' for an astronomer of the era, or a figure from the history of astronomy who factored as

a key component in the competing world views of the cosmos. According to Usher, Prince Hamlet represents the true nature of the universe, the heliocentric (sun-centered) theory proposed by Copernicus and promoted by English astronomer Thomas Digges. Old Hamlet, the deceased king and Hamlet's father, can be seen as Leonard Digges, the father of Thomas Digges. The central connection Usher points out are courtiers Rosencrantz and Gulidenstern as representatives of Danish astronomer Tycho Brahe. These two characters serve as agents of the 'hybrid' model of the universe (where the planets revolve around the sun, but the sun still revolves around the Earth). Laertes becomes a 'stand-in' for English astronomer Thomas Harriot and Bernardo as the medieval philosopher Bernardus Silvestris, an early supporter of a revolving, moving Earth. Nevertheless, the real revelation for Usher was Claudius to represent Claudius Ptolemy, the Greek astronomer who was the founder of the geocentric theory of the cosmos (Falk 172).

The opening of *Hamlet* begins with Marcellus who first presented an expanded vision of the heavens in Shakespeare's day. Pietro Angelo Manzloi, known as Marcellu Palingenius Stellatus, wrote the twelve part poem *Zoficaus Vitae* (Zodiac of Life) with each book representing a Zodiac constellation. Palingenius was an influential figure on Shakespeare and was admired by Thomas Digges. Shakespeare may have used the character Marcellus to honor the poet, who predicated the existence of a universe beyond the human eye. As suggested by George R. Hibbard, Polonius, named after Robert Pollen, a medieval schoolmaster and one of the founders of Oxford University. Polonius' servant, Reynaldo, resembles John Reynolds, a contemporary of Shakespeare, president of Corpus Christi College, and an enemy of the theatre. In 1599, he published *Th' overthrow of Stage Plays* (Usher, *Advances in the Hamlet Cosmic*

Allegory).

However, not all the names Usher alludes to in his connections are based on men of science, some characters, such as Ophelia, refer to the cosmic imagery of the moon's relationship to the sun, and its use can be representative of Shakespeare's knowledge of the Copernican Revolution. Since Shakespeare was a master of blending images of the cosmos with Greek mythology, it appears reasonable that Hamlet associates himself with the sun and Ophelia with the moon; the sun and moon are believed to be the most prominent ancient planets. The name Ophelia has been suggested that it was derived from the prefix ob – (or op) – as in 'opposite' and 'helia,' in reference to the sun. Ophelia and Hamlet seem to be destined to rule, just as the moon and sun dominate the heavens and rule the sky (Usher, *Shakespeare's Support for the New Astronomy*).

Fortinbras is not exempt from the allegory either, and a character whose roots are based upon the Amleth legend. In the legend, Amleth's father kills Kroll (Old Fortinbras) which parallels the events in Shakespeare's *Hamlet*. So it only seems reasonable that Fortinbras would show himself for restitution of his lost lands when he enters at the end of the play, to salute the English Ambassador. It would seem that the playwright was embracing the two favored cosmic models, Copernican from Poland and Digges from England, showing their victory of the demise of the geocentric universe through the death of Claudius (Usher, *Hamlet's Transformation* 56-57).

Astronomers & Astrologers

Nicolaus Copernicus was observing the sky when astronomy was far from a satisfactory

state. A major step in the advancements of predicting the position of the planets occurred in 1543, with the publication of Copernicus' *De Revolutionibus*. The publishing of this work advanced the heliocentric theory that the sun, not the Earth, was the center of the planetary system. This event led the thinkers of the Renaissance to perceive the physical universe in a new manner (Usher, *Shakespeare's Support for the New Astronomy*). The document written by Copernicus broke the geocentric sway that was in place for nearly 2000 years. The beginning of the modern age of astronomy dates around 1500, almost one hundred years before the birth of Shakespeare.

Copernicus believed in the power of unity, the idea that everything is linked together by the common measurement of the Earth to the sun. Copernicus made the sun immobile, but did not use it as his central point of reference, but instead he used it as the center of Earth's orbit (Gingerich 34-40). Copernicus said the sun is the center of the solar system and is credited with abolishing the Aristotelian ideas that the planets' motions can be explained in a perfect circular rotation in regard to their position to the Earth (Worten, "Lloyd Faculty Panel"). Peter Usher believes this is the theory that Shakespeare was writing about through the use of the character Hamlet.

Throughout the allegory, many noted astronomers and astrologers have found their way into this cosmic tale. Each astronomer represented had a profound effect on the ideology of their time, making them important contributors to the world view of a universe we recognize today. Each man also, in one way or another, had a connection to the playwright. The dramatist may have had many chances to encounter some of the greatest scientific minds of his time; at court, Queen Elizabeth had her own astronomical advisers; it would not be doubtful that Shakespeare

encountered some of these men there.

The strongest of these connections is the possible association with the Digges family. Shakespeare was friends with Thomas Digges' son Leonard, who contributed to the introduction of the first folio in 1623, seven years after Shakespeare's death. Thomas Digges was a military engineer and a member of Parliament. Thomas' father Leonard was a man who was well versed in science, with a concentration in the filed of astronomy. Thomas, along with his father Leonard (named after Thomas' father) became a poet and was a fan of the works of Shakespeare. It has been assumed that the playwright may have also been acquainted with Leonard's older brother Dudley, along with their mother Ann, Thomas' widow. After Thomas' death his wife Anne married Thomas Russell, who was from the playwright's native Warwickshire. Russell was at least acquainted with Shakespeare, for he, along with Francis Collins, served as executors of the playwright's will (Falk 159-163).

It has been speculated that Prince Hamlet is a boy in his youth, but in Usher's theory, Hamlet is in his thirties. Usher refers to Act 5 to validate his point based on the fact that Thomas Digges was around thirty years of age when he published *Perfit Description* in 1576. When Rosencrantz and Guildenstern are slain, and right before Claudius' demise, there seems to be a parallel to Digges' work from 1576, that 'killed' the Tychonic and Ptolemaic models of the universe. Hamlet's character as representation of Digges, exemplifies how Hamlet is responsible for the deaths of Rosencrantz, Guildenstern, and Claudius (Usher, *Hamlet's Transformation* 51-52).

Other connections that Shakespeare may have had with scientific minds of the era are to astronomer John Dee. Dee was the astrological adviser to the royal court and Queen Elizabeth;

his study was based in astrology. Dee's way of thinking was a mix of science and magic, embracing both the astronomy and astrology of the times. Dee has been perceived as the inspiration behind Shakespeare's character Prospero from *The Tempest*; in recent times, he has been cited as the inspiration behind J.K. Rowling's Albus Dumbledore from the *Harry Potter* series. Dee was known for his skill as a mathematician, astronomer, navigator, astrologer and alchemist. He was fascinated by occults and magic of various kinds; Dee was not only a man of science, but also had a background in theatre. He worked in prop construction for student productions while studying at Cambridge University (Falk 72-73).

In the second half of the 1600s, Dee was an influential instructor to many of the brightest English mathematicians and astronomers of his day, along with an ongoing correspondence with Tycho Brahe. Dee may have had a direct connection Shakespeare, for the King's Men had a performance in Mortlak in 1603, where Dee was residing. “It is possible that the actors encountered the notorious Dee during their residence at Mortlak” (Falk 74). What one can be certain of is that whoever visited Dee's home would have been exposed to the theories of Copernicus. Some cite evidence of the connection between Shakespeare and Dee in regards to the design of the Globe Theatre, possibly based on Dee's writings in the preface to *Euclid* in which Dee spoke of the harmony of geocentric forms. The design “bears a direct and important relation to [Dee's] preface...simply because it puts theories contained [in Dee's preface] into practice. The Globe Theatre becomes the first example of a classical Renaissance building in London” (Falk 76).

Tycho Brahe is another astronomer with a strong connection to the *Hamlet* allegory. Early in his career Brahe became fascinated with the events of the night sky and observed the first

lunar and solar eclipses of 1599, and 1560. Brahe knew of the theories of Copernicus and wrote about them in his works; while reflecting his own ideas of the heavens. There were aspects of the Copernican theory that Brahe agreed with, though his beliefs were rooted in the Aristotelian thought that there was an unbridgeable divide between Earth and the heavens. From his own views of the sky, he created a hybrid system that followed many of the same thoughts of Copernicus, while still placing Earth at the center of the universe (geocentric theory) in its stationary orbit. In his model of the solar system, Brahe had other planets orbiting the sun, unlike the heliocentric theory where the sun and moon revolved around the Earth. Brahe believed because of the appearances of comets that the planets could not be fixed to their own sphere, but move freely through empty space (Falk 50-62). The astronomer has been connected to Shakespeare's *Hamlet* based on his ancestry, who include Danish courtiers G'vldenstern and Rosenkrans. Through these are common names of the time, especially in Germany, it has been considered that Shakespeare was exposed to the names from an image on the cover of Brahe's *Astronomiea Istaurate Mechanica*, which has the names and coats of arms of Brahe's ancestors engraved on the cover. Shakespeare may have encountered this book at the home of Thomas Digges. (Mar 78).

Giordano Bruno, 16th century Italian philosopher and mystic, spent most of his life traveling across Europe teaching and writing like his contemporaries Brahe and Digges. This was an era in which ancient thought was confronted with new ideology and doubt concerning when the universe began. Bruno's studies would go beyond the works of Copernicus, embracing the concept of an infinite cosmos along with the idea of infinite worlds (Falk 82-84). Steven Greenblatt, in *Will in the World*, identifies a link that could trace the astronomer, Bruno, to the

works of William Shakespeare.

Shakespeare was a friend of the printer Richard Field, who served as an apprentice to Thomas Vautrollier, who published Bruno's works. Greenblatt realized this connection is a long shot, but it's not out of the realm of possibilities. The Shakespeare-Bruno connection can be strengthened through John Florio, who served as a tutor to one of Shakespeare's patrons, the Earl of Southampton. Through the playwright's connection to Florio, he and his company became acquainted with the customs and ways of Italy; material that can be seen in thirteen of the dramatist's works, set either partially or entirely in Italy. Shakespeare could have learned of Bruno's philosophy through Florio (Falk 109-168).

In the 17th century, Johannes Kepler was a pivotal figure who played a defining role in determining the astronomy of his time. As with many of his predecessors and those who were contemporaries of Kepler worked in the realms of both astronomy and astrology, preparing horoscopes and contemplating observations of celestial events of 1604. Kepler played a major role in defining the Earth's position in the cosmos through his development of the laws of planetary motions. Although he studied and practiced in both judicial and natural astrology, he lacked patience for the spiritual and demonic magic associated by others in his field, such as John Dee (Levy 46).

Kepler's conception of motion was based on the idea that a planet would come to a halt unless it is driven at every moment by an outside force. Like many scientists during his time, Kepler believed that God played a central role in the movements of the heavens. To Kepler, there were three aspects of space that mirrored the religious order; God the father (the immobile aspects of the universe located in the center), God the son (the sun) and the Holy Ghost (The

exterior sphere, the space between the two). Kepler found the movements of the planets were more difficult to understand, for his law of planetary motion was based on an orbit that is an ellipse with the sun as its focus. In his second law, Kepler proposed the speed of the planets, where a line from the sun to a planet traces out equal areas in identical time; presenting a harmony of the world (*Cambridge Illustrated History of Astronomy* 113-119).

The Science in Hamlet

In *Hamlet*, disorder ascends at the opening of the play and Horatio reminders us that the chaos on Earth is preceded by the uncontrollable chaos in the skies.

> As stars with trains of fire and dews of blood,
> Disasters in the sun; and the moist star,
> Upon whose influence Neptune's empire stands,
> Was sick almost to doomsday with eclipse.
> And even the like precurse of fear'd events,
> As harbingers preceding still the fates (1.1.120-125)

During Shakespeare's time, there was much going on in the night sky, but the one event that stands out and has perhaps the most influence on the works of Shakespeare, was the supernova of 1572, which was first perceived as a 'new star' located in the constellation of Cassiopeia. This star was the brightest object in the sky, next to the sun and moon, from the fall of 1572 and into the following year, until February 1574. A supernova appears when an explosion takes place from a massive star as it exhausts its nuclear fuel supply and sheds its outer layers in a fiery burst of matter and radiation. Shakespeare was eight years-old when this cosmic event took place and from the magnitude and brightness of the 'new star' the whole of Elizabethan society was looking up (Falk 48-49).

"November 1572, a father from Stratford and his eight-year-old watch a brilliant 'blazing starre' in the night sky" (Levy 1). Some scholars have suggested that Shakespeare had the 'blazing starr' in mind when writing the opening lines in *Hamlet*:

> Last night of all,
> When yond same star that's westward from the pole,
> Had made his course t'illume that part of heaven
> Where now it burns, Marcellus and myself,
> The bell then beating one- (1.1.38-42)

Due to the nature of the changing night sky throughout the seasons, in the late November evening, there would be no bright stars that lie between the pole and the western horizon. For many who have studied Shakespeare's writings, the supernova of 1572 fits in perfectly in Barnardo's speech, especially since the event of the play begins in mid-November (Levy 1-3).

The 'new star' was bright enough to be seen even during the day, making its appearance on November 6, and its first reported sighting was out of Wittenberg. The luminosity of this unknown object called attention to both the scientific world and to the inhabitants of all of London. The event caught the attention of Queen Elizabeth, and her astronomical adviser, John Dee, who wrote a pamphlet about the happening. The supernova remained visible, and was seen throughout the day and night, until its last reported sighting in February 1574. Even though the star faded from existence its impact on the literary world would last for decades (Levy 3).

Tycho Brahe wrote about the new star and stated: "shined without a taile or any scattered beams [for then the star was believed to be a comet] yet nevertheless it might be linked to some of those appearances" (qtd. in Levy 4). What he was explaining was that this star was not the same as all the others. Though his observations, Brahe was able to depict the star's position and through his calculations he noted the star appeared in the Earth's northern

hemisphere (Levy 4-6).

By deciphering the star's position in the sky Brahe made it possible for Peter Usher to believe that Shakespeare used the supernova to serve as a portent of the appearance of Old Hamlet's ghost in the opening act. The action throughout the play takes place in Denmark, but in the opening scene the audience is asked to look up. At the beginning of the play, the guards of Elsinore have been visited by a ghost for the past two nights, who resembles the dead king. Donald Olsen, in his analysis of astronomical references in art and literature, notes there are clues within the text which refer to the time the characters claim that the star was positioned in the sky. Through the text, Olson is also able to pinpoint the month when the events took place. In Act 1, the text states: “gainst that season...Wherein our Savior's birth is celebrated” (1.1.163-164), implying that actions are nearing Advent. The script also lets the reader know that two months have passed since the death of King Hamlet, who died while having a nap outdoors, indicating the season to be at least late summer, and his reappearance to be in November in the opening scenes. The connection of the 'new star' of 1572, located in the constellation of Cassiopeia, would have been located in the right area of the sky to be 'westward from the pole' around one in the morning (Falk 146-148).

Not only does Shakespeare utilize the supernova of 1572, in the opening of the text, but the playwright also employs the pre-modern cosmology of retrograde motion. “ In going back to school in Wittenberg, it is most retrograde in our desire” (*Hamlet* 1.2.113-114). By opposing Hamlet's return to school, Claudius is also opposing the heliocentric world order, giving his line a double meaning. The use of the word 'retrograde' in the 15th century was associated with the word opposition or being repugnant to something. In the astronomical sense, the word refers to

the planets' completion of a full circle through the night sky, and how for several weeks or months during each year, they reverse their direction moving westward, before resuming their eastward direction (Falk 18).

It appears that the sky moves westward relative to the horizon, but the sun and moon do not follow this pattern; they appear to move eastward relative to the stars. Ptolemy attempted to explain this phenomenon in his work *Almagest*, but the concept was more complicated than he anticipated, and his explanation of the movement was never fully defined; for the nature of retrograde contradicted the Platonic geocentric theory (Usher, *Hamlet's Transformation* 49). Copernicus' heliocentric model could explain this movement of the planets. Retrograde was an appearance that arises based on the movements of Earth, and planets as they orbit the sun. The concept of this motion would set the stage for the confrontation of the concept of appearance and reality. James Shapiro's description of Hamlet's poem to Ophelia is considered as a piece of evidence of the playwright's knowledge of the changing cosmological theories of his time. "The Ptolemaic science on which Hamlet's prognostications are grounded, as Shakespeare knew, was already discredited by the Copernican Revolution. The stars aren't fire, the sun doesn't revolve around the Earth. In such a universe the truth may well turn out to be a liar" (qtd. in Falk 166).

Astronomy is a perception based science, for it's purely observational, it attempts to turn the appearance of a two-dimensional view of the sky into a three-dimensional space; this was a task that was purely observational without direct experiment.

> Doubt thou the stars are fire
> Doubt that the sun doth move
> Doubt the truth be a liar
> But never doubt that I love you (*Hamlet* 2.2.115-118)

The astronomy in the passage above alludes to the astronomy of Ptolemy, and Hamlet is urging

Ophelia to question it. In one sense, Hamlet is telling Ophelia that his love for her is more reliable than her knowledge about the cosmos. To many scholars, this poem shows Shakespeare's possible awareness of Copernicus' world view. T.J.B. Spencer shares the belief that the shadow of Copernicus appears in the dramatist' s text. Spencer calls Hamlet's poem "a clever epitome of some of the poetical tendencies of the 1590s: cosmological imagery, the Copernican Revolution, moral paradoxes, all illustrating amorous responses" (qtd. in Falk 166).

Other findings of the playwright's use of astronomy in the text can be seen in the dramatist's use of the phrase 'infinite space'. Girodano Bruno, in his studies embraced the concept of an infinite cosmos and infinite worlds. Bruno states in his view of the cosmos: "There is a single space, a single vast immensity which we may freely call void: in it are innumerable globe like this on which we live and grow: this space we declare to be infinite, since neither reason, convenience sense-perception nor nature assign to it a limit" (qtd. in Falk 84). Bruno believed the Earth is just one of a countless number of worlds in a never-ending universe, along with all the planets and stars in their massive boundless numbers as well (Falk 84).

Bruno's theories are reflected in Shakespeare's text with Hamlet seeing himself as "king of infinite space" (*Hamlet* 2.2.225). This statement from the prince could be alluding to the new infinite universe, described by Bruno and Digges. Shakespeare uses the phrase infinite or infinity around forty times throughout his works, and except for *Hamlet*, the playwright never uses the term to describe spatial extent. This was not a common word during the playwright's era, but Bruno tackled the language in many of his writings, *On the Infinite Universe & Worlds*, in 1584 (Falk 164-166).

Not only did Shakespeare exploit theories and cosmic ideology of his day, but his use of

the ancient planets exceeded common knowledge. The planet Mars has been associated, since antiquity, with war and bloodshed. There are many legends that relate to Mars, along with endeavors with his sister, Aphrodite, about his successes in war. The movements of the planet have been noticed and documented by Ancient Egyptians and Babylonians; it was the birth of the Renaissance that ensured the myth of Mars to continue in Western culture. By the end of the second-century Ptolemy's writings on the heavens, *Almagest*, became an accepted view of the heavens and their position in the geocentric universe (Griffiths 224-225).

Mars has a reoccurring connection to the astronomy of the Renaissance and to the works of Shakespeare. In Act 3, Scene 4, of *Hamlet*, when the prince confronts his mother standing before them in Gertrude's chamber are paintings of both Old King Hamlet and the current king, Claudius. “He asks her to look at the images; to study the men's features. His father's image is clearly more; he has, among other things, “an eye like Mars to threaten and command””(qtd. in Falk 180, *Hamlet* 3.4.57). The interruption of this line has been up for scholarly discourse in the comparison of Old King Hamlet to Mars the Greek god of war. According to Usher this line there is a direct reference to the Great Red Spot on Jupiter: “...the planet Mars...is not known for an 'eye', only for its red color. What Shakespeare means is that Jupiter has an eye that is red; in short, it seems reasonable that Shakespeare is describing Old Hamlet's face as like that of Jupiter, which has an eye that is red like Mars; in other words, a reference to the planet Jupiter's Great Red Spot”(Falk 180).

In Hamlet's description of his father the phase 'an eye like Mars' is placed between Jove and his father's capacity 'to threaten and command'; Jove in this instance is a reference to the planet Jupiter. Throughout the history of science the discovery of the Great Red Spot was first

observed by Robert Hooke around 1664/1665, but if the author of *Hamlet* was able to look up towards the sky with a perspective trunk (telescope) by way of Leonard Digges, he may have seen this red spot as well (Usher, *Shakespeare's Support for the New Astronomy* 10).

Telescopes were yet to be associated with astronomy while Shakespeare was writing,but the perspective trunk, or tube as it's sometimes referred to, has been associated with the astronomical observations of Leonard Digges as early as the 1550s. During the late 16th century. Many professional and armature astronomers were experimenting with mirrors and lenses, contemplating their potential during this era. Thomas Digges claims his father Leonard used a sophisticated telescope-like instrument during the 1550s. This device revealed minute details of people and objects from a great distance. Thomas worked along side his father and would publish the findings of his father's experiments. William Cecil, Queen Elizabeth's adviser, received a letter assuring him that Digges' optical device and its capabilities were true (Falk 111-116).

The early telescopes were easy to fabricate, as anyone with access to a tube and lenses could make one. During the 16th century, the night sky was more visible to the naked eye, due to the lack of light-pollution, which we currently experience. The telescope officially arrived in 1609, but not without warning, as it was preceded by an invention known as “perspective glass,” able to magnify an image of a distant object. Telescopes used before 1610, in England, were called perspective glass and after Galileo, the device was called an 'optical tube' (Levy 59-64).

Hamlet & the Hubble

In Usher's attempt to utilize the arts in his classroom, he stumbled across a discovery that

has both artists and scientist re-examining the works of William Shakespeare. This study, in 1990, has impacted both fields and still is present in the news. On October 27th 2004, an international group of astronomers identified the possible surviving companion star to a titanic supernova explosion from 1572, witnessed by astronomer Tycho Brahe. Tycho's supernova is now considered a Type la supernovae, "which comes from binary star system containing a normal star and a burned-out white dwarf star. The normal star spills material onto the dwarf, which eventually triggers an explosion...Imagine a gigantic thermonuclear bomb about the size of the Earth but containing more mass than our Sun" (*HubbleSite*). Under the question and answers portion of the article *Stellar Survivor from 1572 A.D. Explosion Supports Supernova Theory*, the question arises of why the remnants of this event are so special. The answer to this question was traced back to the original explosion of 1572 and how it is believed to be the closest Type la supernova in recorded human history, and its appearance in correlation with the astronomical revolution. The article, furthermore, states the supernova's place in history, as being referenced to in the first act of Shakespeare's *Hamlet*. The article goes on to quote the interaction between Bernardo and Marcellus in the opening scene, proving that the story behind the science can, at times, create a stronger connection and relevance to its audience (*HubbleSite*). Usher's study still finds new ways to connect science with art, discovering meaning and relevance in their intersection and history.

CHAPTER 4: THE DIVIDE BETWEEN ART & SCIENCE

Unlike the education system of the Renaissance, where the foundation was rooted in liberal studies, today's educational system has distinct divisions of "importance" in the learning process. Mathematics and sciences are a high priority in the teaching of grades K-12 and these, along with other subjects (social studies, history and language) are now the focus of standardize testing. Mandatory testing systems, such as the SOL (Standards of Learning) have replaced knowledge with memorization for testing. This schooling system based on test scores leave the arts with little room to be part of the learning process in the classroom. Budget cuts have also affected many after-school programs, which focus on art education: band, drama club, choir, and even home economics classes have been subsidized or diminished all together.

This change within the education system did not happen overnight, for over the past few decades, these budget cuts have been on a downhill road and show no signs of stopping. In 1959, scientists and writer, C.P. Snow addressed to his collages at Cambridge University on the growing divide of what he referred to as the "two-cultures," and how the lack of dialogue and understanding between the two must be mended if we are going to continue in scientific progress. Snow was trained as a scientist, but by vocation, he was a writer. He felt this divide first-hand in his own cultural settings: "For constantly I felt I was moving among two groups" (Snow 1). He believed these two groups were identical in intelligence, social origins and incomes, but they have almost ceased to communicate with one another. These were not only

issues he noticed at Cambridge University, but in the Western society as a whole. It appeared to Snow that at one pole, there were the literary intellectuals, and at the other scientists, and when the two were joined in discourse there was a mutual lack of understanding among them. It appears that the non-scientists had an impression of scientists of being unaware of man's condition, and the scientists believe the literary intellectuals were lacking in foresight. However, Snow felt that the clashing points of these "two cultures" would produce creative opportunities, and it is through these chances where new innovated breakthroughs can be made by turning 20th century science into 20th century art (Snow 1-4).

Poets and writers from the past use to infuse their language with systematical expressions, which have become less and less frequent after the industrial and scientific revolutions. The merging of these cultures is not calling for artists to become scientists or vice versa, but for artists and scientists to assimilate with one another. Even though Snow's lecture was addressing the upcoming year 1960, Snow believed that this separation would only increase further as the years progressed.

> Thirty years ago the cultures had long sense to speak to each other; but at least they managed a kind of frozen smile across the gulf. Now the politeness has gone, and they just make faces. It is not only that the young scientists now feel that they are part of a culture on the rise while the other is in retreat. It is also, to be brutal, that they young scientists know they with an indifferent degree they'll get a comfortable job, while their contemporaries and counterparts in English and History will be lucky to earn sixty percent as much. (Snow 9-10)

For Snow, the only solution to stop the gap from spreading was to first rethink the way we educate. The creation of specializations, especially in the field of science causes much of a student's education to be spent in one area of study, instead of being able to explore one's knowledge through a variety of fields.

Arts in Education

The No Child Left Behind Act of 2001, under the Bush administration, was an education reform bill that was signed into a law on January 8th 2002. This has been the most drastic education reform since 1965, when President Johnson passed the Education & Secondary Education Act. The NCLBA increased government involvement by guaranteeing the up-rise of the quality of public education and the bill's process expanded the role of standardized testing and required students in grades 3 through 8 to be tested in reading and mathematics every year. After the law became implemented into the school systems, it opened to various reviews. Arts education in most public schools have either subsidizes their programs or have had to cut many of their arts courses out entirely; with focus and funding going to standardized testing (Holcomb). Teachers have also been greatly affected in their classrooms by the materials and topics they can cover along with and having an allotted amount of time for each lesson; so all material on the standardize test can be taught. Jamie Myrich, an English middle school teacher stated: "With the push from NCLB to focus on testing, arts and education are treated as if they're not compatible. People are forgetting that math is taught when a child plays an instrument. English is taught when a child is reading or writing a script. Critical thinking is taught when a child is analyzing art" (qtd. in Holcomb).

According to the Center on Budget and Policy Priorities in May, 2014, at least thirty-five states are providing less funding per student for the 2013-2014 school year. With an emphasis on the improvement of the quality in American education, the government has forgotten about a key component to the learning process, art. When it comes time to cut budgets, the arts are an area that usually take a hard hit. These cuts not only hurt the humanities, but many other programs

where students learn socialization and team building stills through school sponsored athletics and clubs and also include lay offs, which played a part of the 2008 recession, with more than a loss of 324,00 jobs within the school system from 2008-2013. These government spending restrictions have not only affected the variety of education and knowledge students K-12 receive, but also the quality of that education. With the lack for funds in after-school programs and arts education, along with the increasing pressure placed on students' scores in standardize testing, has left little, if any, room to explore and obtain knowledge, instead of the memorization of facts (Leachman, Mai)

Jacob Brownowski, mathematician and theatre author, states: “High-grade thinking in science involves a creative action utterly dependent on human imagination, not unlike that involved in the creativity associated with artistic and humanistic activities” (qtd. in Stinner 13). With a lack of an arts education background, it becomes more difficult for younger students, as they progress in their learning, to integrate into an imaginative mindset as they get older. American educator Jerome Bruner believes that there are two distinct modes of thought: the paradigmatic and narrative. The first mode can be considered analytical, logical, while the second is the thought process of the humanities (these modes are akin to Snow's two-cultures). Bruner believes these two modes of thought are irreducible to one another; for science cannot be reduced to dramatic insights; however, the understanding of scientific events and ideas can be made possible through the creative element in science. Elliot Eisner, professor of Art and Education at Stanford, states: “The scientist, like the artist, must transform the content of his or her imagination into some public, stable form, something that can be shared with others” (qtd. in Stinner 17). A creative mindset must be in place for science to thrive, but with the lack of

obtaining the fundamentals of art curriculum inside the classroom, could we soon ask the question of where will the new generation of scientists find their creativity?

Interdisciplinary Learning in Art

Imagination is what has enabled mankind to develop and make advances throughout human existence. The stories about our ancestors were created against the patterns in the night sky, and these stories have played a fundamental role in our perceptions of ourselves and the physical world around us. We were not born with an innate knowledge about our world; it was only through curiosity and trial- and-error of discovery that humankind has been able to advance in both ideology and scientific development and understanding. Without the courage to ask questions and explore our surroundings, human progress would halt. Science and art go beyond just the need for imagination and curiosity; they also collaborate to achieve the results of the breakthroughs and partake in the creative chances Snow addressed in his Cambridge lecture.

Established in 2009, the ArtScience Call has been part of a global community that encompasses both artists and scientists to explore their collaborations and smashups at the intersection of art and science. The purpose of this program is divided into three sections where they provide resources for art-science collaborations, open the doors to new works and discoveries between the scientific and artistic communities, and support a platform for online networking and dialogue at the intersection of arts and science. The homepage of this site is a call for submissions from a variety of art and science communities throughout the world, coming together to advance both disciplines.

The ranges of topics, projects, and organizations represented on this site are each

distinctly unique. The Royal Society, London, is currently calling for proposals for an art/science exhibit surrounded on the theme of light. In addition with the scientific exhibits on display, the Royal Society also aims to enlighten and inspire knowledge through art. Lancaster University's Biomedical and Life Sciences Division are welcoming artists who would like to explore the theory and practice of the microbiological process. With the use of workshops, the aim of this project is to create scientists and artists as equal partners in the development of hybrid projects and proposals, along with the exploration of the idea of the scientific lab as an artistic studio. Themes associated around Lancaster's project include performative acts in the microbiology research lab and linguistic communication and social intelligence of bacteria (*The ArtScience Call*). With this unique merge between the two fields sites such as the ArtScience Call are taking the steps in bridging the gap between systematical study and creativity. The partnerships in association with this organization are bringing scientific knowledge into a creative light, while allowing for both disciplines to work together to create advancements in all branches of the technological and medical fields as well. Finally, now in the 21st century, our science is turning into our art. Nevertheless, these are only a few examples I have come across in my research. While there are other collaborations between the two disciplines these works do not make our front-page headlines and enter our textbooks as ways to integrate the two in the advancement of knowledge in our education systems. We must seek them out on our own; however, sometimes the connections are right in front of us, we just need the tools on how to recognize them.

The year 2014, brought with it the 450th anniversary of William Shakespeare and Galileo Galilei, and in a celebration of these men and their contributions of each to their fields, the University of North Carolina in Greensboro dedicated an entire season focused on the Globe and

Cosmos. As part of the celebration, the university kicked off its salute in a yearly series know as Collage. Collage is a once a year event where the school of performing arts come together through dance, theatre, music and choir all based upon a central theme. After months of research on the collaboration of arts and science I was excited to see an example of it on stage. Collage was mainly musical interludes, choral performances and ensemble pieces, which led me to question the content of the show. I was learning nothing about science, the only aspect of science that was visible were the names of the pieces being performed. While I was positioned in a 'full-house' in Aycock Auditorium the works of Holst, Shakespeare and Ellington were encompassing my ears with their lyric melody of verse and complex arrangements of harmony, and it was then that I began to find the connections of the night's events in relationship to scientific advancements. My thoughts began to wonder to the field of mathematics and their correlation to music and while listening to "Jupiter, the Bringer of Jollity", from *The Planets*, Op. 32., by Gustav Holst, I was contemplating on how math is a fundamental element in the study of astronomy. While the orchestra was playing I heard the music creating a sound of the cosmos with the majestic atmosphere of the outer limits. What could be a more appropriate expression of the sound of the stars dancing across the sky? I found the complexity of the music to reverberate the complexities of the sky. After the first performance, I realized the connection laid within the harmonies created that gave a musical description of the universe.

As the night progressed, I realized how the complexity of music has changed throughout human history. I found that there was a difference between the music describing the planets compared to the music that represented music of the Renaissance era. I could physically see and hear how musical compositions became more complex as our mathematics became more

advanced. The use of the space also played a part of the correlations I was forming. There were no borders or boundaries in regard to performance space, much like our own cosmos. Musicians were around the entire auditorium, in the mezzanine and aisles, balconies and lined in the back of the house, creating a bombarded of accompaniment through every vibration of sound throughout the body.

Interdisciplinary Learning in the Classroom

With cutbacks in art programs, many educators are seeking new ways to teach their subject material in their classrooms that incorporate artistic elements. There have been many creative approaches to this dilemma, with many of these incorporating aspects of drama education in classroom curriculum. Jamie Myrick, who had a background in storytelling, began to use her own talents in her English classroom by utilizing drama to teach various view points of her course material.

> Storytelling captures the attention of every learning style and every type of student," she says. Myrick, who sometimes dresses in character, had students spellbound when she recently taught a lesson dressed as the Statue of Liberty. "We were reading about immigrants, and I acted out the lesson for the kids from the point of view of 'Liberty' watching all these different people coming into America. (qtd. in Holcomb)

Drama involves doing something as it is real and provides a presentation and interpretation of a physical or mental activity and transforms students cerebral and tangible potential into creative acts. There are various teaching methods used in science and technology courses that provide meaningful learning by creating connections to daily life, and can be used through what Duban and Duzgun call the 'drama method'. This method provides a cooperative learning environment where students employ scientific principles in their studies. In drama,

students are given various roles and then act as the characters to which they were assigned. In these situations, the students speak and think as their related character; within this method, students improve their language and communication skills, for drama in educational settings allows students to become active participants throughout the learning process (Duban & Duzgun 46-47).

During these role playing scenarios in the classroom, students try different solutions and employ the useful solutions that subsequently become improved upon; this process helps to increase problem-solving-skills. Drama as an educational method allows students to reflect, discuss and format challenges in their studies that then create real-life connections, this allows students to see events from a variety of angles. Drama in the classroom aids in the reinforcement of the attainment of cognitive, emotional and technical skills related to analysis, synthesis and evaluation, this method is used as an innovative way to help students learn scientific concepts and topics. Drama has had a positive effect on students, they become more engaged in the course material, have increased participation and higher student achievement. Participants in the drama method overall have a better understanding of the topics and when the material is presented through drama, students fully achieve their objectives; it also makes the material more enjoyable and knowledge learned is retained for longer periods of time (Duban & Duzgun 47-51).

Scripted historical dramas can be used in classrooms to promote learning of scientific aspects that include the social context of science as a human activity and plays as the ground for debate in scientific change. In most school systems, drama is only used in designated classes or at times in language art courses such as literature. What Begorary and Stinner set out to accomplish was to use drama to create a range of codes for learning across subject disciplines,

especially in science, to improve chances for learning. Drama can be used to take over the role of another person to create a variety of perspectives in the learning process. The use of drama helps to involve and motivate students in understanding the world on both a scientific and humanistic level. Scripted dramas for science education allow students to look at events that have shaped modern society and inquire into its history and become a visual and engaging example of demonstrating the function of science. What Begorary and Stinner wanted their audience and participants to consider what it means to comprehend and create a range of codes for learning across the subject areas, particularly in science, to embrace another sign system and thus improve chances for learning. (Begorary, Stinner 461-462).

The infusion of drama in the classroom has been promoted by numerous educators. These activities provide an array of learning experiences and demonstrate the emotional and moral struggles that those in the sciences go through. These productions serve as excellent introductions to discussion or topics such as social responsibility and the element of ethical education of scientists. The advantage of cross-disciplinary learning acknowledges the many ways in which learning can take place and offers more offers opportunities for more students to comprehend and express their ideas about the subject matter. In scientific or technology classrooms narrative and storytelling are less used across the curriculum, however, the utilization of storytelling can help students to learn in various context areas. Stories provide formats that are useful for the recollection of information passed along and provide appealing organization formats for students ((Begorary, Stinner 461-467).

"Drama brings such meaning to the science classroom. It enlivens the presentation of ideas. Science is revealed as a process of negotiation, not always tidy and linear in development

but rather confounded by the personalities of the scientists themselves. Scientific knowledge is built in a crucible of conflicting points of views" (Begorary, Stinner 468). The collaboration of the two fields in the scholastic system begins to bridge the gap between the two disciplines by utilizing them in a creative educational environment. A physics teacher who successfully used *The Physicist* to teach science said he was looking for a way to "promote more holistic and intuitive modes of thought" (qtd in. Begorary, Stinner 462). Many science plays serve as an excellent introduction to a discussion of the social responsibility of scientists and scientific organizations, and these texts aid in forming a useful element in the ethical education of scientists or the science teacher. Academics love to engage in lively exchange of ideas; the more profound their differences of opinion the more pointed the conversation. Of the many ways in which academics find themselves separated from each other; however, none is perhaps as fundamental as the gulf between those in the sciences and those in the humanities. The utlization of drama in the classroom is only one of the several units of historical presentation that Stinner has incorporated in his classroom and with science teaching candidates. Drama brings such meaning to the science classroom for it enlivens the presentation of ideas (Begorary, Stinner 462-468).

CHAPTER 5: INTRODUCTION TO MUSEUM THEATRE

> Museums are inventions of man, not inevitable, external, ideal, nor divine. They exists for the things we put in them, and they change as each generation chooses how to see and use those things. (qtd. in Hughes 23)

Museums have a long history of being regarded as a place among the elite. In the early European museums of the 1700s, there was no touching, loud noise or talking, and young children were discouraged from entering such establishments. Many museums in European society during their early stages of inception would profile their visitors and could deny acceptance based upon social status and appearances. These institutions were based on art works and artifacts from ancient civilizations, with the experience of the museum being led by a docent. The docent would rush the visitors quickly through their halls, allowing the experience of the visitor to be incomplete and full of unanswered questions on what they viewed. These early buildings were based on the architecture of the ancient Greeks and Romans, presenting themselves as houses of scholarly knowledge. However, in reality, they were meeting houses for the elite to show themselves to others in their social ranking (much like the theatre of the era) while the art and historical context displayed were secondary to the experience. Much has changed since these early museums, but many of the preconceived notions a modern-day visitor may have are based on these elite concepts of the 18th century (Merriman 159-163).

The idea of the museum has changed drastically since then, and while museums were once a storage house of lost artifacts and highbrow art, they currently span a wide variety of

subject matter, along with creative and educational experiences in which the visitors can physically engage. These institutions meanwhile are competing for the same dollars as the theatre, film and music industry are for audiences. The museum has now found new, creative and kinesthetic ways to connect to their audiences, while serving a need in the educational system as well; today, deciding what type of museum to go to offers just as much of a variety as picking a genre of film to attend. From the Museum of Modern Art to the Natural History Museum, these buildings of knowledge are welcoming opportunities for interactive learning; providing experiences for patrons of all ages. One of the ways museums are making themselves more accessible is through the use of theatre.

Evidence of the application of theatrical practice in the museum dates back to 1810, with Charles Willson Peale. Peale's Museum in Philadelphia, has been credited as the United States' first public museum, with its original opening in 1786. The building was a collection of Peale's own artistic works, and its intent was to display a collection of natural history and technological objects. The museum was struggling to keep its door open, and as an effort to encourage new audiences, Peale began to offer live entertainment. After Peale's death, his son Rubens took over the business and had a distaste for the theatrics his father implemented in the museum. Rubens perceived that the live entertainment repelled those who wanted to use the venue as a place for relaxation and enjoyment, not entertainment. Based on financial records the museum had become dependent on live entertainment and under Ruben's direction, the museum closed and eventually turned into a dime museum (Radice 24).

The concept of the dime museum was first established around 1826, and it integrated a variety of entertainment types under one roof. The concept of the dime museum flourished and

began a series of chain reactions; with an up-rise of these same themed establishments up and down the east coast. Phineas Taylor Barnum made the dime museum a part of the American cultural landscape. Audiences flocked to the experiences the dime had to offer. Unlike the dime museum, Rubens wanted to create a place of relaxation and enjoyment for a high culture, whereas the dime appealed to the working-class audience. Freak shows, theatrical productions, and circus performances were just few of the many varieties of experiences one could have while attending the dime. It was this array that attracted so many visitors, for Barnum was constantly seeking new exhibits to keep his patrons returning time and time again. The museum's daily programming included live performances where many great actors and actresses of the stage and vaudeville began their careers. Some venues eventually turned into legitimate theatres, such as the Metropolitan Theatre in New York, which began as a dime museum (Radice 24-27).

Though live performances and side show acts have been incorporated widely throughout the creation of the American museum, the use of theatre as an interpretive tool, and not just as added entertainment value, was first employed in 1876, during the Centennial Exhibition in Philadelphia. The utilization of theater as an informative tool, in association with the content being displayed, began to take off in 1907, where the Essex Institute in Salem, Massachusetts began an interpretation program, under the direction of Francis Dow. This program recreated life from the 1750s through the 1800s, and was performed throughout the museum. Dow's endeavor was to recreate historical period events on site to create an illusion of reality for the visitor. While the term 'museum theatre' was still yet to be established, it began under the name “living history” and was a tool for historical interpretation. Living history, as defined by Jay Anderson educator of folklore and museum studies, is: “a stimulation of life in another time for the purpose

of research, interpretation, and/or play" (qtd. in Radice 28). For Anderson, the use of living history is a tool to educate its audience about the past and also serves as a research tool (Radice 26-28).

The word museum is derived from the Greek *mouseion*, meaning "shrine or temple to the museums" (qtd. in Hughes 19). The muses were the nine daughters of Zeus and presided over poetry, epics, music, love, oratory, history, tragedy, comedy, dance and astronomy. The ancient prototypes of museums are rooted in libraries and lecture halls, laboratories and scientific studies, through private and public collections (Hughes 19). The term "museum theatre" is a recent phase that has emerged as a descriptive field. This term encompasses the diversity of performance options. Museum theatre provokes thought through the utilization of living history, environmental theatre, storytelling, dramatic skits, plays, monologues and interactive role playing to represent any human presentation of history in all areas and genres of academics. Museum theatre has been created as an umbrella term that encompasses the practice and the variety of spectacle and theatrical forms that can be used in museum environments (Radice 32).

Theatre & Museums

Museums and theatre present themselves in different contexts; theatre holds a mirror showing human nature as we could have been, how we are, and how we might be. Theatre, utilized in educational settings, provides opportunities for gaining knowledge by approaching subject matter from a variety of perspectives. Theatre tells a story, the story of human nature, the good, the bad and everything in-between, its correlation and connection with the museum should not be surprising. Both theatre and museums share a mutual function, they just execute them in

two distinct ways, they serve as storytellers in some aspect or another. Theatre does this through verbal narrative, traditionally, and museums through their arrangement of exhibition materials, which serves to narrate the evolution of humankind's progress throughout the centuries.

Theatre, as with most art, has been philosophically thought to be in search for a universal truth, or the authentic nature of mankind's psyche. Theatre, much like the museum, is a social art, for both rely on an audience, visitors and participants to reflect upon their story. All art is based in human experience, asking us, in one way or another, what does it mean to be human? Museums ask this question as well, for the museum hold and contains our human errors, discoveries, mishaps and creations, allowing us to follow a dialogue from the past to the present and possibly into the future.

Theatre's place in society is constantly questioned, as an art, theatre is continuously having to make the argument why it is a vital aspect to the function of society. The presentational (direct address) style of theatre is seen in museum theatre where there are few barriers between the speaker and visitor(with the viewing audience in a space not always intended for theatrical productions) and asking for assistance from audience (Hughes 28-30).

Theatre aids in our comprehension and with creating connections with the world around us and beyond. It transcends cultures and times, and exists inherently within us, for the desire to share and connect to personal stories and experiences is something we do in our daily lives. Catherine Hughes in her book *Museum Theatre: Communicating with Visitors Through Drama*, mentions theatre theorist and director Augusto Boal and how his philosophies have helped to shape museum theatre. Boal used theatre in a political sense to create a spark for social change; his works allowed for a multitude of view points to be taken into consideration from one

narrative. In his early works he developed an experimental style known as Forum Theatre.

> In "Forum Theatre," the audience is asked to study the protagonist's problem, consider all available choices, and discuss possible solutions with the actors, stopping the action to influence the train of events and change the given "real-life" situation. The "joker" figure served both as a narrator who addressed [the] audience directly and also as a "wild card" actor able to jump in and out of character and take on any role in the play. By undermining easy judgments, the joker's function was not to simplify, but to render more complex the audience's comprehension. (Gerould 463)

The idea behind Boal's work has inspired many theatre museum practitioners to utilize the aspect of storytelling to allow for multiple view points behind a single narrative. Boal stated: "Forum theatre...instead of taking something away from the spectator, evoke in him a desire to practice in reality the act he has rehearsed in the theatre. The practice of these theatrical forms creates a sort of uneasy sense of incompleteness that seeks fulfillment through real action" (qtd in Gerould 472). Alternatively, in the case of museum theatre, the spectator seeks fulfillment through knowledge.

Science museums, in particular, are constantly trying to find ways to present their subject matter, which at times can be controversial or risky, to an audience in an unbiased setting. The use of drama in these institutions can serve as a device that is currently being integrated more in educational environments. Drama allows for an audience to transcend beyond the theories and facts presented in the text panels and allows the visitor to see the faces and human struggles behind the great men and women who have created these groundbreaking moments in history. One way museums use drama to assist in this process is through narrative and storytelling. While museums use objects to display their narrative, the use of theatre aids in going beyond the tangible objects and develops a focus on the person or the story behind the displays.

Storytelling is a tradition that dates back to the birth of human civilization. American

scenic designer Robert Edmond Jones captures the nature of storytelling best in his book *The Dramatic Imagination*, taking his readers to the stone age, the days of the cave man sitting beside a fire recreating the story about a lion killed earlier that day. Through storytelling the birth of performance emerged, but it is through the verbal narrative that our imaginations could be freed, and the embodiment of performance could be born. Even though the audience around the camp fire that night knew the story already, the accounts of the events being recreated in front of their eyes allowed the listeners to sense the danger and excitement of the hunt. Storytelling is a rich art form with its roots in oral tradition that allows people from all cultures to connect with one another with a shared experience.

> Many thousand of years have passed since that first moment of inspiration when the theatre sprang into being...It is really a kind of magic, this art. We call it glamour or poetry or romance, but that doesn't explain it. In some mysterious way these old, simple, ancestral modes still survive in us, and an actor can make them live again for a while. We become children once more. We believe. (Jones 47-48)

By utilizing storytelling in a museum environment historical characters become represented as real people that are brought to life by giving their accounts of their own history and association with the artifacts and exhibits contained within the institution (Bridal 19-20).

Other aspects included in storytelling and theatrical presentations are the elements of plot and conflict. Plot is crucial to storytelling, it helps to create a sense of curiosity. By engaging the audience in this mental activity, storytelling allows the audience to create their own solution of how they would handle the outcomes and circumstances of the events that are unfolding in the character's life (Radice 38). Equally important as the plot is the conflict. Conflict reveals itself through a character's inner turmoil, along with confrontation of clashing or various view points. Conflict is what directs the story to its resolution. The use of plot and character in narrative and

theatrical pieces allows the audience to respond with an emotional experience and a shared connection to the person whom they are seeing come to life. Emotion helps to spark cognition, which allows the museum to draw visitors through a poignant content, along with an educational one as well (Hughes 51-52). Theater has a tremendous potential as an interpretative method. It can translate material culture and human natural phenomena in a meaningful and provocative way. Theater includes a combination of discourse, demonstrations and interactions that simulate life, allowing the visitor to have an individualized experience. The power of narrative allows people to leave themselves and explore alternatives (Radice 7-9).

CHAPTER 6: THE SCIENCE MUSEUM

A museum can be defined as a collection of objects of the past and present. The science museum fits that criterion. The science museum was contemporary in its approach by its focus on the display of techniques and methods in science and applied science. In 1911, the Bell committee wanted to set course for a new museum "calling for the preservation of appliances which hold an honored place in the progress of science" (Morris 2). The science museum, unlike the British Museum or The Virginia Museum of Fine Arts, is often considered to be associated with children's museums, but originally, it was conceived as a venue for teachers and science experts. From its beginning, the science museum was different than other museums, it was not seen as a cultural setting like fine art museums or as venues of resembling a scientific institution like the Natural History Museum (Morris 1-3).

The science museum struggled to find its market. Was it a venue for displaying the history of science? Should its exhibits be only or hands-on interactive experiences? Is this a place whose target audience is the science expert or the adult visitor or school and family groups? These are the questions the science museum had to think of and with each new wave of directors and educators coming into the museum the function, vision and purpose of the museum changed with it. There has, however, never been any doubt that the main goal of the museum was to present science, in one format or another through various means, making it accessible to the

nation. “Whatever the route taken, the Museum has tried to engage the general public with science and thereby enable visitors to make up their own minds about the significance of science” (Morris 4). Much of what is presented at the science museum is done so through diorama, text panels, models and hands-on interactive displays. However, the science museum is beginning to extend its branches and is now looking to the arts to create new synergistic exhibits that not only allow for entertainment for the visitor, but provide new ways of producing educational information on how man and science interact and the moral and ethical obstacles in our ongoing age of discovery and technological transformation.

Science education has been under scrutiny for centuries about the nature of the subject matter being presented in classrooms. Topics such as stem-cell research and cloning have been considered taboo to teach to younger children. However, such issues are two-sided conversations and give way to discourse about the responsibility of those who work in these fields. With text books full of dates, facts, graphs and charts only allows for students to remember key figures, but lack in the understanding of the social responsibility of a scientist. This is where theatre comes into play. Many science museums across the country have been implementing theatrical pieces in addition to their models and text panels, to bring their visitor closer to the face of the scientist, in hopes to better understand the science. Much akin to the living history museum, with its interactive and live performances, the science museum collaborates with artists to reach beyond the history of their subject and bring the stories behind the science to life.

Because of the cutbacks in funding of art-related courses in the public school systems, museums are being encouraged to add arts programming into their venues as an effort to replace the reduction of these activities in the classroom. By encouraging museums to collaborate with

various disciplines in their educational pursuits, these institutions are now capable of reaching out to new constituencies and attract waves of audiences into their halls. Science museums are not excluded from this, and in some ways they have been able to collaborate with the arts in such a manner that has sparked a fresh wave of theatre in scholastic settings in and out of the classroom. Many museums receive both public and private funding and many of these organizations, such as the National Endowment for the Arts have stipulations which include providing educational components through their funding. These informative contributions are for activities that promote the arts as an integral part of the learning process, not only for children, but adults as well. By creating these stipulations, such organizations are opening museum doors for professional development opportunities for artists and teachers working in the arts, especially those in elementary and secondary education (Radice 13-14).

The Science Museum Theatre as Educator

Let's admit it, science is hard. It is a subject matter that encompasses a range of materials, with words (which use every letter from the alphabet to spell out some unpronounceable theory) we have to look up a dozen times over just to understand. Science classes can be very frightening to many students, with the physics and mathematics involved in learning many of the formulas, theories and concepts, especially in advanced classes. Keeping students engaged in science education is what the NCLB Act tried to accomplish, but when material is presented lecture style, compared to visual and hands-on activities that can help stimulate pupils' cognitive reception of the material, boredom and apathy begin to take place in the classroom, even at early ages. Science museums can aid in bringing the fun back into learning, and theatre has begun to

play a vital process in this.

Museum theatre provides practical learning opportunities and can pick up where the course material leaves off. Through a constructive approach, this type of learning is based on visitors acquiring the information and experiences that go along with the subject matter, and then, after the knowledge is gained, the visitor can subsequently construct various aspects of what they were exposed to into meaning for themselves. Educational psychologist William Perry developed this method to focus on the mental process over an observable behavioral approach to learning; proving knowledge is not passively absorbed, but is actively processed based on a person's existing cognitive structure. Perry's approach is broken down into six factors that can allow a visitor of any age to create their own successful experience. Constructive learning includes: curiosity, by allowing the visitor to be surprised or intrigued; confidence, giving the feeling of competence to those who enter into the institution; challenges, having the visitor seek a perception that there is something to work towards; control, letting those who explore the venue feel a sense of self-determination; play, asking all those who enter to experience a sense of enjoyment and playfulness in the environment; and communication, where all involved in the museum experience engage in meaningful and social interactions; the use of in the constructive approach (Radice 37).

"The immediacy of theater – its ability to seize the visitor's attention – makes it a powerful agent for motivating and empowering people to learn" (Hughes 53). Theatre can move beyond a pleasant experience and can transcend into an experience that leads to positive and continued growth. Museum theater is on a continuum of connected experiences that are influenced by earlier ones, and creates a domino effect where each experience in turn impacts the

next. When theatre can be used to influence the learning process, or aid in creating connections of the material being taught, there is a significance and value in that experience. What this type of theatre does is show the human endeavor behind the inventions, creations, formulas, theories and ideas, through art, and addresses the emotional struggle that can connect with an audience, usually for a longer duration of time, and aids in the retention of knowledge of the subject matter in the performance. At the Museum of Science in Boston, the Science Theatre Program is seen by its colleagues as an educational tool that helps the museum address multiple goals. The museum sees this program as an acceptable way of conveying information and ideas that exhibits cannot. Live programming is a way of creating memorable and stimulating experiences that has the audience leaving with thought-provoking questions and aids in contributing to the main goal of furthering the museum's mission (Hughes 51-56).

The use of science theatre layers the cognitive with the affective in the learning process. *Einstein's Little Finger* was developed to educate its audiences about advances in technology, as well as provoking visitors to speak and think of the pros and cons of the rapid advancements taking place in technology. Those who witnessed the show could leave comment cards, which revealed the piece to be thought-provoking and challenged the viewer about their own conceptions of the advancements made in science. Museum educators, especially in the science museum, have spent much time contemplating exactly what it is that they are teaching through theatre. How much information must a piece present to be effective as an educational tool, and how does the museum approach such topics as the Human Genome Project through theatre without first describing what a gene is? These are questions that museum educators and artists working within the venues are asking themselves. Theatrical productions in reference to such

topics as the Human Genome Project can be used to show the social and ethical implications of science's effect on an audience's daily life. Every visitor who comes to such an institution brings with them different levels of education and personal experience in association with the material being presented to them.Theater is a medium which extends beyond teaching the facts, but its use can inspire the audience to go and seek out the facts for themselves, which Hughes feels is more to the point of the purpose of museum theatre (Hughes 56-57).

Even the use of theatre in educational settings, learning goals and objectives are still necessary and add dimensions to the piece itself, for it aids in providing inspiration, motivation and curiosity for further learning to the visitor. “Plato, among others, pointed out that the beginning of wisdom is having wonder about your world. I am reminded of the adage that to give someone a fish is to feed them, but to teach them to fish is to allow them to feed themselves” (Hughes 119). For museum theater to produce and achieve such effects, it must captivate and amaze its viewer, once this is accomplished it may then aid in reflecting a genuine inquiry of the subject matter. With the infusion of a strong and believable context, such an experience can stimulate and question the connections the viewer is making to the subject matter, allowing for them to take the first step in feeding themselves with knowledge (Hughes 119). Both museums and the arts face a challenge of being seen as venues for entertainment. This is not to say that learning cannot be a fun and an enjoyable experience, but what both must keep in mind is not to exclude aspects of critical thinking in their presentations. Theatre invites visitors to share what they are feeling and aids in addressing the human condition, not only in science, but all other disciplines as well. In the Museum of Science play *No Easy Answer*, by Marilyn Seven, the play surrounds two sisters who in frustration turn to their audience an ask for their help in their

situation concerning their father's treatment for Parkinson's disease. This piece was performed in an enclosed theatre space that was not in connection with an exhibit, but still followed a series of discussions inspired by the audience's reaction to the text (Hughes 40-41).

After a performance is finished there are connections being made, new concepts being explored and feelings are expressed; an experience has been had. One of the wonderful things about the use of theatre in these settings is that it goes beyond entertainment and education, but it allows the visitor to leave with an experience.

> The power of theater is the ability to reach the five-year-old as well as the eighty-five-year-old, to capture the attention of the kinesthetic and the logical/mathematical learner, to provide narrational and experiential entry points, to amuse, surprise, and impress. Theatre can open the senses and touch the heart and mind, challenging audiences' understanding and provoking them to rethink their own ideas. (Hughes vii).

Arts education is a learning approach that goes beyond the traditional linguistic and logical modes of understanding subject matter. The use of theatre allows the visitor to shape their experience through a different format than a conventional docent led tour, for it presents a microcosm of a larger experience that becomes more personal to the participant. When one is allowed to make connections and construct meaning for themselves the desire and retention of knowledge is longer lasting and creates a more profound impression of the learner. The use of interpretation which the theatre offers is not just instruction of a given fact, theory or set of ideas, but provokes one to understand the world around them and their place within that world. "Museum theatre provides opportunities to effectively question visitors' misunderstanding and assumptions about the world, whether it be about animals, art or an event in history" (Hughes 118). Theatre can do this by constructing scenarios, which then creates a safe distance between the viewer and narrative allowing the audience to work through the ideas and concepts on their

own terms. With educational theatre those who partake in such events are in control of the outcome of their experience. They take as much out of the events as they like and construct them in a way where the information can be applied to their own circumstances or ideas around the function of the subject matter being presented. “We must shape museum theatre so that it is part of the world, can be assimilated into visitors' experience, and be used to build on their future experiences” (Hughes 119).

CHAPTER 7: THE CARPENTER SCIENCE THEATRE COMPANY

At the Science Museum of Virginia there is a small company of artists who create and produce works that are simultaneously entertaining and educational, thought-provoking and yet fun. The ensemble use their talents to educate children about the functions and aspects of science and technology. The artistic director of this company is Larry Gard, whose passion and dedication to museum theatre is contagious to any of those who come in contact with him. He has created an environment at the Science Museum of Virginia that is welcoming to all who want to explore the benefits of science education through art. He uses professional actors and technicians and has built a working relationship with theatre companies in the Richmond area to show that education does not have to stop at the classroom, but can be found in our arts and entertainment as well. His current project is what he would call a "think-tank" which consists of local educators, theatre practitioners and those who share his passion of theatre as a tool beyond aesthetic pleasure, but in its use of playing a larger purpose in the function of human development.

The idea for the Carpenter Science Theatre came about in 1995, from two of the museum's staff members, Barry Hayes, who was a local theatre and musical director, and Anne Easterling, who also had a diverse theatre background as well. Both Anne and Barry had strong ties with the theatre community in Richmond; as a musician, Barry had established a relationship with the Science Museum, for he composed for its planetarium, and he served as the museum's

director of multimedia. Anne, on the other hand had a different set of artistic talents to bring to the table, for she served on the board of directors at Lee Playhouse, in Fort Lee, Virginia, where she also functioned as a choreographer. In 1995, Anne and Barry launched an idea to start a museum theatre company at the Science Museum of Virginia. They sent their proposal for the theatre to the Carpenter Foundation, asking for a grant in the amount of one-hundred and sixty-thousand dollars to begin this company; their grant was approved. The opening show performed by the company was Barbara Field's *Playing with Fire (After Frankenstein)*, and the production was done in the museum's forum, for the museum did not have a traditional performance space. (In the late1990s, renovations to the building were underway and in the new additions, the museum included a traditional theatre space.) The opening performance of the Carpenter Science Theatre took place on October 18th in 1996. The show was directed by Randy Strawderman, produced by Anne and Barry and their creation was a hit, placing theatre arts as a new medium of science education. The reasoning behind the idea of the Carpenter Science Theatre was based on a belief, shared by both Anne and Barry, that theatre was good way to educate. It helps to relate the humanity behind the science to its audience, and that has been the theatre's mission ever since: "To use live theatre as a teaching device to interpret the humanity that permeates and surrounds the sciences" (Gard 3/15). The initial grant Anne and Barry received was used to fund two years of programming for the theatre, and with their second grant, they wanted to incorporate more technical and professional elements in their productions through the use of a full-time artistic director and the capability to hire local talent, turning them into a full-time company. The Carpenter Science Theatre underwent a drastic change from producing shows every few months to having theatrical components intertwined with the museum's programming

five days a week. When Larry Gard joined the staff as artistic director in 1998, his assignment was to produce theatre in the museum's new performance space, and he has been doing so ever since (Gard 3/15).

Gard has been the artistic director of the Carpenter Science Theatre for the past sixteen years. He was a graduate of the Conservatory Theatre Arts at Webster College in 1978, in Saint Louis, where he trained as an actor and director; after graduation, Gard began a seven-year period as a freelance actor. In 1980, he moved back to Indiana and began graduate work with his concentration in theatre education. From 1980 to 1986, Gard kept doing professional theatre and even had aspirations for his own side project to help supplement his income. This project would end up becoming Midwest Actor's Showcase and included a curriculum for acting classes for high school students for nine weeks, meeting one day a week. Gard needed a place for this project and had his sights set on the Edinburgh auditorium at the Snite Museum of Art. He was unable to afford the rent, so instead he asked the director of programs to do a semester of creative drama sessions for students who would tour the museum and in return, he could use the auditorium on Saturdays for his own program; the museum went for it. This was Gard's first experience of doing any work associated with museums (Gard 3/15).

During his first semester in graduate school, a representative of the Northern Indiana Historical Society Museum called Gard; she wanted to ask him about getting together to do museum theatre. There was no theatre located in the institution's space so Gard inferred that she must have been wanting creative drama; he was unsure how he would do theatre in a museum. This new partnership would bring about Project Hat (history, art, theatre) and incorporated the historical museum, discovery hall museum and the museum of art. Project Hat's first production

was about Schuyler Colfax and the Teapot Dome scandal and this was Larry's initial experience with museum theatre. From there Gard would later go on to work the Cassidy Repertory Theatre and the Northern Indiana Very Special Arts as a drama consultant, directing theatre activities with disabled children. As a result of his involvement with the Cassidy Repertory Theatre, Gard was invited to give a day-long seminar on how to do museum theatre at the world's largest children's museum in Indianapolis. Gard would spend the next eleven years as the manager of theatre programming at the Indiana Children's Museum. In 1998, Gard heard about an opening for a full-time artistic director at the Science Museum of Virginia, and upon his final interview with the institution, where he gave an acting workshop to the staff, he got the job. "Never would have dreamed of doing theatre in museums" (Gard 3/15).

Museum theatre, though it is becoming more common, is still a device that is not utilized in a majority of institutions. Many theatres that exist within these venues are not funded by the museums themselves, but by grants and sponsored contributions. The Carpenter Science Theatre has been supported over the years, mainly by the Carpenter Foundation, along with other outside sources. "Theatre being in the museum has been well received, as long as the museum can receive financial assistance to help pay for the live theatre programming" (Gard 7/14). However, surprising enough, with these grants and charitable contributions, there have never been any stipulations on how the money is to be spent. "Do it in whatever context that is most appropriate" is how Gard describes the funds he receives. "We report to the foundation on what we are doing, but never has there been any stipulations...In the context of what we do it is important to have that autonomy" (Gard 3/15). Having this kind of freedom is vital for the Carpenter Science Theatre Company, because depending upon the content of the piece, there are a multitude of

applications of creating theatre. Sometimes it is best to perform in a traditional space, or use storytelling in the gallery; it all depends on the topic, the age range for which the piece is aimed, and what space fits best to tell the story. The Carpenter Science Theatre Company exists because it serves the museum, and if the company was unable to complement the mission of the museum in its desire to inspire people to explore science, then the program would not exist. "So in the museum context that we operate within demands that we be flexible on how we approach every project we do. Often scripted pieces are best, or creative drama, or storytelling, but we have been grateful that the Carpenter Foundation has said, however you feel is necessary to spend this money, as long as its purpose is for creating live theatre" (Gard 3/15).

Behind the Facts and Into the Humanity

Through live performances the Carpenter Science Theatre aids in enhancing the exhibits the museum already has on display. "Our goal is to incorporate the humanity of science exhibits through theatre studies" (Gard 7/14). Live theatre is a good teaching tool because it breaks through and communicates on a visceral level, which text panels and exhibits sometimes cannot achieve. It allows one to see what else is involved and how things such as radiation make an impact through telling the stories of the experience of other people. This use of theatre in an educational environment reaches people on a human level, allowing the visitor, who may not have an objective viewpoint, to have an emotional reaction. The exhibits become more well-rounded and import more meaning to the student or observer, especially in science when the question raised often becomes should we do this?

"Theatre thrives on conflict and inquiry and is invaluable in inspiring people, challenging

them and making them less fearful of encountering ideas, especially those foreign or new to them. Theatrical characters can embody what we most love and most fear in a non-threatening way, and we can be invited to laugh and to cry about ourselves and others" (Bridal 7). Over the years, there has been dissatisfaction with how museums have approached telling the human story; such as the way the history museum presents a conflict-free past, or how natural history museums are criticized for ignoring the exploitative relationship between subject and collection. In the last few decades, museums are beginning to incorporate more radical issues, like slavery, into their programming that examine the ethics behind the collections and the artifacts being displayed; and theater has been a major contributor in presenting the story of man-kind's history and as an interpretative tool for uncovering the stories behind the exhibits. "Theatre is fiction to which the audience consents, and thus it can provide a non-threatening framework for dealing with complex, crucial social issues relating to science. Theatre makes it safe to contemplate disturbing controversies and to probe attitudes towards science" (qtd. in Bridal 132). The Carpenter Science Theatre Company uses theatre to appeal to the humanity of its audience. The impact of showing the humanity in science is that it compels one to stand up for what's more compassionate or responsible. "There's an ugly humanity that science theater can address and assist in eradicating, but that does not work without conflict" (Gard 7/14). Both art and science share a common factor, as both have the ability to challenge our perceptions of the world. Poet Samuel Taylor Coleridge stated:

> The proper and immediate object of science is the acquirement, or communication of truth; the proper and immediate object of poetry is the communication of immediate. The communication of immediate pleasure is a function of all the arts, not only poetry, and if we succeed in communicating a truth while giving pleasure, this is a worthy goal in itself. (qtd in. Bridal 159).

While seeking the truth through an entertainment medium, the viewer can choose to engage with the presentation as factual, or they can distance themselves by discarding the stories as mere entertainment. But does the fact that theatre is seen as entertainment hinder the presentation, the goal of the performance? Theater as an aid in museums is not a device that is a panacea. A visitor may not become a participant in the performance-creating process and then create the same type of distancing as a traditional exhibit. The use of theatre is not the solution, but with its emergence in the museum, it has begun to bridge a gap between facts and faces of human history. At the Science Museum of Virginia, the receptiveness to the company residing within the museum walls has had a positive response. The Carpenter Science Theatre Company does not just stop at the museum; it also have a presence in the community as well. Members of this company participate in performances in other local theatres and even take their own productions on the road, doing shows in regional public schools, in association with the topics the children are learning about in their classrooms. In spite of the freedom the company is given, it still has to make sure the science is accurate, and that is why every script that is created for the museum is looked over by a content specialist from the museum's education staff. Providing false information in an educational setting can have extremely dangerous side effects on both the company's part and those who view its performances.

The Future of the CSTC

The future of science theatre is still uncharted territory, but is becoming a more popular avenue for museums as they integrate more aspects of the humanities into their programming. As for CSTC, with the renewing of its funding, the company is now looking forward to branching

out and partnering with other theatres in the Richmond area. The CSTC is part of a large non-profit museum and stands out from other commercial theatres in the area, as, for example, its use of space is a mix between traditional, the Barbara Thalhimer Theatre, and non-traditional, such as storytelling in the galleries. It does not create a season, as its works happen spontaneously, and are constantly being developed year round. Furthermore, most commercial theatres have a board of directors which the theatre serves under; this is not the case for the CSTC. By not having this aspect the company is literally a part of the museum and through the history from the creation of CSTC, it is of the museum. It reports to the Director of Playful Learning and Inquiry. Chuck English, who in a sense works as the executive producer of the CSTC, works with the museum education staff to choose the focus on upcoming productions. However, as much as museum theatre is distinguished from the commercial, there are innate qualities they both share. Even with being such a small company this does not mean that the level of professional work should be of a lower quality. Artistic director Larry Gard maintains a skilled environment and expects the same of those who work with him. Like many theatres the body of work the company creates appeals to a broad range of ages. On the whole, its philosophy is to appeal to the adult in the child as well as the child in the adult. Furthermore, the shows that come from this company are not just concentrated in one type of theatre. It integrates both comedy and tragedy, storytelling and character monologues, and the productions at times are extremely silly, such as *Marco Polo's Adventures,* to more serious topics such as *The Penny Executive.*

> The biggest future goal is to keep creating and producing live theatre that effectively interprets the humanity that permeates and surrounds the sciences. From practical standpoints, I want us to more effectively get integrated into the museum's infrastructure – to help spice up the live demonstrations with some theatrical elements – to assist in training staff members how to more effectively make public presentations. (Gard 3/15).

With the creation of the “think tank” Larry and his colleagues are discussing some interesting and unique ways in which science theatre will cross over the threshold into the commercial theatre of the Richmond area. The future looks bright for these artists whose work and dedication to their field is truly inspiring.

If the arts and sciences do not recognize the need for collaboration, this could place the education system in a predicament. It is up to both fields to make sure this discourse happens, through the infusion of science in the arts and art in the science classroom. When art collides with knowledge, boundless possibilities arise. From interdisciplinary classroom methods, to artists and scientists collaborating together for the betterment of man-kind, and the use of theatre as a way of rediscovering the humanity of human history; the use of arts education creates a lasting effect on the retention of knowledge and understanding of our universe. The collaboration between the disciplines serves as one of theatre's greatest purposes, to educate and represent a living history of man.

CONCLUSION

In the spring of 2015, I stopped reading about science theatre and placed a production on stage. Chiori Miyagawa's *Comet Hunter* is a story about Caroline Herschel, the first known female comet hunter in the world. This play drew me in for its use of astronomy and a strong leading female character. The play traces the life of Caroline and her struggle as a female in a male-dominated field. Caroline's story is one of pain and discovery; of curiosity and sacrifices, as she lived her life beside her brother William, who was credited with the discovery of Uranus. The text itself is dense with scientific language, which presents a challenge for actors, but the use of such language calls attention to the brilliance and courageous nature of Caroline. The choice of this play allowed me, as a director, to explore group dramaturgy with the cast and crew. I encouraged all production members to ask questions during the rehearsal process to make sure, as a group, we all understood the language as completely and as thoroughly as possible. During this production, a majority of the actors were also enrolled in an introductory astronomy course, which created interesting conversations about the collide of arts and science. While the actors were bringing their knowledge from the classroom into their performance, which was an inspiring sequence of events, it allowed for the production to function on another level for the actors and their exploration of interdisciplinary learning in and outside the classroom.

Comet Hunter, so full of history and astronomical terminology, brought a difficult challenge to young actors on how to make the facts interesting and playable. It became essential

that they fully understood the objects in the sky to which they were referring, to the equipment that was constructed and built by the Herschels, such as the forty-foot telescope, which William presented to King George III. Many questions asked by the cast, at times, would turn into lessons of astronomy's history as I would describe how the geocentric theory made man believe that the sun rotated the earth in a perfect sphere to have them understand perihelion (the shortest distance between the sun and Earth and Earth's rotation around the sun). I stressed to the cast the importance of the lines, for saying the inaccurate word would give the audience false information; in this production the science is just as important as the dramatic conflict. Keeping in mind the words Larry had spoken to me in our first interview, "we give science the face of humanity," I made sure that even through the recording of comets and conversations about Kant, the emotional journey of Caroline was never lost. She was more than her discoveries and more than just a fact in a history book, but a woman who made sacrifices for what she loved and the people who inspired her and her love for her brother William.

Through this exploration of the collision between art and science, I have found myself drawn to it most in the form of playwriting, by finding connections between the two fields and how they interact in the physical world. As I read and research theories and discoveries from the men and women in scientific and technological fields, I want to go beyond the facts and into the depths of who these people really are. After all, theatre is storytelling, and we have some many stories that have yet to be shared.

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