

Toward a Synthesis of Science and Theatre Arts

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Abstract

The chasm between science and the arts has been hotly debated during the last century. History reveals that science and theatre arts (drama and dance) have shared a successful symbiosis that has benefited society for at least two millennia. This natural partnership continues to have positive effects on our culture by providing aesthetic satisfaction and educational resources and by influencing public policy.

Introduction

In 1959 C. P. Snow published *The Two Cultures and the Scientific Revolution* in which he lamented the dichotomy of science and art in society. It was a schism, he feared, that at that time showed little likelihood of being reconciled. It is this issue of the relationship of science to the art of theatre---specifically drama and dance---that will be treated here. These two cultures are **not** divided disciplines. They are, and have always been, natural partners. Science and theatre seek the same goals, in the same way, using the same language. That is, they both seek to understand the natural world through intelligence and insight. Scientists speak of finding “truth”; theatre artists work to present verisimilitude, or similarity to life onstage. Indeed, J. Bronowski, as a scientist and humanist, insisted that “there exists a single creative activity, which is displayed alike in the arts and in the sciences.” (Bronowski, 1965, p. 27). Both disciplines share a mutual desire---to help society. Science offers its discoveries and inventions. Theatre presents to us our strengths and weaknesses and points us in a particular direction for the betterment of all people.

This successful alliance of science and theatre has given the world beauty and perspective for centuries. It has made our theatres safer and our performers healthier. The symbiosis of the two cultures also has been influential in setting public policy. We can understand the scientific and artistic synthesis and its potential by examining three avenues: the history of theatre and parallel scientific developments, pedagogical applications of both disciplines, and the argument

for the marriage of the two cultures in education. Engineering, technology, physics, and the social sciences are included here in defining *science*.

Historical Parallels in Science and Theatre

Even a brief survey of theatre production reveals that a partnership between the disciplines of art and theatre is not a new development. Rather, theatrical trends and practice have reflected scientific discoveries in our western civilization since recorded history. Not only do scripts of ancient Greek plays call for engineered machinery onstage, but some nineteen mechanical devices are mentioned by the Greek scholar Pollux in his *Onomastikon*. The best known apparatus for this technical equipment was the “deus ex machina” (a crane-like device that “flew” actors and scenery in and out of the performance area). Vitruvius, the first century Roman architect, offers specific instructions on constructing a Roman theatre in his book *De Architectura*. In his volume on “Civic Public Spaces,” he showed particular concern for acoustics in contemporary theatres. Records of theatre productions during the Middle Ages mention mechanical effects frequently. Several levels often comprised a single set for a drama. In addition, several sets were used for a single production of a series of plots drawn from the Bible. Allardyce Nicoll in his *The Development of Theatre* refers to a stage set of Hell’s mouth that opened, closed, and belched fire; flaming swords; burning altars and houses; thunder and lightning. (Nicoll, 1966, pp. 53-61). Only scientific minds could bring these effects to fruition.

The Renaissance looked back to study the art and science of classical Greece and Rome with eyes focused forward on the new age of science. Interestingly, during this time, science could be recorded **only** through art. For example, Galileo and DaVinci presented their scientific data through drawings. So, too, were designs for scenic devices recorded through artistic

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sketches. Theatre and science continued to work hand in hand with the elaborate “scenery and machinery” in the large proscenium theatres of the Italian Renaissance. The scientific revolution continued to influence theatre productions with apparatuses for flying scenery and performers. These mechanical devices were exported throughout western Europe and America for audiences hungry for spectacular theatrical effects.

Nineteenth century theatre performances reflected further developments in science, the most significant being the introduction of gas and, later, electricity, for stage lighting. Turn-of-the-century realistic dramas illustrated another advance for science, the invention of photography. Sets and costumes were designed as though seen through the eye of the camera, i.e., accuracy, and, therefore, theatrical verisimilitude, was essential.

During the twentieth century scientific advances in stage lighting played an increasingly important role in theatres in the western world. In addition to illuminating actors, lights were capable of creating mood and natural phenomena, e.g., moons and moonlight, stars, sunrises and sunsets, and lightning. In the dance world, Loie Fuller became famous for choreographing dance pieces that depended solely upon light reflected on her costumes created from large volumes of fabric, which she manipulated while dancing. Fuller is also credited with inventing and patenting types of lights and colored “gels” for her dances. Theatres were rendered safer from fires through the replacement of candles and gas lighting with electric lighting. The addition of the “fire curtain” and the introduction of the counterweight system (instead of sandbags) to fly scenery protected both audiences and performers and backstage crews. Science and theatre continued to walk hand in hand.

In the last century Einstein’s Theory of Relativity revolutionized science, as well as most aspects of our society. The concept that space, time, and movement are not absolute as

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phenomena, but are dependent on the “field” of energy from which the observer perceives or experiences these phenomena, is reflected in a drastic change of attitude in sociology, psychology, law, and the arts. In his Special Theory of Relativity Einstein advanced the concept that, since it is impossible to discern whether an object is at rest or in motion, there can be no “preferred” frame of reference. The perspective, then, is that of each individual and the way in which he or she experiences or perceives the space, time, and motion within his own specific field of energy.

A notable reflection of relativity in this country in sociological terms is the civil rights movement---the demand by individual societal sub-cultures to have their own specific points of view considered. In the theatre numerous new plays were presented showing the experience of life from the particular “field of energy” of the various groups of people who live in the world. Changes due to the new relativist attitude are obvious in theatre architecture. Gone is the elaborate façade to a building. Modern buildings, in general, reflect the architects’ interest in presenting the beauty of a design from all angles. Instead of a one-point perspective to the front of a building (as in the Paris Opera House), we find a construction that can be approached “frontally” from any direction (such as the Sydney Opera House). Inside the theatres the performance area moved out of the single performer-audience configuration of the proscenium stage into the relativity of three-quarter and full-arena situations and, eventually, into “environmental” theatre, where actors performed all around spectators.

The spirit of relativity burst into the dance world in the 1960s. Choreographers made no attempt to set up the usual single sight-line perspective of the proscenium theatre. Rather, they established numerous variations of a field of energy. For example, the field configuration might be set by seating the audience in the center or spread out along the sides, divided into segments,

or placed on both sides of the room. Within this continuum of space, time, and force there are specific laws at work which affect the activities in that field. Certainly one of the best known concepts of this aspect of science is the element of *chance*.

Choreographically, the most obvious parallel to the scientific theory of chance is found in Merce Cunningham's work. One of the first to break from the traditional use of emotion and story line in modern dance, he freed movement from the need to express meaning, and his audiences saw the beauty of the "laws of motion." His "chance" choreography emerged onto the dance scene some years after scientists began to experiment with the idea. In 1927 Werner Heisenberg formulated his Uncertainty Principle (also referred to as the Indeterminacy Principle), which argues that it is not possible to determine with accuracy both the velocity and the direction of a particle in a field. That is, the observer can predict and follow the movement pattern of energy-charged particles only within certain probabilities. In a given field, then, the particles radiate and absorb energy as they encounter one another, and the only way to predict their patterns is by admitting to a certain amount of chance. Cunningham and his composer-partner are famous for their use of this phenomenon as a basis for much of their dance theatre work together. In 1953 Cunningham introduced his chance composition appropriate titled *Suite By Chance*. The choreography was determined by flipping a coin for choices from a prepared series of charts indicating dance movements. An exercise from Cunningham technique class presents another example of this choreographic process. From a prepared set of four different movement sequences (each executed in six-count phrases), the dancers are asked to perform simultaneously the series standing in one position in any order they like. A variation of this is to repeat the exercise, this time varying the duration of each spatial design but still completing the

sequence in six counts. In the chance method, then, the resulting choreography can be predicted within a range of so many known possibilities.

In drama Heisenberg's chance principle is exemplified by improvisation (acting out an unscripted scene on the spur of the moment). "Improv" training became an important part of curricula in theatre schools, and improvisational theatre companies became a mainstay of theatre art around the world. Most recently an Off-off Broadway play used Heisenberg's chance principle on the plot development by allowing the audience to decide at certain points how the story line proceeds. At "choice moments" the action stops and the audience votes on what happens next. A *New York Times* article reported that the play, called *Bite*, was advertised as "a different show every time." (Genzlinger, p. E1). Similarly, in improvisational theatre, the audience shares in the development of the action by suggesting topics to the actors throughout the show, thereby making the element of chance a crucial part of the performance.

Theatre as Pedagogue

Because of theatre's ability to instruct while it entertains, productions throughout the ages have often been influential in setting public policy. Dramas were presented in ancient Greece as mandated religious ritual intended to demonstrate how society should behave. Audiences observed the terrible consequences of the protagonists' mistakes and learned what should and should not be done. Horace, the Roman rhetorician, insisted that, while a play should be entertaining, it must also instruct the audience. His well-known "profit and pleasure principle" dates back to his manual on playwriting, *The Art of Poetry*, written in 19 B.C. Medieval cycle and morality plays also offered audiences clear examples of guidelines for living. The famous anonymous morality play *Everyman* strongly cautions audiences to help others with "good

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deeds” to avoid eternal damnation. Elizabethan audiences witnessed the punishments of villainous characters who upset the social order. Shakespeare’s *Richard III* is a good example. In seventeenth century England the popular female playwright Aphra Behn used humor in her dramas to attack the position of women in society.

By the late nineteenth century “modern drama” was beginning to evolve in the “problem plays” that brought attention to many new cultural issues. For example, the dramas of Henrik Ibsen, August Strindberg, and Anton Chekhov were concerned about social ills. Ibsen’s *Hedda Gabler*, *Ghosts*, and *A Doll’s House* shocked audiences by exposing problems of middle class marriage. In a recent study on Ibsen, Theodore Dalrymple remarks on the playwright’s ability to influence his own and future generations.

The scale of Ibsen’s achievement is astonishing. . . .[he] must have expressed what many people had thought and wanted to hear but had not dared to say. He was thus both a cause and a symptom of social change. . . .(Dalrymple, 2005, pp. 79-80)

Strindberg and Chekhov foresaw a leveling of society with the disintegration of the “aristocracy” and the rise of the working classes in *Miss Julie* and *The Cherry Orchard* respectively.

Twentieth century American musical theatre continued to sound a clarion for inequities in society, and ultimately legislation brought changes in policy. Perhaps the best know example of the efficacy of theatre for raising consciousness about the problems of others is *Show Boat*. With the theme of racial discrimination, it opened on Broadway in 1927. The problem of civil rights in America was onstage decades before the movement ended in legislation in 1965. Other

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musicals, such as *South Pacific*, *West Side Story*, and *My Fair Lady*, similarly called for social change while it entertained with song and dance.

Throughout the century various forms of “agit-prop” theatre (agitation-propaganda), or political theatre, became popular as a way of focusing society on particular civic needs. Performers literally took theatre to the streets to protest everything from domestic to foreign policy. Beginning in the 1960s Americans saw the emergence of theatre companies such as the Bread and Puppet Theatre, the San Francisco Mime Troupe, and El Teatro Campesino. These groups exemplify numerous theatre communities that expressed their disagreement with various public policies.

At this same time, college and university theatre departments and community theatre groups were also becoming a force for cultural change. The fact that college students and the surrounding community audiences were attending dramas revealing numerous different points of view parallels Einstein’s relativity theory. Spectators reacted to dramas by and about Asians, Blacks, Hispanics, women, the elderly, homosexuals, the disabled, and, this past season, obese citizens. Recently a drama, *The Exonerated*, which played in New York City, Chicago, Boston, and Washington, received attention as an anti-death penalty production. The following excerpt from a *New York Times* article on the play reveals that, in at least one case, the drama influenced public policy.

Opponents of the death penalty point to “The Exonerated” . . . as powerful and irrefutable evidence that will force supporters of capital punishment to rethink their position. . . .”The Exonerated” arrived at a crucial moment in the national debate over the death penalty. . . .Gov. George Ryan of Illinois, who has seen the play at least twice, recently emptied his state’s death row of all 164 inmates, declaring the system fundamentally flawed. (Liptak, 2003, p. B9)

Science as Pedagogue for Theatre

One of the missions of most educational systems in the U.S. is to nurture the natural creative impulses in human beings. Creativity, the basis of problem solving, often requires inspiration, and science can provide that catalyst. This writer was fortunate to have been part of a two-year grant that allowed college professors from the Physics and the Theatre and Dance Departments to supervise any students interested in learning how the laws of physics work in tandem with the theatre arts of dance and drama. Young people from all disciplines in the college eagerly participated. Physics teachers introduced such scientific principles as Liquid Dynamics, Heisenberg's Uncertainty Principle, Brownian Motion, atomic Fission and Fusion, and Newton's Laws of Motion. Dance and theatre teachers supervised the students who literally "danced" and "acted" these principles. For example, liquid dynamics can be demonstrated very simply with a small model of a boat. The boat on water can execute six "translational" and "rotational" movements. That is, the boat could bob up and down on a wave, slide forward and back and side to side across the water in translational movements. The boat could also demonstrate the rotational movements, "roll, pitch, and yaw." The human body can enjoy imitating these six movements by expressing them physically to music. As Aristotle observed in his *Poetics*, "mimesis" or the imitation of life was normal for human beings. After the scientific explanation, participating students jumped up and down, swung their bodies from side to side, twirled, performed somersaults and cartwheels, i.e., they personalized that particular law of nature. In a subsequent experiment the element of chance from Heisenberg's Uncertainty Principle was introduced by having each participant execute the six movements in any order and for any length of time.

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In a later workshop students were “cast” as the molecules in Brownian Motion (particles in a fluid exhibit random motion). The participants “bounced off” one another using their own improvised dance movements. They also performed as neutrons and protons in the fission and fusion processes of the atom. Everyone understood that the group had “become” those particular principles of physics, for which they now held a greater understanding.

Using science as a catalyst for creativity is only a first step in the integration of science and theatre training. During the second year of experimentation under the grant, science laws were applied to teaching skills in drama and dance. Participants learned that an actor’s movements onstage were more effective when they followed Newton’s First Law of Motion (inertia and momentum: a body will either remain at rest or in motion unless acted upon by an outside force). For example, as a character onstage the actor stays in motion on entering until another character bids him to be seated. He remains at rest until the butler announces dinner. The actor’s blocking is controlled by other “forces” onstage, which give him his motivations for motion or rest.

Newton’s Second and Third Laws of Motion (“the rate of acceleration of a body equals force times mass” and “for every action there is an equal and opposite reaction”) are useful in teaching stage combat. A performer’s reaction to “attacks” in a fight must equal the applied force of the aggressor. For example, if, in a serious drama, he responds to a gentle shove by falling violently backwards onto the floor, the audience will undoubtedly laugh heartily at his over-acting, because the action will not appear natural.

The use of physics to teach and improve dance skills is becoming more widespread since the physicist Kenneth Laws popularized the technique. Dancers learn, e.g., that effective use of their arms can produce the “torque,” or turning force, necessary for “rotational acceleration,” or

turns. They can understand that Newton's Third Law of Motion (for every action there is an equal and opposite reaction) is at work to produce elevation for leaps and jumps. That is, the deeper the bending of the knees to push off from the floor, the greater the resistance from the floor, which results in optimum height in the air. Dancers have become slimmer, and therefore, healthier, since physics has revealed how much more force is required of thicker legs to perform "entrechats" (the multiple crossing and uncrossing of the legs during vertical jumps). (Laws, 2002, pp. 169-171)

Implications for Public Policy

Sir Snow pointed out in *The Two Cultures: A Second Look* that, in addition to understanding our world, the scientific process seeks also "to control it." (Snow, 1965, p. 67) Similarly, J. Bronowski in *Science and Human Values* remarked that "power is the byproduct of understanding." (Bronowski, 1965, p. 10) This brings up the possibility of a "third culture," i.e., the continued partnership of science and theatre through interdisciplinary education. Because of the ability of theatre to instruct while it entertains and the ability of applied science to make a safer and healthier world, can we not confidently put our trust in an educational system that produces citizens grounded in both science and theatre?

Last year a *New York Times* editorial lamented America's profound illiteracy about science and math." In his scathing condemnation of a lack of science education, Nicholas D. Kristof decried the "diet of poetry, philosophy and history." (Kristof, 2005, p. 27) On the other hand, a recent study released by the Guggenheim Museum in New York City revealed that elementary students who studied art "performed better in six categories of literacy and critical thinking skills. . . than did students who were not in the program." (Kennedy, 2006, p. E1) Less

than two weeks later, the Guggenheim was awarded one million dollars by the U.S. Department of Education for another study “to conduct research into whether students’ problem solving skills are improved by studying art.” (McElroy, 2006, p. E2) It would appear that a synthesis of two positives, i.e., hybrid courses in science and theatre arts, would make an effective solution to “one-sided education.

Conclusion

When considering a hypothesis, the scientist asks if it can be tested. And, if so, can the hypothesis be re-tested with the same results. In making a case for interdisciplinary curricula in science and theatre for our education system, that partnership already has been tested consistently for over two thousand years with successful results. In this continuing tradition of the theatre and science alliance a multi-media and experimental theatre company is working toward re-establishing its operations at the site of the ruins of the World Trade Center. A newspaper article titled “A Theater Group Offers Hope at Ground Zero” reported the efforts of the group that combines theatre and technology to help bring vitality back to the devastated area. The company, the 3-Legged Dog, is perceived as a way of “opening a window of cultural opportunity for Lower Manhattan.” Using the science of technology and the creativity of theatre, this group wants to bring “some concrete evidence of progress.” (Kendt, 2006, p. E4)

Forty years ago Edward Hall maintained in *The Hidden Dimension* that man cannot begin to settle his social ills, “the ethnic crisis, the urban crisis, and the education crisis,” until he begins to understand that individuals are products of their various “cultural dimensions.” (Hall, 1966, p. 178) Once we understand Einstein’s concept of numerous relative “fields” each operating differently, we can apply this theory to each cultural field and learn how the energies

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within it operate. Theatre helps us to see those multiple perceptions that make up our world. Building on the time tested natural partnership of science and theatre arts through education would give us that true synthesis of science and art that could be the “social hope” of our planet.

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