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Tom Stoppard's Science Plays: Metaphor and Experiment

Tom Stoppard, the critically and popularly renowned English playwright, who has been a constant presence on British as well as world stages since his 1966 hit play *Rosencrantz and Guildenstern Are Dead*, is a celebrated author of the "comedies of ideas"—plays that are not just entertaining, but also intellectually stimulating. After successful experiments with concepts from, inter alia, philosophy (*Jumpers*, 1972), nonsense language (*Dogg's Hamlet*, 1980) and reaching beyond the limits of traditional dramatic genres (*The Real Inspector Hound*, 1968; *The Real Thing*, 1982), he recognised a dramatic potential of science, too.[1] His first science play was *Hapgood* (1988), followed by *Arcadia* (1993) and, most recently, *The Hard Problem* (2015). This article follows the trajectory in Stoppard's science plays, tracing how they involve science on various levels: from a playful exploration of the possibilities of applying science to a play's plot and structure in the two former plays, to a primarily ethical appeal in his latest. All three plays may also be considered as vehicles of popularisation of science as Stoppard uses various narrative and performative means to inform his audiences about selected scientific issues. While *Hapgood* and *Arcadia* are highly experimental in the ways they engage with science, *The Hard Problem* resorts to a few visual metaphors and remains a conservative

[1] In the mid-1980s, Stoppard remarked: "the mathematics of physics turned out to be grounded on *un*certainties […] if you're like me, you think—there's a play in that," quoted in Ira B. Nadel, *Double Act: A Life of Tom Stoppard* (London: Methuen, 2002), p. 367.

play, which involves science metaphorically but refrains from as radically experimental an approach as its two predecessors.

Before focusing on Stoppard's three science plays, some historical context and development of the genre need to be delineated. The contemporary science play is one of many literary genres that popularise science at a time of an unprecedented growth of popular science in all kinds of media.[2] This genre follows on two traditions. One consists of plays dealing with science as a metaphor, and the second includes science shows—public events with theatrical qualities that served to present science to the public (from public lectures and demonstrations to extravagant "wonder" shows).

There are numerous themes that border on science that can be found in drama since its earliest days. For example, blindness as a medical theme is present in Sophocles' *Oedipus Rex*. But treating Sophocles' tragedy as a science play would be rightly seen as anachronistic because dramas dealing with science explicitly have been common since the dawn of modernity. Christopher Marlowe's *Doctor Faustus* is the first modern English science play. Kirsten Shepherd-Barr writes that over the last four centuries, the "way in which scientific themes and ideas have been engaged by playwrights and directors has become increasingly sophisticated."[3] *Doctor Faustus* has the main character who is a scientist, and William Shakespeare routinely uses medical terms and metaphors, such as in Marcellus' remark: "Something is rotten in the state of Denmark."[4]

Another evolutionary stage of the genre occurred in the second half of the twentieth century. Plays focusing on scientific discoveries and prospects for technological inventions became common in the 1960s, to the point that the science play became a recognised genre. While science plays still use science as a metaphor, they increasingly include science in their plots as well as structures, achieving an essential level of the "formal and structural integration of the science. The playwright structures

[2] For an overview of history of popular science since the seventeenth century and its most recent forms in various media including the new media, see Nicholas J. Russell, *Communicating Science: Professional, Popular, Literary* (Cambridge, UK, New York: Cambridge University Press, 2010). For various issues related to presentation of science in various old media, see Jane Gregory, Steve Miller, "Media Issues in the Public Understanding of Science," in: *Science in Public: Communication, Culture, and Credibility* (New York: Plenum Trade, 1998), pp. 104–131.

[3] Kirsten Shepherd-Barr, *Science on Stage: From Doctor Faustus to Copenhagen* (Princeton: Princeton University Press, 2006), p. 15.

[4] William Shakespeare, *The Tragedy of Hamlet*, ed. G. R. Hibbard (Oxford: Oxford University Press 2008 [1987]), p.184 (Act 1, Sc. 4, line 65).

his or her play according to the scientific idea at its core, making the piece performative in nature."[5] Among others, two plays of the English provenance, Stoppard's own *Arcadia* and *Copenhagen* by Michael Frayn, are considered representative of this shift towards performativity of science in the theatre, which received both critical and popular praise in the 1990s. But it was precisely the combination of integrating science into the structure of the plays, explanations of scientific issues understandable to the audiences, metaphorical use of science for dramatic conflicts, scientists as lead characters, and a science-inspired innovative view of the past and present, that "has distinguished plays like *Copenhagen* and *Arcadia* from more routine works that employ science."[6]

Besides the dramatic tradition reaching back to *Doctor Faustus* and other plays that involve a scientist or present science on stage as a metaphor, contemporary science plays also follow the tradition of science shows. As the name suggests, these are popular public presentations of scientific phenomena. Such lectures were popular in the eighteenth and nineteenth centuries, as "the middle and upper classes found excitement and entertainment in the latest science; and skilled workers [...] drank in the knowledge that might improve their prospects in the new industries."[7] During the nineteenth century, these lectures were gradually replaced with live presentations. Michael Faraday's "series of Friday evening discourses, which were popular with mainly middle-class audiences,"[8] is an example of a Victorian scientific entertainment involving displays of the latest discoveries in physics and chemistry. Advancements in physics and electric inventions led to the so-called War of the Currents, in which proponents of Thomas Edison and Nikola Tesla's competing technologies showed the wonders of electricity in the late nineteenth century.[9] Science and technology presentations became a common sight for the general public in the twentieth century.

The true educational value of the science play remains problematic. This is mainly due to three issues: the lack of a criterion for distinguishing

[5] Shepherd-Barr, *Science on Stage*, p. 16.

[6] Shepherd-Barr, *Science on Stage*, p. 104.

[7] Gregory, Miller, *Science in Public*, p. 21.

[8] Gregory, Miller, *Science in Public*, p. 133.

[9] Mike Winchell, *The Electric War: Edison, Tesla, Westinghouse and the Race to Light the World* (New York: Christy Ottaviano Books/Henry Holt and Company, 2019).

fact from fiction, the metaphorical nature of the science presented, and the emphasis on its moral implications. The explanatory dialogue also needs to be cut short to provide only sufficient information for the storyline. Several authors agree that "science theatre should take advantage of its physical and visual potential (science as spectacle) rather than emphasizing knowledge and theory articulated through dialogue."[10] Yet despite these problems, there are didactic dramas that present science in a performative way with an educational aim. Playwriting scientists like Carl Djerassi explain their science through theatre, employing its demonstrative potential to educate their science students and general audiences alike.[11]

Most science plays emphasise understandability and entertainment. Actual scientific research is not the source of information about science for a layperson playwright. And, although scientists often participate in the playwriting and rehearsal processes, they do so predominantly as consultants and advisers. When writing *Hapgood*, for example, Stoppard communicated with a number of scientists, yet these discussions concerned their popularising and introductory works.[12] The "main source of information tends to be popular science writing."[13] Thus, science plays are popular science trans-medial adaptations, "translating" popular science from non-fiction to drama (dialogical text) and theatre (performance).

Stoppard's science plays, as the following analyses illustrate, employ "theatricality as well as textuality"[14] to convey complex ideas by a simple act of staging. Furthermore, the structure of the plays (such as the sequencing of scenes and their other formal aspects) is also crucial. All these elements

[10] Russell, *Communicating Science*, p. 307.

[11] Russell, *Communicating Science*, pp. 311–13.

[12] See, for example, Ira B. Nadel, *Double Act*, pp. 368–371, for a description of Stoppard's exchanges with the physicist J. C. Polkinghorne, the author of *The Quantum World* (1984), an introduction to quantum mechanics for a general readership. This book is among the sources for *Hapgood*. Stoppard became intrigued by several of the concepts it includes and approached Polkinghorne with a request to discuss them further to verify whether his playwright's instincts comply with what the popular understanding of the quantum physics theory implies. Stoppard also discussed the possibilities of a metaphorical use of quantum mechanics in *Hapgood* with the Nobel prize-winning theoretical physicist Richard Feynman. Stoppard and Feynman corresponded about theatrical potentials of quantum mechanics. Feynman's famous series of popular lectures for a wide audience was also Stoppard's inspiration while writing the play. At the same time, Feynman's "belief that physics was an art" (Nadel, *Double Act*, p. 370) enabled a rather creative approach to the core "mysteries" (Ibid., p. 370) of science.

[13] Liliane Campos, "Science in Contemporary British Theatre: A Conceptual Approach," *Interdisciplinary Science Reviews*, Vol. 38, No. 4 (2013), pp. 295–305.

[14] Shepherd-Barr, *Science on Stage*, p. 28.

use science as a metaphor for human behaviour and as a way to deal with ethical issues related to characters' actions.[15] Liliane Campos suggests that these metaphors work on several levels regarding human behaviour: "Is the playwright using the action as a metaphor for the science, to make it more accessible to us, or is the science providing new metaphors for the human interactions we observe?"[16] Thus, besides providing popular scientific knowledge, the plays also tell human stories through science and vice versa: "Scientific metaphors, then, do not simply hijack scientific concepts to tell human stories: they are also a way of conveying them through human stories."[17] In his three science plays, Stoppard uses science to create what William Demastes calls "Stoppard's staged thought experiments."[18] The aim of these experiments was to examine what potent metaphors for human behaviour science offers and what the limits of the incorporation of scientific concepts into a play are.

Joseph Kerner, the main character of *Hapgood*, is a physicist and a defector from the Soviet Union, who was turned by the British secret service chief Elizabeth Hapgood. While he continues to live as a double agent, some British and American operatives suspect him of providing the Soviets with valuable information. After Kerner is cleared of suspicion, a trap is set for Ridley, another British agent, who is eventually caught and recognized as the actual double agent. Hapgood and Kerner both leave the secret service, and their future life prospects remain open.[19]

The plot of *Hapgood* is full of complications, which is thought to be why the play was not entirely successful when it first opened in 1988 and received only "lukewarm responses."[20] The plot was seen by the then audiences as overcomplicated and characters' "far more complex than typically envisioned"[21] behaviour as difficult to follow. The play combines the spy-thriller genre and principles of quantum mechanics. Stoppard is

[15] For a detailed discussion of the role of science as metaphor in contemporary fiction serving primarily an ethical purpose—as it provides the reader with new paradigms of looking at human behaviour (this argument is extendable to drama, especially the three plays discussed) —see Peter J. Rabinowitz, "'The Impossible Has a Way of Passing Unnoticed': Reading Science in Fiction," *Narrative*, Vol. 19, No. 2 (2011), pp. 201–15.

[16] Campos, "Science in Contemporary British Theatre," p. 297.

[17] Campos, "Science in Contemporary British Theatre," p. 298.

[18] William Demastes, *The Cambridge Introduction to Tom Stoppard* (Cambridge, UK, New York: Cambridge University Press, 2012), p. 30.

[19] Tom Stoppard, *Hapgood*, in *Plays Five* (London: Faber and Faber, 1999), pp. 483–593.

[20] Shepherd-Barr, *Science on Stage*, p. 88.

[21] Demastes, *The Cambridge Introduction to Tom Stoppard*, p. 83.

convinced that "it's not the physics that's the problem" with the play's limited success, but rather "the twins, all that."[22] When Stoppard read about quantum mechanics in J. C. Polkinghorne's *The Quantum World* (1984), he saw physics as a perfect metaphor for secretive human behaviour of spy thrillers. Demastes describes Stoppard's process as follows: "Stoppard began with a yoking-together thought experiment, wondering in what ways is a spy like a quantum of energy, in what ways are all humans like spies, and in what ways is being human like being a quantum of energy?"[23] He then wrote a play that metaphorically applies science to characters' behaviour and the general plot structure, and illustrates it performatively in acted-out scenes.

The plot coalesces several principles of quantum mechanics into the starting point for its spy-thriller action: Heisenberg's uncertainty principle guides the overall action of the spying world, where no one can be certain about all things all the time. The double-slit experiment[24] determines that spying operations end differently when observed and unobserved, and there are always two radically different sides to each character. Last but not least, the most difficult and crucial aspect of the play's action capitalises on the notion of sub-atomic twin particles, introducing at least three biological twins among characters (Russian twin agents, Ridley and his twin, Hapgood and her twin), twin objects and twin set pieces.[25]

The play opens with a "meet" between Kerner and the Russians in a municipal swimming pool men's changing room. Kerner is supposed to hand over a marked briefcase, which will show whether he is loyal to the British or not. The outcomes are counterintuitive to what might be expected to happen in the everyday world: it turns out that there are twin Russian agents, two cubicles, even two briefcases. The agents are confused because the results of the "meet" are not predictable. In the following

[22] Shepherd-Barr, *Science on Stage*, p. 88.

[23] Demastes, *The Cambridge Introduction to Tom Stoppard*, p. 31.

[24] It serves as a demonstration of the wave-particle duality of light.

[25] Particular concepts from quantum mechanics and mathematics have been described in several analyses of *Hapgood*—most notably in a very rigorous manner in John Fleming, *Stoppard's Theatre: Finding Order amid Chaos* (Austin: University of Texas Press, 2001), pp. 175–90. This paper does not present an exhaustive list of scientific issues in the play and their presence in the play, but it rather focuses on the main principles of including science in the script (popular science as a text), its metaphorical use for character behaviour and as a blueprint for the play structure, science-metaphorical stage action (the performative aspect) and its connection to ethical issues. The same strategy is applied below in the sections dealing with *Arcadia* and *The Hard Problem*.

scene, Kerner explains the physics behind the double-slit experiment to elucidate the mechanics of the scene: "When you shine light through a gap in the wall, it's particles. Unfortunately, when you shine the light through *two* little gaps, side by side, you don't get particle pattern like for bullets, you get wave pattern like for water. […] The act of observing determines what's what."[26] This explains why all previous exchanges had gone as planned (because they were not observed), while this one produced an even greater uncertainty about Kerner's loyalty (the experiment was observed by the British and US operatives).

The first two scenes of the play thus serve as illustrations of Stoppard's textual and performative strategies in presenting science in a popularised form. Viewing the concept of the duality of light two-slits experiment as a metaphor for secretive spying behaviour, he construes a real-life-sized structure with slits on the stage in Act 1, Scene 1—men's changing rooms cubicles that let particles/waves of agents in and out. The outcomes differ when the lights are off (unobserved) or on (observed). This mute action serves as a performed illustration of the behaviour of particular sub-atomic particles (photons) and as a metaphor for the behaviour of secret agents. In Act 1, Scene 2, Stoppard's textual strategy is used for the first time. Kerner explains the two-slits experiment, as quoted above. In fact, he explains each issue from quantum mechanics and mathematics that is present in the play, providing us with popularised understanding of the science in question as well as explaining the plot developments.[27] Formally speaking, the dialogue constitutes a popular science lecture. Kerner provides his partner—and by his proxy, the audience—with illustrative examples drawn from the first scene, thus connecting the performative and textual levels of the play.

Furthermore, *Hapgood* is structured like a scientific text: "The play also clearly reflects and muses on the methodology of science. […] The main finding or result—the answer—is given up front."[28] We can see an experiment carried out, hear Kerner's explanation of the science in question and its methodology, and then, see the experiment replicated in

[26] Stoppard, *Hapgood*, pp. 500–501.

[27] This applies to the original 1988 play script. Stoppard reworked it for the American production at the Lincoln Center in 1994, changing lines related to the fall of Communism and reducing Kerner's explanations to avoid long lectures.

[28] Shepherd-Barr, *Science on Stage*, p. 89.

Act 2 in Hapgood's attempt to catch Ridley and his twin. The results of the replicated experiment verify the hypothesis laid out before the first experiment. The two experiments and the two acts at large make another couple of twins, which are alike, but radically different.

As we can see, *Hapgood* involves science on various levels and in a variety of forms. Effectively, science serves as a metaphor for uncertainties in human behaviour, its two-facedness and the confusing nature of the secret-service operation. Thus, its ultimate message is ethical: human behaviour under certain specific conditions becomes uncertain and its results unpredictable. People behave differently when observed and unobserved.

While this first attempt at a science play received mixed responses, Stoppard's second science play, *Arcadia* (1992), is considered by many as one of his best plays ever. The plot unfolds in a "room on the garden front of a very large country house in Derbyshire"[29] but on two different time planes. The story set in the past takes place in the 1800s and involves a schoolgirl Thomasina and her tutor Septimus. Thomasina is a gifted student and their conversations reveal her advanced understanding of mathematical problems: she intuitively grasps iterated algorithms, mathematics behind fractal geometry, and principles of post-Newtonian physics, like the second law of thermodynamics. Her mother, Lady Croom, hosts a large company of family, visitors and employees, among them Mr Noakes, an architect redesigning the estate's garden to make it a more Romantic environment. There is also Mr Chater, a self-confident but horrendous poet whose wife routinely engages in extramarital affairs. Another visitor is Lord Byron who is never seen. They all "engage in discussions about math, science, art, sex, and landscape gardening."[30]

The second storyline, embedded in the present day, involves Bernard, a literary historian setting out to prove that Byron, in fact, killed Chater in a duel back in 1809. He visits the country estate now occupied by the family heir Valentine, a mathematician researching chaos, and a fiancé of Hannah, a landscape historian. Valentine's contemporary knowledge of mathematics provides him with insight into Thomasina's notebooks, recognising her premature genius, while Hannah's discoveries made in the house prove Bernard's theory about Byron wrong. The present-day plot

[29] Tom Stoppard, *Arcadia*, in: *Plays Five* (London: Faber and Faber, 1999), p. 7.
[30] Fleming, *Stoppard's Theatre*, p. 192.

also involves the eighteen-year-old Chloë, another heir to the estate, who is sexually attracted to Bernard against all odds.[31]

A list of inspirational sources for this play runs long and includes, just as a necessary minimum, the painting of Arcadia by Poussin, traditional English landscaping, Romantic literary classics, and a fair portion of various popular sciences.[32] Two popular science books stand out among the sources: *Chaos: The Making of a New Science* by James Gleick (1987) and *The Fractal Geometry of Nature* by Benoit B. Mandelbrot (1982). The science is adapted to the dialogical form and presented textually. When Thomasina shows her discovery of mathematical methods that enable computing irregular shapes, she uses an intuitive Newtonian language. Her description in a notebook reads: "I, Thomasina Coverly, have found a truly wonderful method whereby all the forms of nature must give up their numerical secrets and draw themselves through number alone,"[33] and she calls her method the New Geometry of Irregular Forms. The present-day chaotician Valentine studies her records and realises: "It's an iterated algorithm."[34] In a short lecture, he explains to Hannah how mathematics works. This example illustrates Stoppard's creative work with the textual presentation of popular science. In *Arcadia*, he combines Thomasina's intuitive language corresponding to a popular understanding of a complex phenomenon of advanced science, with Valentine's explanations that involve technical vocabulary.

Science works in the play as a metaphor on the performative level, too. Depicting life as chaotic, non-deterministic, and irregular, the play involves a great deal of action illustrating science in the form of stage business. Among these, the concluding scene connects the two-time planes and all characters meet on stage. Both Valentine and Septimus finally understand Thomasina's mathematical equations. While Valentine identifies it as "diagram of heat exchange," Septimus recognizes its consequence: "So, we

[31] Stoppard, *Arcadia*, passim.

[32] Jim Hunter, *A Faber Critical Guide. Tom Stoppard: Rosencrantz and Guildenstern are Dead, Jumpers, Travesties, Arcadia* (London: Faber and Faber, 2000) offers systematic overviews of scientific phenomena and theories, and various other sources for the play on pp. 155–238, with brief explanations of relevant references in the play. Fleming's *Stoppard's Theatre* and Katherine E. Kelly, *The Cambridge Companion to Tom Stoppard* (Cambridge New York: Cambridge University Press, 2001) also explain the science included in the play.

[33] Stoppard, *Arcadia*, pp. 62–63.

[34] Stoppard, *Arcadia*, p. 63.

are all doomed!"[35] As the second law of thermodynamics states: all systems tend to fall apart and move towards disorder. In a parallel way, the stage is filled with objects from both historical periods, characters wander around and the level of chaos rises: "The table contains the geometrical solids, the computer, decanter, glasses, tea mug, Hannah's research books, Septimus's books."[36] This spatial and objectual arrangement is a performative metaphor of the science involved, culminating in what the present-day characters know about the past—that the dance we watch will end up in a fire that will kill Thomasina: the ultimate chaos and disorder.

The play, then, combines time planes, motifs and scientific concepts in a seemingly disorderly, chaotic way. Events which are chaotic in themselves only make sense when looked at from a higher-order perspective: "As disorderly as the play appears, there is clear method in the madness."[37] All the previous motifs and scientific phenomena connect in the last scene, thus showing that, on the structural level, the whole play behaves like a chaotic system: indeterminate on individual levels but organised as a whole.

In *Arcadia*, Stoppard reapplies the strategies used in *Hapgood*. While he does that with the textual and performative strategies of the metaphorical use of science, he also reapplies the science metaphor to human behaviour, stressing its indeterminate nature and chaotic form. Thus, the ethical element of the play's metaphorical use of science is preserved, too. The greatest difference lies in the application of science to its structure. *Arcadia* metaphorically reproduces the content of the science it involves: deterministic chaos, thus adapting concepts explicated in Gleick's popular science book to the textual, performative, and structural metaphors with ethical reach.

Stoppard's last science play up to now is *The Hard Problem* (2015). It received mixed to negative responses, including a few gibes at the complexity of the play's structure.[38] In the words of a merely three-star review of it, in comparison to *Arcadia*, "[t]he great adventurer [Stoppard]

[35] Stoppard, *Arcadia*, p. 131.

[36] Stoppard, *Arcadia*, p. 135.

[37] William W. Demastes, "Portrait of an Artist as Proto-Chaotician: Tom Stoppard Working His Way to *Arcadia*," *Narrative*, Vol. 19, No. 2 (2011), p. 237.

[38] A reviewer in his two-star review called it "a major disappointment"; see Dominic Cavendish, "*The Hard Problem*, National Theatre, Review: 'A Major Disappointment,'" *The Telegraph*, 28 January, 2015, accessed 20 May, 2020, https://www.telegraph.co.uk/theatre/what-to-see/the-hard-problem-dorfman-review-a-major-disappointment/. A rare positive response came from Michael Billington in his four-star review; see Billington, "*The Hard*

looks strangely conventional."[39] The play involves many scientific issues from evolutionary biology and consciousness studies, which are presented to the audience textually. But the structure of the play remains largely unaffected by the science involved: the play is not a metaphor of a scientific experiment on the level of sequencing or plot construction.

The plot follows the early career of a psychology student and later researcher, Hilary, at a cutting-edge privately funded institution. She and her mentor, lover and later colleague Spike, discuss psychological and cognitive-science issues related to evolutionary biology and the "hard problem" of consciousness.[40] Hilary is also a mother, having become a parent as a teenager and given her daughter away for adoption. One discussion between Hilary and Spike contrasts various scientific approaches to human behaviour—what is, after all, a mother's love? While Hilary calls it a "virtue" (an intuitive, popular approach with ethical rather than scientific rooting), Spike refers to evolutionary biology, according to which mother's love is a "genetically selected behaviour."[41] But Hilary does not "like the idea that [she is] an animal"[42] and believes consciousness to be something more than what is hard-wired. This scientifically unorthodox attitude wins her a position at the prestigious Krohl Institute—or so we are led to believe, until the moment we learn that the magnate Krohl's daughter is adopted.

The play effectively uses evolutionary biology and the body-mind problem on the levels of textuality, characterisation, motivation and emplotment. "In *The Hard Problem*, Stoppard raises issues that are central to science and to life. He raises some of those issues directly, some implicitly and indirectly, through characters that are average […], and ultimately it might be up to readers or spectators […] to answer the difficult questions that the play raises."[43] The main focus on the play remains within the ethical dimension of questions it poses. Unlike *Hapgood* and *Arcadia*, it is not a staged experiment but a science play popularising issues of the

Problem review—Tom Stoppard Tackles Momentous Ideas," *The Guardian*, 29 January, 2015, accessed 20 May, 2020, https://www.theguardian.com/stage/2015/jan/28/the-hard-problem-review-tom-stoppard.

[39] A review by Susannah Clapp quoted in Daniel Meyer-Dinkgräfe, Gregory F. Tague, "Consciousness Studies and Evolutionary Biology in Stoppard's *The Hard Problem*," *Etum*, Vol. 2, No. 2 (2015), p. 48.

[40] The problem was popularised by David Chalmers in his book *The Conscious Mind* (1996).

[41] Tom Stoppard, *The Hard Problem* (London: Faber and Faber, 2015), pp. 13–14.

[42] Stoppard, *The Hard Problem,* p. 15.

[43] Meyer-Dinkgräfe, Tague, "Consciousness Studies and Evolutionary Biology," pp. 56–57.

human mind and behaviour with an emphasis on the ethics involved in these areas.

The 2015 National Theatre production of the play included several designs that incorporated science in the performance. The designer Bob Crowley and lighting designer Mark Henderson installed a large sculpture consisting of convoluted light tubes.[44] These lit up and started flickering to the music by J. S. Bach in a demonstration of neural paths and their complicated interactions in the human brain. This design illustrated the brain in an appealing visual way but was far from the complex metaphor of science applied in Stoppard's earlier plays. Perhaps Stoppard himself is aware that he applies the scientific metaphor in a restricted way in his third science play, limiting it to the textual and performative levels, but not structuring the play as a mind experiment. This view seems to be illustrated in Hilary's remark to Jerry, before her departure to New York to work at NYU there: "There's someone teaching philosophy there whose ideas are … undemonstrable."[45] It seems that she refers to the play itself: science is undemonstrable in not being demonstrated the way it was in *Hapgood* and *Arcadia*.

That last point illustrates the latest shift in the use of the scientific metaphor in Stoppard's science plays. All three provide sufficient explanations of the science involved on the textual level in the form of dialogised popular lectures and involve stage action and motifs in the plot that employ science as a metaphor of human behaviour and its ethics. *Hapgood*, involving mind-boggling phenomena from quantum mechanics, parallels the strange behaviour of subatomic particles to secret-service operations and is structured as if it were a scientific paper. *Arcadia* engages notions of deterministic chaos, employing them as metaphors for the undetermined nature of human behaviour. Its structure is "chaotic"—confusing in detail but producing meaningful patterns on a more abstract level. *The Hard Problem* tackles the science which involves ethical issues: the existence of human consciousness. Its form does not engage with the science involved in an experimenting way, like the previous two plays do, but leaves a lot of issues unresolved and up to the audiences to decide. The experiment, thus, takes place in the mind of the members of the audience not on stage.

[44] Tom Stoppard, *The Hard Problem*, a theatre production, directed by Nicholas Hytner, 2015.
[45] Stoppard, *The Hard Problem*, p. 74.

Tomáš Kačer

Tom Stoppard's Science Plays: Metaphor and Experiment

The science play is a well-established genre of dramatic writing in the English-speaking theatrical tradition. This paper discusses three full-length science plays by the prominent British playwright Tom Stoppard. These are *Hapgood*, *Arcadia*, and *The Hard Problem*. The plays are based on popular science sources and offer their audience an access to science. After providing a brief history of the science play and the science show, the paper shows that Stoppard develops the dramatic and theatrical traditions by involving science on the textual (giving popularised scientific knowledge in the form of dialogised lectures) and performative levels (demonstrating or illustrating science on stage), primarily to turn it into a metaphor of human behaviour. *Hapgood* and *Arcadia* further engage with science on the structural level, thus becoming thought experiments reflecting upon science. The most recent play, *The Hard Problem*, develops textual and performative strategies related to science but ceases to experiment with the form, leaving more space for the audience to draw ethical conclusions.

Keywords: Tom Stoppard, science play, theatre, metaphor, textuality, performativity
Słowa klucze: Tom Stoppard, sztuka naukowa, teatr, metafora, tekstualność, performatywność