MPC MAJOR RESEARCH PAPER

Sensational Science: A Rhetorical Analysis of Public Science Education in Entertainment Programming

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ABSTRACT

Film and television media's adherence to the deficit model has been under scrutiny by science communication scholars for decades. This model suggests that building public trust in scientific authority is as simple as 'dispensing' scientific facts to a "scientifically illiterate general public" through mass media (Kirby, 2003). However, despite a virtual scholarly consensus that the deficit model is deepening the public's misunderstanding of science/scientists, it remains relevant as a method for building trust in scientific authority (Kirby; Vidal, 2018). Using Sonja K. Foss's generic rhetorical criticism methodology melded with rhetorical film criticism, this MRP assesses the narrative structures, tropes, and stylistic motivations that sustain the deficit model in modern entertainment media. Focusing on didactic scenes, this research paper identifies the rhetorical strategies deployed by the respective directors of the following films and television programs: *Interstellar* (2014), *Stranger Things* (2016), *Event Horizon* (1997), and *Cosmos: A Personal Voyage* (1980). The programming that this research paper explores were selected to represent a small sample of both accurate and inaccurate portrayals of theoretical science and to discover if their organizing principles adhere to the deficit model. For science communication scholars this research will highlight effective methodologies of communicating scientific content in narrative formats and serve as an important step in untangling the mystery of the deficit model's longevity in popular media.

Keywords: Rhetoric, Communication, Entertainment, Science, Sonja K. Foss, Film Criticism, Public Understanding of Science

INTRODUCTION

The extensively criticized deficit model of public science education forwards that mass media should be used to educate a supposedly scientifically illiterate public (Vidal, 2018b). To this end, film and television programming, both fiction and non-fiction, have served as vehicles for translating scientific knowledge to their audiences for the purpose of engendering trust in scientific authorities (2018b). However, as numerous scholars have demonstrated, simply providing more scientific information to the public is not enough to alter their perception of scientific institutions (Wynne, 1991; Gross, 1996; Kirby, 2003). Despite this, the deficit model remains active in modern mass media.

While primarily meant to entertain and advance a narrative, entertainment media's conceptions of science are nevertheless educating the public and altering their perception of scientific concepts (Szu, 2017). Indeed, popular representations of science on film and television have a surprisingly long life, melding with real scientific explanations and influencing the public's understanding of not only scientific content, but scientists themselves (Kirby, 2016). For example, the films and television programming explored in this paper, *Interstellar* (2014) and *Event Horizon* (1997) *Cosmos: A Personal Voyage* (1980) and *Stranger Things* (2016), all use the same image of a folded paper to represent travel through space-time (Nolan, 2015; Anderson, 1997; Malone, 1980; Duffer, 2016). This method of visual simplification for explaining a complex topic is now employed by science educators as a shortcut to initiate their students into threshold concepts of theoretical physics (Surmeli, 2012). However, while these images may be used as a tool to spark the interest of future scientists, sensationalized portrayals of scientific concepts may create misunderstandings that persist and damage the public's understanding of real scientific concepts (Kirby, 2003). This research paper will assess how these non-scientist directors and writers rhetorically approach the inclusion of an unfamiliar scientific concept, namely, wormholes, explore the longevity of the deficit model, and assess the degree of sensationalism in portrayals of science in narrative forms of entertainment media.

This paper analyzes the rhetorical arguments in several didactic scenes in science-oriented entertainment programming using Sonja K. Foss's *Generic Rhetorical Criticism* methodology. These effects will be assessed qualitatively by melding science communication criticism, rhetoric of science criteria, and film criticism. This approach is designed to account for variance between written texts and filmic scenes, including an analysis of the mise-en-scène (colouring, framing, level of intimacy, etc.), narrative, and musical cues to assess the degree of sensationalism and its rhetorical effect on knowledge translation.

LITERATURE REVIEW

The rhetorical approach of scientific-oriented subject matter in entertainment is influenced by several factors, including the monetary motives of production companies, the creative license of directors, pressure from science advocates, and the expectation of audiences. This literature review is divided into three respective sections to help deconstruct the interplay between these factors: the deficit model and public understanding of science (PUS), research and history on the effects of science in media, and the rhetoric of science.

Beginning with literature focused around the public understanding of science, this literature review highlights how science advocates of the last century introduced a problematic approach to science communication, the deficit model, that limits how scientific research is discussed in public forums. Second, continuing to deconstruct the functional effects of the deficit model, I will discuss the tension between entertainment and education in science-oriented media, delving into the complex interplay between sensationalized portrayals of science and public science education. Finally, I will discuss how the rhetoric of science is altered by the medium through which it is presented, noting how scientific discoveries are presented with more certainty by non-scientific sources. Tracing the development of ideas from scientist to television, I will highlight the literature that is taking a rhetorical analysis approach to solving the problem of the deficit model.

The Deficit Model and Public Understanding of Science (PUS)

The search for an effective methodology for public science education has concerned science communication scholars, natural scientists, and science advocates for decades. In the 1980s, the Royal Society, anxious due to a rising distrust of science, voiced the opinion that a lack of scientific knowledge was leading to a deficit in the public's trust of science-backed policy (The Royal Society, 1985). To remedy the situation, The Royal Society adopted the "the axiom: 'the more you know the more you love it'" and forwarded that science would be trusted if it were only 'properly' disseminated to the public and popularized in locations like entertainment media (Vidal, 2018b).

This position, which views the 'crisis in confidence' in science as a deficit in the public's scientific literacy, in now known by critics as the *deficit model* (Bauer, 2009). The earliest use of this terminology comes from two 1991 articles written by Wynne and Ziman respectively. These critics note how the deficit model limits avenues for criticism of science education to only *why* science is trustworthy rather than *how* science is conducted, enforcing an attitude that science should be understood simply as facts rather than an on-going process, "obliterate[ing] the circumstances that shape how science, theory, or experiment are understood" (Wynne, 1991; Ziman, 1991). This oversimplification has greater implications not only for the public understanding of science, but also scientific research. As literature on methods of improving the public support of science suggests:

> In continuously reinforcing artificially strict boundaries between scientific and non-scientific knowledge […] scientists simply leave their findings open to framing and interpretation by media and the public. This is unfortunate, as no

> one is better positioned to interpret and disseminate a "murky and fragmented research literature than those who understand all of its limitations and qualifications" (Mikulak, 2011).

Mass media, operating under the deficit model, forward research findings as absolute—a discovery by *the* scientific community rather than the outcome of a single study—raising the stakes if any portion of the research is faulty to the diminishment of scientific credibility as a whole (Mikulak, 2011).

In film, the deficit model judges the scientific quality of a piece of content by how it distinguishes between fact and fiction. The science is thus treated not as a portion of a given text, but an insertion of fact surrounded by fiction. Vidal identifies two "problematic assumptions" in this formulation: "First, it suggests that scientific knowledge is produced in isolation from non-scientific contexts, especially those of its public dissemination. […] Second, the deficit model obliterates factors such as entertainment appeal […] [that] take precedence [for a filmmaker] over accuracy" (2018b). For entertainment media, the science is only a vehicle for audiences to suspend their disbelief in the content of the story, particularly its more outlandish elements. Paradoxically, a narrower gap between fact and fiction may thus produce a greater misunderstanding of scientific concepts in viewers.

In 2004, Bauer et al. put the deficit model to the test, determining if there was a correlation between knowledge and attitude towards science of lay persons in a collaborative research project across both India and Europe. The results ran contrary to the claims of the deficit model, showing that distrust of science was not a product of a lack of knowledge.

Rather than the positive correlation that the deficit model predicted, the pattern that emerged was an inverted 'U.' This meant that people at both ends of the knowledge spectrum had some distrust of science (although for varying reasons) (Bauer, 2009).

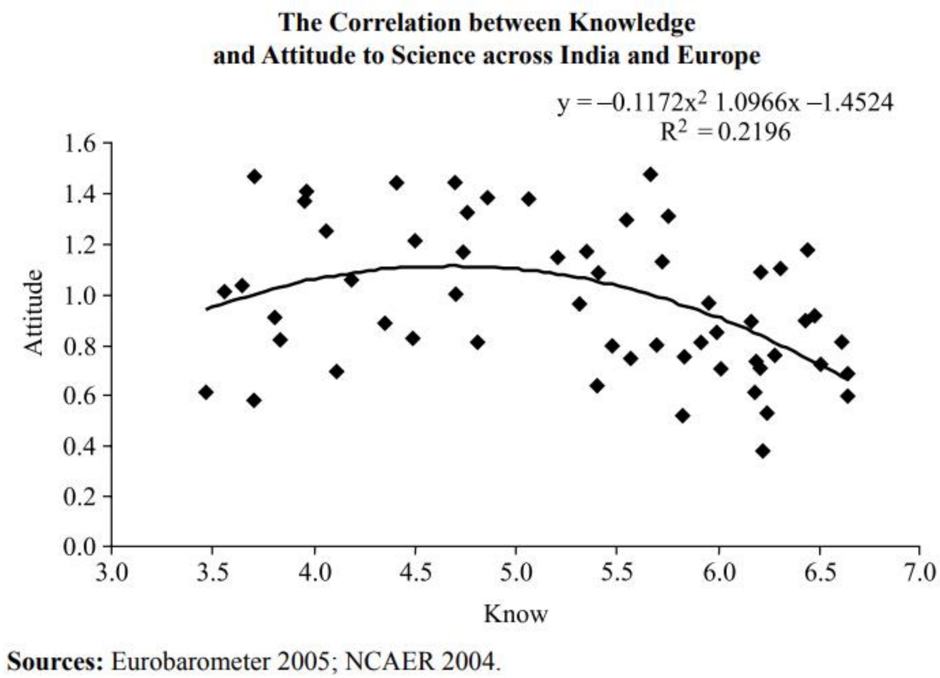

Figure 1

Despite its many ethical failings, ineffectiveness, and preferable theoretical alternatives, however, the deficit model has remained largely intact (Bauer, 2009). Indeed, the journal *Public Understanding of Science*, who, in 2007, said science communicators had "clearly moved from the old days of the deficit frame," were forced to ask, "Why does the deficit model not go away?" (Einsiedel, 2007; Vidal, 2018b).

Entertainment and Education – A Tension in Science-oriented Media

The development of cinema and film technology is closely tied to scientific study and methodology (Vidal, 2018b). As Landecker notes, detailing the societal forces surrounding the emergence of cinema in the late 18th and early 19th centuries, "scientists experimented with it by tinkering with film, film camera, microscopes, and the paramets of exposure magnification" (Landecker, 2006; Vidal, 2018b). The ends that scientists sought were simple: a tool for recording experiments, "capturing phenomena over time" (Vidal, 2018b). For non-scientists, these works of film-making produced by scientists brought an insight into the world of science: microbiology, laboratories, and the scientific method (Landecker, 2006).

This direct insight into the world of science for non-scientists was substantially diminished after World War II as science for entertainment was produced by broadcasters: "TV and film producers" (Vidal, 2018b) This shift had larger implications for how science-oriented media was consumed. Earlier 'recordings' of science were "characterized by a firm commitment to observational realism…a record of an ongoing, and at least partly media independent, reality" (Vidal, 2018b; Kirby, 2016). Now, in the hands of broadcast networks, it was entertainment designed to seduce viewership, focusing on sensationalism (Kirby, 2003).

The sensationalism that entertainment media brought to the public's understanding of science was not limited to the 'mad scientist' films of the 1920s (Vidal, 2018b). As Kirby discusses, the public saw documentaries that portrayed interactions with nature that were "carefully staged," producing images that were designed to become knowledge (Kirby, 2016). Put simply, heightened fictional scenarios were presented as representations of reality meant to educate. Cinema technology was not only a method of producing public entertainment but was a sight for "relating the inter-subjective with the objective"—blurring the lines of what was real (Vidal, 2018b). Paradoxically, this blurring of the boundary between the real world and filmic representations is why film is the location for the scientific community's interest. Films create the interplay between science and society that may be lacking in the public's day-to-day interests. However, this has obvious limitations as film produces narratives that are not purely observational or scientifically-oriented. The goal for film makers is to create a spectacle, not accurate representation (Vidal, 2018; Kirby, 2003).

This "tension" between entertainment and education is what led the science community to have "frequent clashes… [with] media producers as scientists attempted to exert control over media content" (Vidal, 2018b). This mindset is understandable: if mediatization is a mechanism by which science is proliferated and popularized to the public, it must be accurate so as to not negatively impact science-backed policy. The underlying belief that motivates this assertion, however, is the previously discussed deficit model of public understanding of science. When depicting science in media, "there is a manifest and inevitable 'gap' in the information and knowledge between experts and non-experts, and while it is obvious that media may misrepresent science", resolving these issues requires one to "…unravel the complex processes of scientific knowledge production and management" and rhetorical presentation in film (Öztürk, 2017; Vidal, 2018b).

Science Communication through Narrative

Understanding why scientists rely on television and film producers requires an analysis of the communication methodologies of mediatization practitioners, namely, narrative communication. Indeed, narrative communication is a key component for both success and longevity in written and visual media (Dahlstrom, 2014). There is a constant struggle for "the attention of audiences," and reliance on "stories, anecdotes and other narrative formats" allow a piece of media to "cut […] the information clutter and resonate with audiences" (Dahlstrom, 2014). Academically sound communication "aims to provide abstract truths that remain valid across a specified range of situations. An individual may, then, use these abstract truths to generalize down to a specific case and ideally provide some level of sound inductive reasoning" (Dahlstrom, 2014). Logical, scientific communication often limits the rhetorical tools of narrative that evoke emotion that may lead to confusion or create uncertainty (Kirby, 2003). Whereas communication from a purely scientific source, such as an academic journal, has different goals in its communication, primarily accuracy.

Communication in sound scientific sources follows a methodology that purposefully prioritizes specificity above engagement. In the struggle for public attention, this puts scientific communication at a severe disadvantage. Narratives, unlike an academic scientific article are a malleable artform free to break rules and reinvent reality within its narrative world, given it remains emotionally relevant to an audience. Success in a narrative is "judged on the verisimilitude of its situations"—an event in a narrative is true if it is consistent in its own logical formulation (Dahlstrom, 2014). This lack of predictable structure and freedom of creation in narrative communication presents a serious problem for scientists who want to expand and educate the public regarding their findings. As Kirby explains,

> "The representation of natural phenomena, scientists, and research spaces, whether they represent 'good science' or not, are all rendered 'realistic' within the filmic framework, making difficult for the public to separate fact from fiction. The 'naturalizing' effect of visually based fictional media is one reason why scientists believe that fiction negatively affects the public understanding of science." (2003)

In a void of information regarding a scientific concept or procedure, a viewer may engage with a narrative and leave with a consistent, even 'natural,' understanding that is factually incorrect (Kirby, 2003). In other words, narrative may blur the lines between accurate science and science fiction.

Thus, the freedom that fiction allows presents distinct advantages in the struggle for societal influence over more accurate presentations of reality. Questioning if fiction "can be used in science education," Avraamidou notes that researchers "have contended that stories have the potential to influence people's understandings and beliefs, and essentially, promote a societal and cultural change" (Schank & Berman, 2002; Brock, Strange, and Green, 2002, Avraamido et al., 2009). The emotional resonance that a carefully crafted narrative evokes may allow the information presented in a fictional world to carry over into a reader/watcher's real life. For science advocates, the personal investment that fiction allows towards otherwise remote concepts is a valuable resource for shaping culture. Certainly, the gap between experts and non-experts will remain; however, what if the narrative is factually accurate and rhetorically differentiates for the audience the real from the unreal? Can narrative be used to educate the public? Literature is only now emerging that tackles how science may be effectively communicated through narrative (Dahlstrom, 2014; Avraamidou et al., 2009).

The Rhetoric of Science Communication in Entertainment

Effectively communicated science has a profound impact on society, and the methods by which scientific documents are structured, reported, contested, and agreed upon is under the purview of the rhetoric of science. Kuhn, the originator of "the paradigm shift," noted that new ideas in science require rhetorical persuasion—the newly discovered facts must contest with the past (Gross, 1996). As Gross notes "Newton's Opticks and Einstein's early papers were rhetorical to their cores, but so were Darwin's Notebooks and Boyle's experiments on the spring of the air" (Gross, 1996). Indeed, although literature regarding the rhetoric of science is relatively new, it is describing methodologies of argumentation that relate as far back as Aristotle's original *Rhetoric* from the 4th century BCE (Gross, 1996).

The authority of science is often pre-supposed; however, the framework of the rhetoric of science is most apparent in moments of crisis—when scientific explanations are rejected. As Lynda Walsh (2015) explains, *Kairos*, or the appropriate/opportune time, is central to understanding how rhetoric is perceived. There are a host of factors that may alter how one perceives information: "the forum or setting, the media of communication, constraints on communication such as interruptions, obstacles and other structures, and so on" (Walsh, 2015). For science communicators, this means that works of fiction will function differently as vehicles for scientific knowledge than a documentary or text book. Whereas one may require proof in one medium, in another he/she will suspend disbelief. Identifying the general form or pattern of argument will thus vary from location to location (Walsh, 2015).

In 1935, Fleck "suggested an image of concentric spheres of science"; his main thesis intimated "that an esoteric center of scientific activity is surrounded by concentric exoteric genres of public communication such as handbooks and textbooks, popular science productions, mass media coverage of science and everyday conversations" (Bauer, 2009; Fleck, 1979 [1935]).

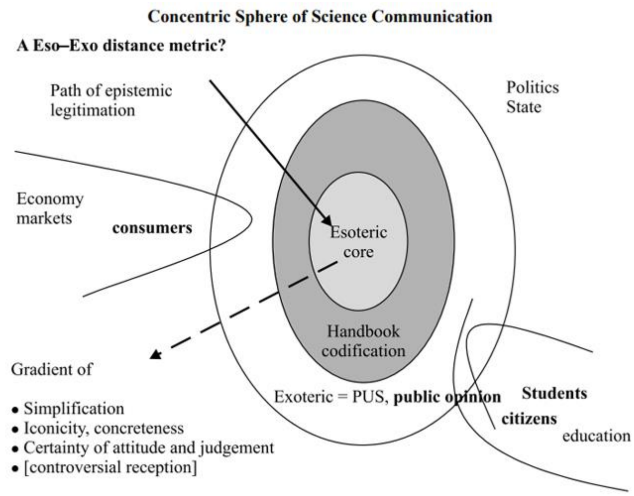

Figure 2 (Bauer, 2009; Fleck, L. (1979 [1935])

Moving through these many spheres from esoteric to exoteric, one finds that science "gets simplified, more concrete and more certain in judgement" (Bauer, 2009). Increasing simplicity and certainty of scientific content requires that readers or watchers of popular media (part of Fleck's *exoteric* sphere) rely on the authority of presenters. Lacking the specialized knowledge necessary to verify the sound reasoning and merit of a given scientific concept, audiences are often presented with its function or relative importance to their everyday lives— "exactly what one expects popular science to do" (Bauer, 2009). Thus, in the journey from journal to public opinion, popular science contextualizes scientific discoveries, granting a measure of public relevance for the purposes of future integration/use in society. The increase in certainty when scientific concepts are presented to the public, as noted throughout this literature review, is informed by the deficit model.

As new mediums for the expression of scientific concepts continue to emerge through new technology, including graphical visualizations, non-scholarly online databases, and social media, literature is only now emerging to address how science communication should be altered to increase trust in the scientific process (Avraamidou and Osborne 2009).

RESEARCH QUESTIONS

Drawing from both communication and rhetoric of science perspectives, the goal of this study is to address the enduring problem of the deficit model of the public understanding of science through an analysis of the rhetorical tropes in public science-oriented entertainment programming. Therefore, the research questions guiding this MRP are:

1. To what degree are scientific concepts in didactic scenes misrepresented (sensationalized) within both popular television and cinema science-oriented programming?
2. How is the public understanding of science impacted by the unique rhetorical approaches employed by science-oriented television and cinema?
3. Using existing scholarship, how is the deficit model served by the rhetoric employed by science-oriented entertainment programming?

DATA COLLECTION METHOD

The research questions listed above are focused on entertainment media that forwards its content as an accurate portrayal of science. As a result, the scenes that will be analyzed for rhetorical tropes within each piece of media content will be didactic, portraying a concept from the natural sciences.

Following the preliminary steps in Sonja K. Foss's generic rhetorical criticism methodology, this study assesses similar didactic scenes in the following films/television programs:

Video 1: Television, Cosmos (1978), episode 10, "The Edge of Forever"

Video 2: Event Horizon (1997)

Video 3: Film, Interstellar (2014)

Video 4: Television, Stranger Things (2016), Season 1 Episode 5, "The Flea and the Acrobat"

Alongside these data sources, video clips from YouTube of similar scenes and promotional interviews will be examined to reinforce my findings, including several documentaries, various uploaded genre film/ television, and 'edutainment' programming.

Generic Criticism contends "certain situations provoke similar needs and expectations in audiences and thus call for particular kinds of rhetoric" (Foss, 2018) This study discovers commonalities in the above didactic examples from entertainment to find "rhetorical patterns across recurring situations" (Foss). This process will highlight how scientific content in entertainment attempts to influence the "comprehension and response" of audiences of said content, as well as the methods and constraints of film makers discussing scientific concepts with general, non-specialist audiences (Foss).

Although character motivation, location in time and space, and significance varies from scene to scene, narratively, they are providing the same information to the audience, detailing the theoretical scientific concept of a wormhole. The similarity in content allows for a closer examination of the rhetorical techniques, filmic style, and sensationalism of each article. According to Foss's methodology this requires individual examination of each rhetorical article's situation, substance, and style, detailed below in the methodology section. These preliminary steps will than inform a deeper analysis of each scene's rhetorical gestures serving the deficit model, which will answer the following questions:

1. Does the scene establish a hierarchy between scientist and audience?
2. Does the scene effectively differentiate accurate science from pseudoscience?
3. Are the scientific concepts presented in an overly simplified or certain manner?

I manually recorded my findings within a codebook, using categories such as 'narrative servicing science,' 'science serving narrative, 'presented as fact,' 'hedged position,' 'accurate,' 'inaccurate' and 'overtly inaccurate' in reference to specific scenes. Then, after the generic qualities or tropes are discovered, and recorded into further, situational subcategories, I compiled the results to discover the organizing principle, rhetorical structures linked to sensational representations of science that serve the deficit model.

METHOD OF ANALYSIS

This paper examines a small sample of science communication in didactic scenes in both television and science fiction cinema and investigates how those media's claims act to benefit/oppose the scientific community's attempts at public science communication through the deficit model. I will accomplish this by identifying and categorizing rhetorical patterns found in performance-oriented public science education in popular entertainment media, namely, *Cosmos, Interstellar, Event Horizon, and Stranger Things,* and by doing generic rhetorical criticism melded with film criticism, comparing my findings with qualitative studies that address the effects of these rhetorical appeals on public science discourses.

Rhetoric & Visual Narrative Media

Narratively driven media in film and television deploy rhetoric when "they attempt to influence the way we think and the way we feel" (Behrens, 1979). The success of these arguments lies in the speaker's (the director's) ability to convince the audience of his/her claims. Is the audience emotionally invested in the reality of the narrative or the moral choices of the characters? Do the stylistic choices convince the audience of the director's "sound judgement and solid craftsmanship" (Behrens)? If the answer to these questions is 'yes,' then the director has made a successful rhetorical appeal to the rational (logos), emotional (pathos) and moral (ethos) quality of their work.

In a similar vein to written narratives, visual narratives do not necessarily make overtly didactic arguments (Behrens, 1979). These messages are instead concealed in the progression of a film's events, within the substantive choices and dialogue of the characters, and the stylistic choices of the film's presentation (Behrens). This potential for concealment, when analyzing the rhetoric of a narrative as opposed to a classical rhetorical article like a speech, explains why a direct application of classical rhetoric is not fruitful for filmic analysis (Behrens). Analyzing a film's rhetoric requires one to differentiate not only the rhetoric deployed within the film's diegesis (the filmic, imagined world) but also the decisions made in the real world of the director and audience (Behrens, 1979; Kirby 2003). Indeed, the non-diegetic elements of the film (i.e. stylistic choices) may have a substantial impact on the rhetorical effect on audiences without altering the plot of the film (Behrens, 1979). A director may, for example, place a camera so it is looking up at an actor, making the character seem imposing or larger than life to the audience. The character within the diegesis of the film is unaware of this framing and so his/her presentation to other characters may not carry the same rhetorical connotation. The director may have numerous reasons for this decision: he/she may be foreshadowing an approaching shift in character or increasing the audience's sense of dramatic irony when they are aware of something the characters within the scene are not. Thus, any rhetorical reading of the film must differentiate between the diegetic and non-diegetic elements of a film to fully grasp its rhetorical methodologies and effects.

Generic Rhetorical Criticism

According to Sonja K. Foss, discovering "commonalities in rhetorical patterns across recurring situations" reveal how people derive meaning and value from similar situations across space and time (Foss, 2009). If a pattern is discovered, the rhetorical articles are analyzed to identify a genre or recognizable rhetorical category with predictable goals and outcomes. In other words, following the recognition of a genre, a rhetor may forward how audiences identify and expect certain outcomes based on rhetorical cues of an artifact belonging to that genre (Foss). These generic expectations function across both written and visual texts.

This research paper will expand on this methodology with film criticism's differentiation of style and narrative to account for the variation that occurs in the presentation of visual fiction due to real-world staging and the limitations of production. This is important as a film with a limited budget may fail to evoke a sensory experience necessary for audiences to follow along with a presented situation. A tangible link to the real world through effective visual representation creates verisimilitude that allows audiences to suspend their disbelief and trust the feasibility of a presented situation (Dahlstrom, 2014).

Generic Application:

Foss identifies three variations within her generic rhetorical criticism methodology: *generic description*, *generic participation*, and *generic application* (Foss, 2018). Here, we will be following the procedure of generic application. This includes identifying the genre and evaluating its rhetorical success against a set of situational demands. For the purposes of this paper, these demands will be those imposed by the deficit model of public understanding.

Foss names four elements that are necessary for identifying a rhetorical genre:

> (1) observing similarities in rhetorical responses to particular situations;
>
> (2) collecting artifacts that occur in similar situations;
>
> (3) analyzing the artifacts to discover if they share characteristics; and
>
> (4) if they do share characteristics, formulating the organizing principle of the genre. (Foss, 2018)

These elements are defined in this study as follows:

Situation: A situation is the set of conditions that limits an effective rhetorical response. In the context of a film or television article, these are the conditions defining the characters, (i.e. their motives, their location in place and time, and the limitations of their social standing within the diegesis.)

Substance and Stylistic Characteristics: The substantive and stylistic characteristics are determined by the form a scene takes. These are the presentational elements, the meta-discourse between audience and the artistic direction of a film or television article, such as camera placement, musical ques, and other similar choices. This may include both the stylistic choices of the character's rhetoric within the diegesis of an article in addition to the non-diegetic choices of the director.

Organizing Principle: The organizing principle is the rhetorical goal of the scene. Why does the scene exist? What is its rhetorical effect? Foss defines this as "the root term or notion that serves as an umbrella label for the various characteristic features of the rhetoric" (Foss, 2009).

Identifying Generic expectation: Once these four elements have been discovered and related to similar patterns in other works, a generic expectation may be discovered. Furthermore, it will become possible to model a rhetorical pattern for the use of scientific language and content in these scenes.

Categorization, Usage and Sensationalism: A further step of verifying the accuracy of the science in the scene will be used in this research paper to determine the degree of sensationalism and limitations of the rhetorical method for possible future uses.

ANALYSIS

Common Situation: A Discussion of Two-Dimensional Space-Time

Generic Communication Methodology: Visual Simplification

Video 1: Television, Cosmos (1978), episode 10, "The Edge of Forever"

Situation:

This scene in the tenth episode of Carl Sagan's seminal television series, *Cosmos*, explores the cosmological theory that we exist in a closed-off, fourth-dimensional universe. Sagan begins his explanation of this complex topic using a simple narrative. He asks the audience to imagine a fictional two-dimensional being who is traveling on an extremely large three-dimensional object, saying, "increase all the dimensions in this story by one and you have something like the situation which many cosmologists think may actually apply to us." While speaking, he models the behaviour he is describing, walking on a gridded pattern seemingly floating in space. Placing himself on the horizon line in perspective he creates the illusion of being a two-dimensional being, staying in place while walking. The two-dimensional being is unaware of the third dimension even though he is traversing it. As Sagan explains, this hypothetical being's senses are limited to the second dimension. This simplification is designed to overcome the human inability to imagine a fourth dimension. Like the fictional two-dimensional being, humans cannot imagine a dimension higher than their own. Finally, as Sagan begins to extrapolate on the possible phenomena that may result from a closed-off universe, he proposes the concept of a wormhole: "a hypothetical tunnel, or wormhole, through the next higher dimension, a place sucking in matter and light." He closes the didactic scene with a series of questions: "Can we find such a wormhole? Could we survive the trip?" While sliding down a wormhole visualized as a warped grid descending into a dark hole, Sagan concludes, saying, "We might emerge in some other place and time."

Substance and Stylistic characteristics:

There is no shortage of literature analyzing Sagan's science communication methodology (Helsing, 2016). *Cosmos* popularized the science behind many of the images that science fiction relies upon to portray theoretical scientific concepts such as wormholes (Helsing). It is not surprising, therefore, that these concepts, although set with the backdrop of otherworldly graphical visualizations, are presented on a human scale with Sagan as the focal point. Indeed, the purple and blue graphical vistas of geometric shapes are treated with a sense of wonder within the program. Underscoring this feeling of discovery is the gently prodding, symphonic score of Greek music composer Vangelis (Helsing). There is a stylistic merging of the familiar with the unintuitive at every turn within this sequence, including the inclusion of Sagan himself speaking directly to the audience from an otherworldly location.

The rhetorical challenge here is significant: Sagan must not only speak about specialized concepts in simple, relatable terms, but also emphasize the unrelatability of those same concepts to the human experience. The further development of these ideas into a discussion of wormholes must remain equally simplistic in its imagery and diction. The solution to this dilemma is a narrative that scales through dimensions. Sagan is careful not to mislead his audience into a certainty of belief regarding these theoretical concepts. Thus, Sagan is obliged by his scientific rigor to qualify his discussion by couching it in diction that hedges his position: 'if,' 'perhaps,' and 'might' are used often. Sagan's reasoning for this is important because he is discussing contested theoretical concepts that must be indirectly observed. The rhetorical effect of these organizing principles of simplicity and scientific accuracy are notably at odds with each other. Indeed, Sagan does not use similar implications to describe competing theories, removing himself from the visualizations of the open universe concept that are not as easily imaginable. The rhetorical effect of this juxtaposition leaves a lasting impression of only the narrative explanation, the closed-off forth dimensional universe.

For the purposes of analysis, I have categorized this scene as: ‘authoritative presenter, fictional scenario,’ ‘narrative serving scientific accuracy,’ and ‘hedged position.’

Video 2: Film, Event Horizon (1997)

Situation

This scene from Paul W.S. Anderson’s *Event Horizon* has Dr. Weir (Sam Neill) explaining to the crew aboard the spacecraft, *Lewis and Clarke,* the purpose of their mission. The Event Horizon, a spaceship designed by Dr. Weir, is a secret government project capable of faster than light travel (FLT). Lt. Starck (Joely Richardson) argues that the law of relativity prohibits FLT and the other crew members agree. Dr. Weir concedes the point but explains that while the ship may not break the law of relativity, it skirts it by creating a dimensional gateway. This gateway allows the spaceship to move from one point in space to another instantaneously. When pressed for an explanation, Dr. Weir hesitates, saying, “well its difficult… it’s all math.” Captain Miller (Laurence Fishburne) intercedes, saying, “try us, Doctor.” “Right, well, using layman’s terms,” Dr. Weir says, beginning his explanation, “we use a rotating magnetic field to focus a narrow beam of gravitons, these in turn fold space-time consistent with velar-tenser dynamics, until a space-time curvature becomes infinitely large and you produce a singularity.” The Doctor is stopped in his monologue by the Captain who frustratedly says, “layman’s terms,” mocking the Doctors earlier statement. Cooper (Richard Jones,) the ship’s rescue officer, asks, “do you speak English?” Seeing his unsatisfied audience, Dr. Weir looks around and notices several papers tucked away in a side panel. Picking a paper up with a pinup model on it from the year 2047 and a pen, Dr. Weir, says, “imagine for a minute that this […] attractive piece of paper represents space-time and you want to get from point A, here, and point B, there.” As he mentions each respective point, he pierces the paper at both ends. Then, deepening the didactic nature of the scene, he asks the crew, “what is the shortest distance between two points?” Justin (Jack Noseworthy) says the obvious answer, missing the purpose of the demonstration, “a straight line.” While the other crew members are laughing at the answer, Dr. Weir says, “No, the shortest distance between two points is zero, and that’s what the gateway does. It folds space so that point A and B co-exist in the same space and time. And the spacecraft passes through the gateway and space returns to normal.” As he says this, he passes the pen through the previously punctured Point A and Point B holes in the folded piece of paper, then unfolds the paper, putting it away. “It’s called a gravity drive,” Dr. Weir says, satisfied that the crew now understand.

Substantive and Stylistic Strategies

The director, Paul Anderson, notably simplifies the visual and auditory stimulus in this scene, likely to reduce distractions. Indeed, there is no musical accompaniment to Dr. Weir’s explanation. The filmic set, while evoking futuristic imagery has a noticeably bland colour palette, made up of fluorescent lights and unreflective grey metal and plastic. The crew are similarly dressed in desaturated colours. Due to this unappealing setting, the characters’ dialogue must carry the audience through the scene. Among these characters, Dr. Weir is central and generates tension by struggling to explain concepts to the crew.

This scene serves dual expository purposes. First, it is an introduction scene for the characters, providing names and personalities, highlighting their professional roles and relative resistance to the ideas being presented by Dr. Weir. Second, it explains the science fiction necessary for the film's plot. These two purposes are intertwined, and Dr. Weir's explanation is often interrupted by the other crew members, usually to request further simplification and further differentiate themselves from each other.

Dr. Weir's explanation passes through three distinct phases: (1) denying an explanation (2) speaking in purely specialized language (3) and demonstrating his ideas through visual simplification. Each phase evokes a different response from the other crew members. The first phase is overcome by [the ship's] Captain and highlights the need for translation. The second phase, despite Dr. Weir calling it a layman's explanation, is entirely made of specialized language, which forwards theoretical concepts such as graviton and electromagnetic field interaction. A common trope in science fiction, that of frustrated non-specialists dealing with a verbose scientist is deployed, here, by having Dr. Weir miscommunicating his 'layman's' explanation. The final phase is the most certain and simplified, reducing the science to its function, travelling from one point to another instantaneously.

Rhetorically, this scene prioritizes creating a sense of frustration around Dr. Weir. The Doctor is an absolute scientific authority, not only understanding the science within the film's diegesis but also as the mind behind the gravity engine capable of faster than light travel. The crew, as the audience's surrogate in the scene, are required to listen to Dr. Weir as per their Captain's orders, but repeatedly express their misgivings.

In my analysis, I have categorized this scene as 'authoritative presenter, fiction,' 'science serving narrative,' 'presented as fact,' and 'attempted accuracy.'

Video 3: Film, Interstellar (2014)

Situation:

In this scene in Christopher Nolan's 2014 film, Interstellar, Romily (David Gyasi), a NASA astronaut and physicist explains to the film's protagonist, the NASA pilot Cooper (Matthew McConaughey,) why a wormhole appears to be spherical. Shocked that his mission's pilot is unaware of such an idea, Romily asks, "What you thought it would just be a hole?" Cooper is still unsure and tells Romily, "it's just that all the illustrations I've ever seen […]" Without allowing Cooper to finish, Romily quickly grabs some NASA stationary, a pen and piece of paper and begins to draw. He pens down two points on the piece of paper and draws a line between them, signifying two points marking the beginning and end of the Endurance's journey through space. "It's too far," he explains, to traverse using traditional means. Folding the piece of paper so that the two drawn points touch each other, Romily says that the "wormhole bends space […] so you can take a shortcut through a higher dimension." The illustrations, Romily says, show this in two dimensions, turning the wormhole into a circle, a two-dimensional shape. "What's a circle in three dimensions?" Romily asks. "A sphere," Cooper says in sudden understanding and the two both look back to the wormhole.

Substance and Stylistic characteristics:

In this scene, Nolan prioritized using real sets, limiting the use of CGI (Computer Generated Images) to a brief moment of spectacle showing the wormhole (Clery, 2014). While the perspective of the two characters is fixed on the celestial phenomena visible through their cockpit window, the audience is looking inward, at the characters and their intellectual response to what they are seeing. Cooper and Romily take up over two-thirds of the screen, leaving the spaceship around them slightly blurry. This seems to be a conscious effort to simplify the scene and remove any distractions. The choice to not include any musical accompaniment further highlights this effort, forcing the characters' dialogue to maintain the audience's interest, much like any day-to-day conversation. This scene, in other words, is not about the wormhole per se, but rather about audience expectation and re-education. Indeed, the film's visuals are partially informed by on-set physicist Kip Thorne, who helps Nolan ground the scenes with scientific models of celestial objects and phenomena that are predicted by theoretical physics but haven't appeared on film (Clery, 2014). Taken together, the film is choosing to purposefully limit the sensationalism inherent in a scenario where people are utilizing a wormhole for interstellar travel.

Interstellar has the rhetorical goal of making the theoretical tangible. Within the film, the wormhole is real and plainly visible, yet Cooper doubts what he is seeing. In this sense, Cooper is a surrogate for the audience, who have only seen illustrations of a wormhole: two dimensional representations of warped grids on paper. Taken thusly, the film is attempting to re-educate the audience, altering what they believe a wormhole should look like. Although a wormhole is only a theoretical possibility, the facts presented are accurate within the diegesis of the film. Here, the powerful rhetorical forces of narrative and scientific authority intermingle. The film is taking the time to create a new visual language, one that is more accurate, while simultaneously limiting a discussion of the actual question: why is there a wormhole in the first place? There is no doubt in this scene regarding the science, the theory is true—it is real and functional.

In my analysis, I have categorized this scene as 'authoritative presenter, fiction,' 'science serving narrative,' 'hedged position,' 'presented as fact,' and 'attempted accuracy.'

Video 4: Television, Stranger Things (2016), Season 1 Episode 5, "The Flea and the Acrobat"

Situation:

This scene from Netflix's Television series, *Stranger Things*, portrays the main cast of children speaking to their science teacher, Mr. Clarke (Randy Havens,) about theoretically traversing through dimensions. The children are looking for their friend, Will, who is communicating to them from a place that is an evil mirror of their hometown in Indiana, the fictional *Upside-down*. The children are aware of Carl Sagan's *Cosmos* and ask Mr. Clarke, "theoretically how do we travel there [to the *Upside-down*]". Clarke begins his explanation by drawing a crude picture on a paper plate of an acrobat and flea walking on a tight rope. The tight rope in this example is meant to represent "our dimension" because it places restrictions on the acrobat, allowing him to only move forward and backward. The flea, however, is free to move in any direction, including upside-down. The children, excited by this possibility, ask "is there any way for the acrobat to get to the upside down." Clarke is reluctant to answer but confirms that it is possible given one uses more energy "than humans are currently capable of creating" to create a "tear in time and space." He then punctuates this concept by folding the paper plate in half and poking a hole through it with a pen. The children are quick to offer a simile to make the concept more relatable. The tear is “like a gate,” they excitedly proclaim. However, the scene does not conclude until Mr. Clarke gives his students a warning, “this is all theoretical […] Science is neat but I’m afraid its not very forgiving.”

Substance and Stylistic characteristics:

The show is set in a small town in the 1980s where the American government is conducting secret experiments—a common trope in science fiction film and television (Kirby, 2003). The motivations, methodologies and results of these experiments are central to the mysteries propelling the show. However, rather than simply criticizing science, the show offers it both as the source of conflict and the mechanism for finding a solution.

Stranger Things’ layered framing of theoretical scientific concepts such as dimensions and tears in space and time is notable because it highlights the complex motivations of the writers and directors. This scene provides some answers while personalizing the information for the children by having it delivered by their favorite teacher. This has two rhetorical effects: it makes the science more personal, while also adding more improvisational energy to the lesson’s delivery by Mr. Clarke. The music is similarly designed to add the atmosphere of revelation, providing a low pensive beat to go alongside Mr. Clarke’s lesson.

The episode is named after Mr. Clarke’s ‘acrobat and the flea’ metaphor. Prior to this didactic scene, through the progression of the show’s plot, viewers are likely asking the same questions as the children and are thus primed to hear Mr. Clarke’s lesson. It is clear that in the show’s diegesis, what Mr. Clarke is saying is accurate. Lacking any knowledge of the children’s supernatural experiences, Clarke is portrayed as a well-meaning mentor who is firmly situated in the real, ordinary world. This creates a barrier between the real, scientific world and the fictional elements that propel the plot of *Stranger Things*. Mr. Clarke is always quick to qualify his statements, repeating often that what he is saying is purely theoretical and not currently possible. Indeed, the overt mention of Sagan's *Cosmos* rhetorically strengthens the impression that Mr. Clarkes lesson is an accurate portrayal of a scientific concept allowing for the existence of the show's supernatural other-world, the *Upside-down*. The children are careful to mislead their teacher regarding their motives, effectively separating the real science from fantasy. The scene concludes with an ironically ignorant Mr. Clarke.

In my analysis, I have categorized this scene's organizing principles as 'authoritative presenter, fiction,' 'science serving narrative,' 'hedged position,' 'presented as fact,' and 'inaccurate.'

DISCUSSION

A key focus of portraying science in fiction is representing its functional purpose within the sequence of a narrative. In a similar manner to any form of exposition, without a functional purpose, scientific information seems superfluous and limits the flow or momentum of the narrative; in that, a character must pause the action to listen or watch and comprehend an explanation. Directors aware of this impediment yet desiring to include relevant information, must balance the inclusion of scientific communication so that it remains strictly relevant to both the characters in a scene and the audience's expectations (Behrens, 1979). This has two rhetorical effects: first, it limits the ability for directors to include accurate science that may require in-depth explanations; and second, it makes the science more certain, free of complications or strict limitations. Put simply, this makes abstract scientific theories into tangible elements of the plot and, more broadly, science into a vehicle for a narrative's resolution, rather than a focal point for the audience's interest.

This inherent call for recognizability when portraying provocative or foreign scientific concepts is a rhetorical challenge for film and television, and it follows that media producers often depend on scientists or scientific material as shortcuts to aid their portrayals (Kirby, 2003). It is in this dependence on real scientific authorities by film and television where the deficit model becomes problematic for science communication. Critics (Kirby; Durant, 1993; Wynne, 1991) have identified three major failings of the deficit model's application to entertainment media: first, the deficit model requires an audience to differentiate between "good" science and "bad" science; second, although the aid of scientists may increase the scientific accuracy of a scene, it is not possible for them to make the filmic representation entirely accurate; and finally, it requires that pseudoscience not be ‘naturalized;’ that is, seem real to the audience (Kirby). This section of the research paper provides evidence for these claims and expands on them to specify the rhetorical techniques and degree of sensationalism through specific examples.

Event Horizon

Building trust in science through a hierarchical relationship between scientists and the public is central to the deficit model (Vidal, 2018b). The emphasis in this formulation is on the accuracy of the scientific knowledge presented to the public rather than the qualities of the presenter. This is problematic as “survey data suggest[s] that trust in institutional actors matters more for the acceptance of technologies than individual knowledge or education levels (Dahlstrom, 2014). Similarly, the link between knowledge and concern about climate change was found to depend upon levels of trust in scientists” (Dahlstrom). One of the major hurdles of scientific communication is presenting ideas that are beyond a human scale. As Dahlstrom explains, “accurate values and explanations do little to provide an intuitive sense of something as parts per billion, or as distant as 10,000 [light years] away” (2014). In other words, building trust is situational for audiences and depends on *how* something is communicated as much (or more) as *what* is communicated. Lacking specific knowledge, the public trusts institutional actors or scientists rather than differentiating accurate information from misinformation. The deficit model thus limits the audience’s connection to a scientist character by focusing on solely accuracy. In fiction, actors can mimic or misrepresent the authority of scientists without demonstrating the prerequisite knowledge to make scientific claims. Although portraying scientists as authorities forwarding information reinforces the hierarchy between scientists and lay persons, it makes scientists more remote and less trustworthy—hurting their cause.

An example of this remoteness between scientists and laypersons is demonstrated in Event Horizon by Dr. Weir's (Sam Neill.) In his lesson to the crew of the *Lois and Clarke*, Dr. Weir as the inventor of the gravity drive and the ship's resident scientific authority on the *Event Horizon* (spacecraft) is required to explain to crew why they are boarding the lost spacecraft. Throughout this didactic scene, Weir is at odds with the crew, speaking in overly specialized terminology with absolute certainty. In short order, the crew turns against him, forcing Dr. Weir to simplify his explanation, scaling it down to the second dimension.

It is notable that Paul Anderson takes time to make Dr. Weir's authority onerous. *Event Horizon* is a horror film with science fiction trappings. As the film progresses, it becomes more metaphysical dealing with ideas such as evil, guilt, and moral consequences. The audience and crew soon learn that Dr. Weir's gravity engine did not work as intended but instead released horror aboard the Event Horizon's previous crew. Thus, Dr. Weir authority becomes questionable alongside, reinforcing his earlier remoteness. His authority, scientific or otherwise, takes on a sense of dramatic irony and the accuracy of his scientific explanation loses all relevancy in the face of his failure. *Event Horizon* is a significant departure in terms of character from the other examples in this study. Although, on the surface, Anderson's presentation of scientific concepts mimics Interstellar by adhering to the hierarchical approach of the deficit model, its treatment of its scientist character is vastly different. This contrast between the two movies highlights the failure of the deficit model in differentiating perceptions of scientific authority from specialized knowledge. Thus, *Event Horizon* demonstrates how scientific authority may be coloured differently depending on factors other than their demonstrable knowledge Nevertheless, *Event Horizon*'s didactic scene strictly follows the deficit model.

Interstellar

Christopher Nolan's *Interstellar* is of particular note in my analysis of the deficit model because of the films metatextual framing. *Interstellar's* promotional material highlights how a leading physicist, Kip Thorne, informed the portrayal of the film's scientific concepts (Clery, 2014). The questions must be asked: what does the film or director gain by framing its visuals and narrative as scientifically informed? Why is a scientist's input necessary for an entirely fictional story? The answer to these questions is surprisingly straight forward. *Interstellar* requires that a wormhole exist, and that the audience *believe* in its existence. The barrier that Nolan endeavors to overcome with the aid of a scientist is not one of the wormhole's functionality, but of its visual quality. Even though the concept of a wormhole is mathematically plausible irrespective of the film's diegesis, it is nevertheless without any real-world counterpart—no visualization that mirrors the theory on a one-to-one scale. Due to this lack of a common visual language between the director and audience, there is a real possibility that viewers may confuse what they are seeing as something entirely fictional and even lazy, reducing their investment in the film's events.

Interstellar is purposefully re-educating the public and updating the visual lexicon of the science fiction trope of the wormhole. Indeed, there is a direct reference to inaccurate scientifically produced visual material that has informed Cooper's (and perhaps the audience's) confusion regarding wormholes. This reference reveals a rhetorical argument that is extending beyond the film's world, into the real world—the audience's expectation of what a wormhole should look like. In effect, the film is arguing that the wormhole portrayed in *Interstellar* is a more scientifically accurate portrayal than *any* other image *you*, the audience member, have seen. To this end, Nolan appeals to the authority of a real scientist, stylistically grounds the scene with relatable imagery, and emotionally challenges the audience by questioning their prior knowledge through the character of Romily. But what is the image of the two-dimensional wormhole that Cooper is referencing in Interstellar? What does it look like? This is not clearly stated in the film. However, extrapolating from Romily's discussion, it is likely one very similar to the wormhole portrayed in *Cosmos's* episode, "The Edge of Forever." *Cosmos*'*s* wormhole is a simple two-dimensional grid representing spacetime warped into a hole.

Figure 3: *Cosmos* (1980)*:* Sagan sliding into a wormhole.

Prior to Sagan's portrayal of the wormhole, he explains how *Cosmos'*s visualizations of this scientific concept is a two and three-dimensional reimagining of higher dimensional subjects. Interstellar, despite being an artistic work is thus challenging prior educational norms regarding wormholes. It is using its visual effects and the input of Kip Thorne to remove simple representational gestures and create a realistic portrayal of a fourth dimensional object in three-dimensional space. However, as critics of the deficit model reveal, these attempts are misguided (Kirby, 2003). The representation of these concepts is *too* certain, it implies the reality of the wormhole not only in the film, but in the real world by attempting to challenge textbook images. Where scientists hedge their position, highlighting the limitations of what is real and possible in the realm of theoretical physics, Interstellar requires that traversing through a wormhole become 'naturalized.'

Cosmos

Carl Sagan's Cosmos occupies a unique position in this discussion; in that he is an actual scientific authority speaking directly through his popular science program. Whereas *Interstellar* uses a science advisor to naturalize the reality of a wormhole, Sagan presents the science directly. This directness creates a notable difference in *Cosmos*'s rhetorical approach. The overtly hedged position of Sagan defies the certainty of *Interstellar's* explanation and mirrors the eso-exo model; in that, Sagan is quick to qualify each statement he makes, like a scientific paper, noting that the theories he is discussing are still under debate and challenged by alternative theories to the closed-universe, the open, un-foldable universe. This is unsurprising since Sagan is a scientist himself and thus is closer to the center of the eso-exo model as a matter of course—his language is directly linked to personal knowledge (Fleck, 1979 [1935]).

The sensationalism in *Cosmos* is found instead in the overly-simplified visualizations of folded space-time that accompanies Sagan's words. While discussing wormholes, for example, Sagan is shown sliding into a wormhole to another dimension (*Figure 3*). Sliding down the wormhole instills the impression of potentially utilizing the theoretical concept but muddles his scaling two-dimensional metaphor. This is clearly an attempt at garnering interest through relatable imagery, that of a child sliding down a slide. Similarly, to the more narratively driven examples in this research paper, the desire is to emphasize the functionality of the science being discussed. This exact image of a wormhole appears in *Star Trek: Voyager*, but unlike *Interstellar*, the phenomena remains as a warped two-dimensional object.

Figure 4: *Star Trek: Voyager*: Wormhole

Sagan's scaling two-dimensional narrative is easily imaginable, even if it is not a plausible representation of a wormhole. Indeed, the vast majority of wormholes in fiction are imagined in this two-dimensional way, ignoring the fact that it is a simplification rather than a realistic representation (Clery, 2014).

Stranger Things

Didactic scenes in entertainment fiction often settle for implying scientific communication through the visual language of science, namely, the use of beakers, specialized lab equipment, or diagram drawn on chalk boards (Kirby, 2003). Rhetorically, this has the effect of suggesting a simplistic or predictable quality to scientific discovery. This characteristic is countered by portrayals of science that are limited in some way, revealing hardship on the part of scientists and the constraints of the scientific process. In scenes where this is not possible, scientific limitation is portrayed by the presentation of probability or uncertainty. The audience's interest, then, is generated not from facts but from the questions that curious characters are asking or endeavoring to answer through the scientific process (Kirby). This focus on the scientific process rather than simple facts or scientific authority may be a powerful narrative strategy that does not rely not he deficit model to create trust in scientific institutions.

The children who portray the protagonists of *Stranger Things* seek out the help of Mr. Clarke to discover where their friend, Will, has disappeared. This depiction of trust and reliance on a scientific authority in solving their problem is not only a realistic option for children who have limited agency, but also serves as replicable behavior for viewers. The children's curiosity is one of their key characteristics, and the overt reference to Sagan's discussion regarding dimensional travel highlights a desire to seek out scientific material. This is why their desire to speak with their teacher outside of school is significant. Where similar didactic scenes would use the paraphernalia of a science classroom, *Stranger Things* purposefully makes a diner the location of the children's lesson. This is a simple yet effective rhetorical argument: one can engage in scientific discussion anywhere, and the language of science is not informed solely by technical jargon, but also an active curiosity.

However, this is not to say that *Stranger Things* is not reliant on the deficit model. The directors of the show, Matt and Ross Duffer, modify the wormhole concept to serve their narrative function. However, they are careful to not discredit their scientific authority within the show, Mr. Clarke. Whereas the children are aware of the supernatural elements of the show, they keep Mr. Clarke ignorant of the truth. This creates an effective barrier between the 'bad' pseudoscientific qualities of the show (i.e. psychics, telekinesis) from the 'good' science of Mr. Clarke. Indeed, the example of the 'acrobat and the flea' is used insofar as it allows for the usage of the words 'the upside-down,' a fictional location in the show where Will is trapped; however, Mr. Clarke is never aware of this fantastical location.

Mr. Clarke's explanation is also problematic. Balancing a rhetorical separation of the real from the unreal is difficult to maintain, and Mr. Clarke mixes his metaphors by folding the plate he had drawn the flea and the acrobat on originally, confusing the directionality of his previous example. The sensationalization of 'punching' a hole into the plate to represent going through a wormhole is also not a simplification of a higher dimension as was the case in both *Interstellar* and *Cosmos.*

Organizing Principle

Fictional scenarios are locations of the metamorphosis of ideas, where facts, audience response, and expectation are altered. Whereas normally, a viewer may hesitate or reject a scientific explanation, he/she will suspend his disbelief if that explanation in relevant to a narrative (Kirby, 2003). This impression may last only for the length of a piece of entertainment; however, if the rhetorical power of a film's argument is sufficiently convincing, this impression may last longer, perhaps altering a person's understanding of reality (Kirby). While, in theory, this makes fiction a possible location for scientific education, in practice, a strict adherence to scientific accuracy limits the persuasive power of a fictional scenario.

Directors like Christopher Nolan are inspired by scientific content, but only insofar as it serves their narrative purposes (Clery, 2014). This tension between accuracy and narrative functionality is central to the deficit model's untenability in entertainment fiction (Vidal, 2018). Rather than rejecting the deficit model, however, the scientific community continues to pursue partial success; that is, increasing the ratio of accurate to inaccurate science (Vidal, 2018b). This attitude provides insight into the rhetorical arrangements of the didactic scenes discussed above. Indeed, Stranger Things attempts to differentiate the "good" science of Mr. Clarke from the show’s more pseudoscientific elements. Similarly, *Interstellar*’s use of physicist, Kip Throne, in its promotional material reveals a desire to communicate not only the film’s entertainment value, but its scientific accuracy. The science discussed in these entertainment articles, however, remains simple, limited by time and their relevance to the fictional scenario, providing only enough information to add certainty to their function within their respective diegeses. Thus, authoritative scientific figures in fiction serve as a gateway to gain audience approval, to overcome what may be considered factually incorrect, whatever the truth may be in the real world.

When real world accuracy is attempted in a fictional world in which a single theory is established as correct, those hedging their positions appear ignorant, as is the case with Mr. Clarke who repeatedly denies the demonstrable truths established throughout the plot of *Stranger Things*. This diminishment of scientific authority is amplified in *Event Horizon.* Unlike Carl Sagan, Sam Neill is portraying what Paul W.S. Anderson vision of how a scientist speaks and acts. On the surface, Dr. Weir serves the deficit model nearly perfectly. However, through the course of the film’s events, what defines Dr. Weir is not his scientific knowledge but what he fears, what drives him, and the horror he eventually unleashes upon the crew of the *Lewis and Clark*.

Whereas the deficit model requires that scientists maintain certainty to establish a hierarchical relationship with audiences, *Cosmos* serves as a necessary counterpoint to how accurate science should be presented, detailing all possibilities. Indeed, the language of science is not defined solely by its authority, but also its rigor. Carl Sagan demonstrates this in *Cosmos* by qualifying all his statements, detailing their status as theoretical possibilities, and discussing counter arguments. Unlike the other examples in this study, Sagan prioritizes education above entertainment, increasing the uncertainty of his discussion. Anderson purposefully overshadows the achievements of science with the crushing weight of the unknown, a metaphysical threat that cannot be overcome. It is an outlook that defies scientific accuracy and echoes the themes of the mad scientist films of the early 20th century (Vidal, 2018). It is this sort of representation, one that trivializes knowledge and actively discourages scientific curiosity, that diminishes the public's appreciation of science, not a lack of scientific accuracy (Kirby, 2003).

It is important to note that this is not an argument for decreasing the scientific content in film and television. Besides being impossible to implement, it would reduce both a story's plausibility and complexity. Instead, the results of this study recommend a shift in priority when presenting scientific content in entertainment media. Whether the portrayal and discussion of a wormhole is accurate does not matter, if it facilitates interest in the topic of theoretical science and science more generally (Kirby, 2003).

Despite its service to the deficit model through the character of Mr. Clarke, *Stranger Things* demonstrates a necessary step towards a more rounded discussion of science in film, namely, curiosity. Indeed, it is not the voice of the teacher, Mr. Clark, but the wonder, ingenuity, and eagerness of the children speaking to him that demonstrates how science may become relevant to a general audience. Currently, popular media, when presenting scientific content, is rhetorically beholden to the deficit model. However, If the goal of popular science-oriented fiction is to increase the public's trust in science, it will not be as simple as correcting misconceptions or reducing inaccuracy, it will require instilling the audiences with scientific curiosity.

CONCLUSION

Using Sonja K. Foss's generic rhetorical criticism model (2009), this paper analyzes four didactic scenes in popular entertainment media portraying the same theoretical scientific concept: the wormhole. Noting a similar method of communication and rhetorical methodologies, I studied the framing and narrative qualities to identify the constraints on the directors and their use of sensationalism to garner audience interest in their presentation of scientific concepts. The characteristic that I forward as central to this genre is the utilization of the deficit model with regards to the audience, namely, is the audience expected to differentiate between 'good' and 'bad' science? Is an attempt made to identify a piece of information as accurate in the *real* world? And are the pseudoscientific claims clearly differentiated from said accurate explanations (Kirby, 2003)? In conclusion, this paper has found that *Interstellar*, *Stranger Things*, *Event Horizon*, and *Cosmos* have adhered to the deficit model by attempting to create a balance between accurate portrayals of science and the sensational qualities of an entertaining visual narrative. All the analyzed scenes place emphasis on scientific facts rather than the scientific method, use their popular mediums as vehicles to educate a supposedly ignorant public, and make the science they are presenting more certain, either verbally or visually. However, as an analysis of literature on the topic of public science education has shown, this is misguided as the scientific portrayals are only accurate to a certain point and the variance in rhetoric to delineate the 'good' science from the 'bad' falls apart in favor of establishing the fictional scenario or producing interest through sensationalism. In other words, the science is only a vehicle to allow for the suspension of disbelief, and to introduce more sensational or unfamiliar science fiction concepts. Attempts to educate the public through fiction designed primarily to entertain is mistaken as the accurate science only serves as a gateway towards pseudoscience or misunderstanding (Kirby, 2003). Certainly, the presence of accurate science increases the depth of the narrative scenes, highlighting the complexity of certain subject matter and engendering interest in audiences (Avraamidou, 2009). However, accuracy should not be the main objective; instead, portrayals of science and scientists should focus on avoiding stereotypes, oversimplification, and certainty in their presentation. This paper recommends focusing on producing an active curiosity in audiences, providing the public with popular narratives that inspire them to incorporate the understanding of science into their daily lives.

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