CHAPTER 17

Watchmen, Scientific Imaginaries, and the Capitalocene: The Media and Their Messages for Science Educators

Noel Gough and Simon Gough

Scientific Imaginaries and Science Education in the Capitalocene

We write this essay collaboratively because, as father and son, we have first-hand experience of different generations interpreting popular media texts in different ways. However, like Deleuze and Guattari (1987, p. 3), we understand the limits and opportunities of writing together: "Since each of us was several, there was already quite a crowd." Each of us is indeed several, but we agree that some things might be better said with one voice.

Notwithstanding this book's title, we are reluctant to call the present epoch "the Anthropocene." We prefer *Capitalocene*—the age of capital—because, as T. J. Demos (2016, n.p.) writes, "it names the culprit, locating climate change not merely in fossil fuels, but within the complex and interrelated processes of global-scale economic-political organization." With respect to alternative epochal names, Elizabeth de Freitas and Sarah Truman write:

> Concepts like the Capitalocene and Plantationocene remind us that the Anthropocene has been manufactured by a portion of humanity invested in accelerated capitalist accumulation and white supremacy. Science has played a crucial role

N. Gough (✉)
La Trobe University, Bundoora, VIC, Australia
e-mail: N.Gough@latrobe.edu.au

S. Gough
University of Melbourne, Parkville, VIC, Australia
e-mail: simon@simongough.net

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> in shaping this "global" condition as a legacy of European imperialism. And yet it would be foolish to deny scientific knowledge as simply serving the white establishment, particularly today under neoliberal post-truth conditions. Science denialism is on the rise, allied with nationalist anti-establishment movements and libertarian free market interests. (2020, pp. 1–2)

Regardless of which term best encapsulates our current crises, we share de Freitas and Truman's (2020, pp. 1–2) interests in "foregrounding speculative fiction as a way to open up scientific imaginaries... to think through the many pasts, presents, and futures of science."

"Scientific imaginaries" are abundant in popular media, especially (but not exclusively) in the storytelling genres signified by "SF."[1] Some audiences see popular artistry as ephemeral and/or inconsequential, but as J. G. Ballard (quoted in Vale & Juno, 1984, p. 155) observes, "pop artists deal with the lowly trivia of possessions and equipment that the present generation is lugging along with it on its safari into the future." We focus on *Watchmen* not only because the novel and film speak to us of issues in science education, but also because they are among the "lowly trivia of possessions" we are "lugging... into the future"—"equipment" that connects us with the world and helps us to make sense of it. We argue that familiarity with (and informed appreciation of) the "lowly" artworks that *Watchmen* exemplifies should be understood as key indicators of a science educator's "cultural literacy."[2] We also suggest that critically appreciative readings of scientifically inflected popular media texts (such as we demonstrate here) are particularly relevant to the multigenerational practice of science teacher education, which typically involves professors, trainee teachers, and the learners they anticipate teaching.

From Clockwork to Complexity: (Re)Connecting Science and Fiction

Modern Eurocentric science (beginning with Copernicus, Brahe, Kepler, Galileo, and Newton) was constructed on the assumptions of empiricism and experimentalism. By the mid-nineteenth century it was typified by Newtonian

[1] Donna Haraway (1989, p. 5) writes: "In the late 1960s science fiction anthologist and critic Judith Merril idiosyncratically began using the signifier SF to designate a complex emerging narrative field in which the boundaries between science fiction (conventionally, sf) and fantasy became highly permeable in confusing ways, commercially and linguistically. Her designation, SF, came to be widely adopted as critics, readers, writers, fans, and publishers struggled to comprehend an increasingly heterodox array of writing, reading, and marketing practices indicated by a proliferation of 'sf' phrases: speculative fiction, science fiction, science fantasy, speculative futures, speculative fabulation.".

[2] Coined by E. D. Hirsch (1988), "cultural literacy" refers to the ability to understand and participate fluently in a given culture—in this case, the culture of science education as a multicultural, multigenerational, cross-class, and cross-disciplinary activity. If readers are not already familiar with the two graphic novels to which we refer here (*Watchmen* and *Animal Man*) we strongly recommend doing so before reading further.

physics and mathematics, with the universe likened to a gigantic mechanical clock, continually ticking along with gears governed by Newton's laws of motion and universal gravitation. Scientists and educators alike assumed that science was chiefly a matter of patiently seeking the "facts" of nature and accurately reporting them.

In the late 1880s, the discovery of radioactivity led to a revolution in the goals and structures of physics. As Joseph Schwab (1964, p. 198, his italics) observes, "The new physics... did *not* come about because direct observations of space, place, time, and magnitude disclosed that our past views about them were mistaken." Rather, assertions about these matters changed because physicists found it productive to treat them in a new way—not as matters for empirical verification but as principles of inquiry—conceptual structures that could be revised whenever necessary. Schwab concludes:

> Today, almost all parts of the subject-matter sciences proceed in this way. A fresh line of scientific research has its origin not in objective facts alone, but in a conception, *a deliberate construction of the mind*. On this conception, all else depends. It tells us what facts to look for in the research. It tells us what meaning to assign these facts. (1964, p. 198, our italics)

In other words, many of the interpretations and explanations that constitute "reality" and our experience of it are not "facts" (as empiricist science conceived them) but meanings fashioned by human agents: that is, they are fictions. "Science" and "fiction" do not exist in separate domains but are culturally connected. This is not simply a matter of science and literature finding common meeting places in SF, or of scientific imaginaries being translated into literary themes, a practice that long preceded the early twentieth-century emergence of SF as a distinctive literary mode in popular culture.[3] In her study of scientific field models and literary strategies, Katherine Hayles (1984, p. 10) concludes that "the literature is as much an influence on the scientific models as the models are on literature," there being a two-way traffic in metaphors, analogies, and images between them.

The emergence of chaos and complexity as foci of scientific speculation provides a relatively recent example of SF incorporating the leading edges of scientific inquiry. Ilya Prigogine's investigations during the 1960s and 1970s explain how complex, far-from-equilibrium systems spontaneously transform themselves into new levels of complex organization. Prigogine's model of self-organizing systems as "dissipative structures" reconciles several contradictions in twentieth-century science, including the divergent models of physical function provided by entropy versus evolution and the different roles and attributes of time in physics and biology. The cosmological significance of Prigogine's work was recognized by his receipt of the Nobel Prize for chemistry in 1977, but his work was not published in English in any popular form until 1984,

[3] For example, Copernican cosmology permeates the poetry of John Donne (1572–1631). For other examples see Brian Stableford (2003).

when *Order Out of Chaos* (Prigogine & Stengers) was translated from the French.

Stories about chaos and complexity began to appear in popular media during the mid-1980s (e.g., Atkinson, 1985), at about the same time as their applications in educational philosophy and theory were beginning to be explored (e.g., William Doll, 1986). James Gleick (1987) popularized chaos theory with *Chaos: The Making of a New Science*. Given this chronology, we agree with David Porush that.

> it is a tribute to the general intuition of SF, and in particular the long-distance imaginative radar shown by A. A. Attanasio, that in his extravagant and lavishly imagined tour de force, *Radix*, Prigogine's theories make a crucial, if cameo, appearance. Attanasio must have seized very quickly upon Prigogine's work . . . in order to have abstracted some of its essential implications . . . in a novel that was published as early as 1981. (1991, p. 372)

Other SF authors to give imaginative form to Prigogine's work and its successor projects include Bruce Sterling (1985, 1989), William Gibson and Bruce Sterling (1991), Lewis Shiner (1988), and graphic novelists Alan Moore and Dave Gibbons (1987).

Prigogine's thinking catalyzed highly original interdisciplinary work in astrophysics, biology, biophysics, chemistry, ecology, economics, education, management, neurology, particle physics, thermodynamics, and traffic studies. However, it had little or no effect on the "textbook science" of late-twentieth -early twenty-first century school science curricula, despite many of Prigogine's ideas and their implications being accessible through SF.

Why Comics/Graphic Novels?

Our engagement with comics/graphic novels began with Noel's longstanding interests in the potential contributions of SF to curriculum studies (Gough, 1991) and in particular to science and environmental education (Gough, 1993a). His monograph, *Laboratories in Fiction: Science Education and Popular Media* (Gough, 1993b) offered a vision for science education that rejected the "textbook science" of late-twentieth-century schooling, which retained a nineteenth century conceptualization of science as a study of the material structures of simple systems. *Laboratories in Fiction* was received enthusiastically by US science educators and curriculum scholars (see, e.g., Appelbaum, 2019; Weaver, 1999, 2019). Noel did not argue that SF is what Catherine Hasse (2015) calls "a motivating fantasy," that is, as "bait" on a "hook" that lures and lands learners in the flawed representations of late-twentieth-century textbook science. Rather, he demonstrated that SF gives imaginative form to the limits of our socially constructed knowledges (including whatever might lie *beyond* those limits) and thereby opens

up conceptual territories in which to explore scientific imaginaries in more accessible ways than conventional science textbooks.

Seeking examples of SF beyond adult-oriented books and films, Noel looked for works oriented to younger audiences. Simon's fascination with the 1987–1996 children's animated series, *Teenage Mutant Ninja Turtles*, which premiered in Australia during 1989 (the year after Simon's birth), led Noel to the graphic novel on which the series was based (Eastman & Laird, 1986), which in turn led him to other comics and graphic novels that interrogated scientific imaginaries, including *Animal Man* (Morrison et al., 1991) and *Watchmen* (Moore & Gibbons, 1987).

For example, *Animal Man* reimagines superhero myths as it chronicles the adventures of a sometimes over-zealous, sometimes self-doubting animal-rights activist with the power to take on the capabilities of animals with whom he comes into contact (e.g., flight). Early issues rework the conventions of superhero comics in a sinister tale of scientific research corrupted by agents of the capitalist military-industrial complex, and includes an implicit comment on Ruth Bleier's (1988) question: "Lab coat: Robe of innocence or klansman's sheet?" Bleier identifies the contradictory meanings of the white coat as a scientific imaginary:

> It is the lab coat, literally and symbolically, that wraps the scientist in the robe of innocence—of a pristine and aseptic neutrality—and gives him, like the klansman, a faceless authority that his audience can't challenge. From that sheeted figure comes a powerful, mysterious, impenetrable, coercive anonymous male voice. (1988, p. 62)

In one episode (Morrison et al., 1991, Ch. 1, p. 27), a scientist's spectacles appear to be opaque, contributing to his "mysterious, impenetrable" presence, but later in the story (Ch. 3, p. 17), when challenged to tell the truth, he *removes* this symbol of detachment and objectivity, thereby undermining the mystique of what scientists actually *do* in pursuing "truthful" accounts of the world.

Why *Watchmen*?

Watchmen initially appeared as 12 issues of a comic-book series between September 1986 and October 1987. It features a self-contained narrative requiring no prior knowledge, with new characters and a setting separate from other publications in the DC Comics universe. When packaged as a "graphic novel" it was widely acclaimed as a groundbreaking work of SF (Van Ness, 2010, pp. 8–15).

Watchmen is a dark satire on superhero[4] mythologies and US politics. One of its central characters is Dr. Manhattan, an aptly named superhuman physicist. Manhattan is the reincarnation of Jon Osterman, a nuclear scientist who is materially "disassembled" when accidentally irradiated by subatomic particles. In a sequence of three pages (1987, Ch. IV, pp. 118–120), *Watchmen* depicts Osterman's reconstruction through two intertwining—and to some extent contradictory—metaphors, one of which borrows from Albert Einstein's (alleged) rueful reflection on his role in the release of atomic power: "if only I had known, I should have become a watchmaker" (Ch. IV, p. 138), despite his role in overthrowing Newtonian mechanics. Osterman (whose father is a watchmaker) repairs a friend's wristwatch shortly before his demise, and his resurrection as Dr. Manhattan (foreshadowing and remembering his transformation by reference to watchmaking) is depicted as "just a question of reassembling the components in the correct sequence" (Ch. IV, p. 119). But other visual and verbal cues suggest that his transformation can be understood as a metaphor of emergence in complex systems, insofar as Osterman's disassembled components can be interpreted as a dissipative structure that progressively reorganizes itself (shown as an emerging sequence of a neural network, a circulatory system and a partially muscled skeleton) into a higher level of complexity represented by Dr. Manhattan's superpowers. In this sequence of words and images, Dr. Manhattan's ambiguous genesis can be interpreted as symbolizing the contesting paradigms of modern and contemporary science: of the deterministic mechanics of Newton's "clockwork universe" versus the unpredictable dynamics of complex self-organizing systems.

Watchmen's brief (but conceptually rich) interpretation of competing scientific paradigms is a stark reminder that although the explanatory power of complexity has transformed many disciplines, it has had relatively little impact on science education. For example, the current specifications for Australia's national science curriculum (ACARA [Australian Curriculum Assessment and Reporting Authority], 2020a) make no mention of complexity as a key *scientific* concept, as distinct from suggesting it as a criterion for judging the quality of a student's learning relative to achievement standards: "Inferences can be drawn about the quality of student learning on the basis of observable differences in the extent, complexity, sophistication and generality of the understanding and skills typically demonstrated by students in response to well-designed assessment activities and tasks" (ACARA, 2020b).

[4] Few comic-book "superheroes" actually possess superpowers. Those that do are likely to be aliens (Superman), mutants (X-men), or physiologically altered by a laboratory accident (Spiderman, The Flash). Most have deliberately enhanced their physical powers by harnessing fictional and/or advanced technologies (Batman, Iron Man, Wonder Woman). As crime fighters, they often function as masked vigilantes. In the alternative USA of 1985 depicted in *Watchmen*, masked vigilantes have been outlawed and only one character, Rorschach, continues to wear a mask in defiance of the law. *Watchmen's* "heroes" refer to themselves as "adventurers".

The Sciences of *Watchmen*

Brent Fishbaugh (1998, p. 191) argues that the significance of the sciences is signaled in *Watchmen's* first chapter, wherein Moore and Gibbons subtly depict the advanced technologies existing in their alternative 1985, where people drive electric cars (we later learn that Dr. Manhattan made this possible) and airships travel the skies between buildings:

> It is in the heroes themselves, however, that Moore proposes his primary question: Is humanity responsible and humane enough to properly use science? As such, he personifies the sciences within the major characters and through the text, asks the reader if placing the power of various sciences in the hands of the subject morality and wisdom of human beings is a wise idea.

Fishbaugh (1998, p. 194) interprets the major characters as "exact personifications" of various sciences. For example, Rorschach, the first character that readers encounter as he investigates the Comedian's murder, is linked to the sciences through psychology, as his name (and mask) implies:

> Rorschach is the epitome of soft science not only in his obvious connection to psychology but in his subtle connections to it as well. Two easily recognized examples of this link are revealed in his relationship with his psychiatrist and in the way he is shaped by his environment. (p. 194)

Fishbaugh (1998, p. 194) considers Dr. Manhattan to be "at the opposite end of the science spectrum; where Rorschach represents the soft, personal, somewhat subjective sciences, [Manhattan] represents the cold, hard, true mathematical and chemical sciences." This is illustrated in a sequence (Ch. I, p. 29, emphasis in original) in which Rorschach asks Manhattan if he is "concerned about Blake's [the murdered Comedian's] death," who replies, "a live body and a dead body contain the same number of *particles*... structurally there's no discernible *difference*... life and death are unquantifiable *abstracts*... why s*hould* I be concerned?".

Fishbaugh (1998, p. 196) also argues that Adrian Veidt (previously known as masked adventurer Ozymandias) personifies a melding of the hard and soft sciences by embodying soft sciences (especially history), while manipulating hard ones (especially genetic engineering) to achieve his plans. However, we suggest that from the standpoint of science educators, Fishbaugh's exaggerated "personifications" risk reinforcing stereotypes of "hard" and "soft" science, and see little merit in debating whether (or not) any of the major characters' personifications of science are "exact." We see more educative possibilities in examining the ways in which *Watchmen* illustrates dilemmas of science education. For example, the novel includes expository materials (appended to chapters 1–11), fictitious documents from within *Watchmen*'s world which help readers to understand the chronology of events or reveal details of the adventurers' private lives. One such document is an article

"reprinted from the [non-existent] *Journal of the American Ornithological Society*" (Ch. VII, p. 241) ostensibly written by Daniel Dreiberg (an ornithologist who was the masked adventurer Nite Owl II). The article begins:

> Is it possible, I wonder, to study a bird so closely, to observe and catalog its peculiarities in such minute detail, that it becomes invisible? Is it possible that while fastidiously calibrating the span of its wings or the length of its tarsus, we somehow lose sight of its poetry? . . . I believe that in approaching our subject with the sensibilities of statisticians and dissectionists, we distance ourselves increasingly from the marvelous and spell-binding planet of imagination whose gravity drew us to our studies in the first place.

In its entirety, the mock scholarship of Dreiberg's article (it mocks many subjects including itself, science, and the discursive forms it both emulates and criticizes) is a lucid critique of identifying-naming-collecting-measuring-classifying-dissecting[5] approaches to bird-watching (and other "scientific" studies of nature). Moreover, unlike a "real" scientific journal article, it is written in language that is accessible to people of all ages.

Simultaneity: The Message in *Watchmen*'s (1987) Medium

The comic/graphic novel *Watchmen* exemplifies sequential art's ability to convey the experience of *simultaneity*—a key imaginary in contemporary physics—by representing objects and events assumed to be isolated in space and time as coexisting in the "fourth dimension" of a space–time continuum. As Mark Bernard and James Bucky Carter (2004, p. 1) explain, the fourth dimension "refers to a special relationship with space and time wherein the two conflate such that infinite multiple dimensionalities become simultaneously present":

> When the reader's interaction, his or her own space-time, is accounted for, this evocation of space-time becomes quite literal and expands exponentially. The fourth dimension is bridged by human experience and interaction. The spontaneous, real-time interplay of all these forces at once create an ethereal dimension of its own. . . . Therefore, the fourth dimension is defined as simultaneous, multitudinous dimensionality deeply entwined in and part of individual experience. There is special artistry in sequential art and narratives in the relationship of this metaphorical and literal space-time continuum.

In the novel *Watchmen*, simultaneity is clearly illustrated by the ways in which Dr. Manhattan experiences every moment simultaneously. In 1959, he knows what will happen in 1969 because he is already there; he knows about

[5] See Gough (2002, pp. 118–121) for a critique of dissection and associated practices in school science classrooms..

JFK's assassination at his rebirth because he was already experiencing it, unable to change the course of history (see Ch. IV, p. 128).

Watchmen as sequential art not only represents simultaneity as something that Dr. Manhattan experiences, but also provides the reader with their own experience of it:

> From the very opening pages of *Watchmen*, it is clear that the reader is in for a virtuoso bridging of space and time, made all the more complete by his or her own role. For example, while two detectives investigate the apartment where the Comedian [Edward Blake] … has been murdered, we are able both to hear about the murder through their dialogue and to see it through Gibbons' graphic illustrations of the crime that are spliced in-between the detectives' examination of the murder scene. Through the combination of texts and visuals, we, the readers, are truly in both places at the same time as well as in our own space. (Bernard & Carter, 2004, pp. 4–5)

Bernard and Carter (2004, p. 5) argue that this bridging of the space–time continuum is particular to sequential art, and that comics/graphic novels constitute a twentieth-century culmination of the artistic goals of pivotal modern and postmodern genres such as cubism and futurism, which they illustrate with Michel Duchamp's (1912) cubist *Nude Descending a Staircase No. 2*.[6] Watchmen also gestures toward surrealism in panels showing Dr. Manhattan perusing a reproduction of Salvador Dali's (1931) *The Persistence of Memory* (Ch. IV, p. 128).

Adapting Simultaneity and Science in *Watchmen* (2009 and Beyond)

Watchmen now represents other forms of simultaneity, insofar as its existence includes both a sequential art novel and a filmic text, Zack Snyder's (2009) Watchmen and Damon Lindelof's (2019) television series *Watchmen*. Transformations from comics/graphic novel to film/video necessitate creative alterations to the source text, and critical engagement with the film often centers on what is done differently between the texts (see Van Ness, 2010, pp. 172–179). Yet, as is the case with many adaptations, these critiques often imply that any alteration is unnecessary or inferior to the initial enunciation—a symptom, as Robyn McCallum (2018) writes, of the emphasis in discourses on adaptation toward venerating fidelity, excluding the possibility that a filmic adaptation might improve upon or positively enact ideas that diverge from its pre-text. Our consideration here is not to envision the film as an imperfect reimagining of the graphic novel, but rather to assess how each text represents comparable ideas of simultaneity, science, and the Capitalocene crisis.

[6] See https://www.philamuseum.org/collections/permanent/51449.html.

As noted above, representations of simultaneity are key aspects of the novel's narrative. Attempts to render simultaneity in the filmic text of *Watchmen* (2009) are necessarily transformed by the constraints of the medium. Following Brian McFarlane (1996, p. 28), we consider that just as spatiality is key to the filmed image, it is also essential to the graphic novel page in a manner distinct from the spatiality of the unembellished written word. Yet these media types each hold divergent relationships with linearity in terms of their engagement with the movement of time. As Scott McCloud (1994, p. 100) writes, "in learning to read comics, we all learned to perceive time spatially, for in the world of comics, time and space are one and the same." While the comics page is spatially stable and unchanging, differential access by the reader in individuated moments creates a highly subjective sense of time. By contrast, the film-image is constantly moving forward, and particularly in conventional mainstream film, presents only one filmic sequence at a time within the viewing frame.

Consider, for example, the sequence in which Dr. Manhattan's televised interview is presented in parallel with Dan Dreiberg (Nite Owl II) and Laurie Juspeczyk (Silk Spectre II) fighting a gang attacking them in an alley (Ch. III, pp. 86–91). Whereas the graphic novel uses sequential art to express the simultaneity and parallels in these scenes through repeated panel placement, or matched transitions and dialog, the film attempts to replicate this sequence through cross-editing and parallel editing. In the novel, images and speech echo and resonate between the sequences, but the film can only present the sequence as a series of cutting shots, and alters the dialog and context to better fit within the flow of the film's narrative arc. In other words, the film cannot replicate the simultaneity of spacetime because it can only depict the forward flow of time, whereas the comic presents an illusion of time in which past, present, and future exist simultaneously. As McCloud (1994) observes, the past and future always surround the present in comics, because unlike the forward motion of film, the reading eye can change direction, moving up, down or across pages. Moments of simultaneity remain embedded within the narrative of the film—for example, Dr. Manhattan's existence remains suspended in a past/present/future assemblage—but the expressive possibilities of simultaneity enacted in the graphic novel are difficult—perhaps impossible—to render on the filmic screen. As such, the sequential art of comics/graphic novels constitutes a uniquely accessible site of engagement with the possibilities of simultaneity.

What, then, of science? If, as Fishbaugh suggests, the sciences in the graphic novel are represented implicitly by character-avatars, they are explicitly enacted in the film by manifestations of science as a force of creation—and potential destruction—that are central to its narrative. This transformation is interwoven with one of the most common criticisms of the film, namely an alteration of the novel's ending amusingly referred to in social media as "Squidgate" (see Van Ness, 2010, p. 184), with the shadow of Richard Nixon's presidency informing both works. In the novel, Veidt (Ozymandias), initiates a

purposefully bizarre cataclysmic event—summoning a monstrous (genetically engineered) psychic squid creature that kills millions of New Yorkers in its explosive death throes—which the film replaces with a similar plotline in which Veidt, ostensibly working with Dr. Manhattan to create a new source of energy, uses his insights into Manhattan's powers to cause explosions in major cities across the globe, framed as being attacks by Manhattan. Van Ness (2010, pp. 179–184) discusses the motivations for this change at some length, but here we are more concerned with how this change alters the relationships of each text with science and the products of scientific inquiry.

Early in the film, the shift of emphasis is signaled by Veidt/Ozymandias discussing the world's environmental crisis, which is also flagged as an issue in the novel, where it is positioned as a consequence of the Cold War and the military arms race. The film inverts this logic, portraying the Cold War conflict between East and West as less an ideological battle than a war for resource control, with Veidt emphasizing that his work with Dr. Manhattan would end the conflict by creating free, limitless, clean energy, thereby eliminating reliance on fossil fuels. The novel depicts Manhattan engaging with subatomic physics in an attempt to discover gluinos, which is reframed in the film as collaborative work with Veidt, and his cadre of scientists in Antarctica, to create a power generator derived from Manhattan's unique energy structure—science with more obvious use-value to a layperson than discovering hypothetical elementary particles. Similarly, throughout the film, Veidt is presented as a benevolent celebrity capitalist—his pursuit of clean, free energy brings him into conflict with oil barons and captains of industry, whom he silences with the reminder that he can buy and sell them at his leisure. This benevolence is undermined by the film's conclusion, in which noble aims of science and environmentalism are repurposed into a force of destruction. Science, in the film, is more directly tied to the fate of the globe than the posturing of state-ideologies, and is depicted as offering an apolitical solution which extends beyond their subjective reach.

These changes point to a broader reorientation in the film toward emphasizing the power of science as both a creative and destructive force. Whereas the novel emphasizes the hidden labor of artists and creatives in the creation of the monstrous squid, it is scientists—bedecked in the requisite white laboratory coats—who provide the labor for Veidt's scheme. Working with Manhattan to understand how his abilities may be harnessed for a greater good, their intentions are ultimately betrayed by Veidt, who poisons them all before using their work to kill millions. Their fate, more so than in the novel, reflects that of many scientists who have either been killed by, or come to regret, the fruits of their labors, and thereby offers a valuable illustrative point: that even the most noble pursuit can, and perhaps will, be coopted for purposes outside of what was initially envisioned. Much of the science depicted in *Watchmen* remains implausible in film and novel, yet the metaphor of Manhattan transforms. In the novel, Manhattan is viewed as a potential obstacle to Veidt's scheme, but in the film the global fear of Manhattan is

central, because this accidental product of science is no longer under control, and must be resisted for the sake of human survival.

This alteration points to a broader change for *Watchmen*, namely, the creative context within which it is embedded. *Watchmen*, in 1986, was created in a time where the Cold War was the existential threat facing the globe, but as Tim Rayner (2009, n.p.) argues, "cinema audiences today no longer experience the mortal dread of nuclear annihilation that MAD [mutually assured destruction] left hanging above our heads." The apocalyptic posturing of nation-state superpowers in the novel is replaced with something far more pertinent to the contemporary viewer: the gradual, ongoing destruction of the global environment and biosphere through human (in)action, unconstrained by geo-political affiliations. In 2009, New York is no longer the sole site of destruction, as it is in the novel—major cities across the globe are destroyed, including Hong Kong and Moscow. The world does not unite in the wake of a single attack, but through the realization that nobody is safe if Manhattan can no longer be depended upon for safety. The idea that humanity might have to unite in a global defense against the uncontrollable products of our own scientific and technological development is now more pertinent than the shock of interdimensional invasion, and more accurately depicts the crises of the Capitalocene: as we enter the era of climate change, how do we defend ourselves against the results of our own "progress"? What will the eventual cost be? As Rayner (2009) puts it, the utilitarian argument of Veidt/Ozymandias presents the "friendly face of fascism," by suggesting that sacrificing millions of people may be worth the cost if it saves the remainder. Or perhaps it is more appropriate here to extend the metaphor to the friendly face of *scientism*—the idea that we can imagine the morally untenable as something palatable so long as we cloak it in the "klansman's sheet" of white-coated rationality. As we presently watch celebrity capitalists promote their funding of developments in rockets, electric vehicles, and artificial intelligence, we must acknowledge that beneath "scientific" surfaces there are human drives, emotions, and irrationalities that underpin these labors, including the work of the countless thousands who mine the resources required. There is always a cost, although we may not always be aware, or wish to know, of what price has been paid—until, as in Percy Shelley's (1818) sonnet "Ozymandias," we "look on [our] works and despair."

Watchmen's transformation from comic to film, and the transfigured readings made possible through such adaptations, is only one example of textual simultaneity. The intellectual property notoriously remains under the control of DC Comics despite creator Alan Moore's protestations, and has been expanded by multiple comic books, including *Before Watchmen* (Azzarello et al., 2018), an anthology series featuring backstories for the characters from the original work, *Doomsday Clock* (Johns & Frank, 2019), a sequel and crossover within the DC Comics universe. More recently, Damon Lindelof's (2019) television series *Watchmen* negotiated the comic's world and anxieties through the lens of the turmoils of race in American society.

Each of these texts provides a form of access to *Watchmen*, and all in their own way reimagine the chronologically prior novel's relevance for contemporary audiences. Regardless of fidelity-first criticism, reading *Watchmen* today is a wildly different context from reading the novel in 1986–1987, and the scientific imaginaries it communicates and critiques extend beyond the contexts in which it was created.

As a collaborative endeavor, this chapter demonstrates that *Watchmen*'s interrogations of the goals, products, and outcomes of scientific research—and of how ideologies are intertwined with "progress"—generates dialog and engagement across generations. In the opening section of this essay we affirmed our support for de Freitas and Truman's (2020, pp. 1–2) quest to foreground SF as a way to "open up scientific imaginaries... to think through the many pasts, presents, and futures of science." By opening such imaginaries, *Watchmen* demonstrates that popular media (in this case selected comics/graphic novels and films/television series) can function as generative texts (as distinct from "textbooks") for contemporary science educators.

References

ACARA [Australian Curriculum Assessment and Reporting Authority]. (2020a). *Australian Curriculum Science*. https://www.australiancurriculum.edu.au/f-10-curriculum/science/key-ideas/.

ACARA [Australian Curriculum Assessment and Reporting Authority]. (2020b). *Australian Curriculum, Senior secondary curriculum, Science, Earth and Environmental Science, Structure of Earth and Environmental Science*. https://www.australiancurriculum.edu.au/seniorsecondary/science/earth-and-environmental-science/structure-of-earth-and-environmental-science.

Appelbaum, Peter. (2019). Speculative fiction, curriculum studies, and crisis: An introduction and invitation. *Journal of the American Association for the Advancement of Curriculum Studies*, *13*(2), 1–6. https://doi.org/10.14288/jaaacs.v13i2.192252.

Atkinson, Daniel. (1985, June 8). Evolutionary process from chaos to order. *Los Angeles Times*, Part II, p. 2.

Azzarello, Brian, et al. (2018). *Before Watchmen Omnibus*. DC Comics.

Bernard, Mark, & Carter, James Bucky. (2004). Alan Moore and the graphic novel: Confronting the fourth dimension. *ImageTexT: Interdisciplinary Comics Studies*, *1*(2), n.p. http://www.english.ufl.edu/imagetext/archives/v1_2/carter/.

Bleier, Ruth. (1988). Lab coat: Robe of innocence or klansman's sheet? In Teresa de Lauretis (Ed.), *Feminist studies/Critical studies* (pp. 55–66). Macmillan. https://doi.org/10.1007/978-1-349-18997-7_4.

de Freitas, Elizabeth, & Truman, Sarah E. (2020). New empiricisms in the Anthropocene: Thinking with speculative fiction about science and social inquiry. *Qualitative Inquiry*. https://doi.org/10.1177/1077800420943643.

Deleuze, Gilles, & Guattari, Félix. (1987). *A thousand plateaus: Capitalism and schizophrenia* (Brian Massumi, Trans.). University of Minnesota Press (Original work published 1980).

Demos, T. J. (2016, September 11). Anthropocene, Capitalocene, Gynocene: The many names of resistance. *Frontiers of Solitude*. http://frontiers-of-solitude.org/blog/442.

Doll Jr., William E. (1986). Prigogine: A new sense of order, a new curriculum. *Theory into Practice*, *25*(1), 10–16.

Eastman, Kevin, & Laird, Peter. (1986). *Teenage Mutant Ninja Turtles*. First Comics.

Fishbaugh, Brent. (1998). Moore and Gibbons's *Watchmen*: Exact personifications of science. *Extrapolation*, *39*(3), 189–198.

Gibson, William, & Sterling, Bruce. (1991). *The difference engine*. Bantam.

Gleick, James. (1987). *Chaos: The making of a new science*. Viking.

Gough, Noel. (1991). An accidental astronaut: Learning with science fiction. In George Willis & William H. Schubert (Eds.), *Reflections from the heart of educational inquiry: Understanding curriculum and teaching through the arts* (pp. 312–320). State University of New York Press.

Gough, Noel. (1993a). Environmental education, narrative complexity and postmodern science/fiction. *International Journal of Science Education*, *15*(5), 607–625. https://doi.org/10.1080/0950069930150512.

Gough, Noel. (1993b). *Laboratories in fiction: Science education and popular media*. Deakin University. https://www.researchgate.net/publication/246635016.

Gough, Noel. (2002). A postmortem on dissection. In John Wallace & William Louden (Eds.), *Dilemmas of science teaching: Perspectives on problems of practice* (pp. 118–121). RoutledgeFalmer. https://ecommerce.tandf.co.uk/catalogue/DetailedDisplay.asp?ISBN=0415237629&ResourceCentre=ROUTLEDGEFALMER&RedirectPage=PerformSearch%2Easp&curpage=1.

Haraway, Donna J. (1989). *Primate visions: Gender, race, and nature in the world of modern science*. Routledge.

Hasse, Catherine. (2015). The material co-construction of hard science fiction and physics. *Cultural Studies of Science Education*, *10*(4), 921–940. https://doi.org/10.1007/s11422-013-9547-y.

Hayles, N. Katherine. (1984). *The cosmic web: Scientific field models and literary strategies in the twentieth century*. Cornell University Press.

Hirsch, E. D. (1988). *Cultural literacy: What every American needs to know*. Houghton Mifflin.

Johns, Geoff, & Frank, Gary. (2019). *Doomsday Clock Part 1*. DC Comics.

Lindelof, Damon (Director). (2019). *Watchmen*. HBO.

McCallum, Robyn. (2018). Introduction: "Palimpsestuous intertextuality" and the cultural politics of childhood. *Screen adaptations and the politics of childhood: Transforming children's literature into film* (pp. 1–32). Springer.

McCloud, Scott. (1994). *Understanding comics: The invisible art*. HarperCollins. http://www.scottmccloud.com.

McFarlane, Brian. (1996). *Novel to film: An introduction to the theory of adaptation*. Clarendon Press.

Michel Duchamp. (1912). https://www.philamuseum.org/collections/permanent/51449.html.

Moore, Alan, & Gibbons, Dave. (1987). *Watchmen*. DC Comics.

Morrison, Grant, Truog, Chas, Hazlewood, Doug, & Grummett, Tom. (1991). *Animal Man*. DC Comics.

Percy, Shelley. (1818). https://www.poetryfoundation.org/poems/46565/ozymandias.

Porush, David. (1991). Literature as dissipative structure: Prigogine's theory and post-modernism's roadshow. In N. Katherine Hayles (Ed.), *Chaos and order: Complex dynamics in literature and science* (pp. 54–84). University of Chicago Press.

Prigogine, Ilya, & Stengers, Isabelle. (1984). *Order out of chaos: Man's new dialogue with nature*. Bantam.

Rayner, Tim. (2009, March 8). *Watchmen* in times of change. *Philosophy for Change*. https://philosophyforchange.wordpress.com/2009/03/08/watchmen-and-change/.

Salvador, Dali. (1931). Museum of modern art. https://www.moma.org/collection/works/79018.

Schwab, Joseph J. (1964). Structure of the disciplines: Meanings and significances. In Gervaise W. Ford & Lawrence Pugno (Eds.), *The structure of knowledge and the curriculum* (pp. 1–30). Rand McNally.

Shiner, Lewis. (1988). *Deserted cities of the heart*. Doubleday.

Snyder, Zack (Director). (2009). *Watchmen*. Universal Pictures.

Stableford, Brian. (2003). Science fiction before the genre. In Edward James & Farah Mendlesohn (Eds.), *The Cambridge companion to science fiction* (pp. 15–31). Cambridge University Press. https://www.cambridge.org/core/books/cambridge-companion-to-science-fiction/science-fiction-before-the-genre/6C616545DB0452A28686806850DCBDA9.

Sterling, Bruce. (1985). *Schismatrix*. Ace.

Sterling, Bruce. (1989). *Islands in the Net*. Ace.

Vale, V., & Juno, Andreas (Eds.). (1984). *Re/Search # 8/9: J.G. Ballard*. Re/Search Publications.

Van Ness, Sara J. (2010). *Watchmen as literature: A critical study of the graphic novel*. McFarland.

Weaver, John A. (1999). Synthetically growing a post-human curriculum: Noel Gough's curriculum as a popular cultural text. *Journal of Curriculum Theorizing*, *15*(4), 161–169.

Weaver, John A. (2019). Curriculum SF (speculative fiction) Reflections on the future past of curriculum studies and science fiction. *Journal of the American Association for the Advancement of Curriculum Studies*, *13*(2), 1–12. https://doi.org/10.14288/jaaacs.v13i2.191108.