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Serial / Simultaneous

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1905 is famously Albert Einstein's *annus mirabilis*, the year in which the patent office worker wrote a series of papers that would change forever the way in which physicists understood the universe, especially how time and its navigation would be reimagined in the twentieth century. After centuries of Newtonian physics, time was no longer absolute, nor was it any longer separate from the three dimensions that defined space. Einstein's special theory of relativity highlighted the paradoxical relationship between two seemingly contradictory models of time: *seriality*, as the model that corresponds with how we experience time; and *simultaneity*, as the model of time that emerges from Einstein's insights into relativity (and which would be subsequently reinforced—and complicated—by the quantum mechanics that followed).

It would take years for physicists fully to come to terms with the consequences of Einstein's insights, and longer still for these insights to make their way into popular culture. And more than a century later, our lived *experience* of time remains unable to match the insights of 1905. However, even before Einstein's discoveries, new narrative media were already engaged in experiments that would begin the slow process of bringing these two seemingly irreconcilable models of time into productive dialogue. Comics and film had been born a few decades earlier, themselves the product of a century of experimentation with optics and new insights into the nature of human vision. In 1905, the first nickelodeons opened, featuring as their first "hit" Edwin S. Porter's *The Great Train Robbery* and its pioneering innovations in parallel editing—what Tom Gunning describes as "a dialectical leap in the portrayal of space and time."[1] In the other new narrative medium of the twentieth century, comics, the first experiments with long-form storytelling began that same year, resulting in a new narrative form: the open-ended serial.[2] And this was to be only

the beginning of the temporal experiments of the comics form. A century later we can now recognize that comics would be the form to make available storytelling and reading practices that finally fully embrace the insights into time Einstein first described in 1905.

Serial

The serial version of time we experience every day is often termed "tensed time." Our very grammar is adapted to naturalize it. This is the time of the moving present, that node at which a fixed but always-already lost past and an as-yet unreal future converge. Tensed time—what McTaggart called "A-series" time—imagines events as occupying variable positions "from the far past through the near past to the present, and then from the present to the near future and the far future."[3]

Despite being so deeply felt, this model of time has troubled philosophers and scientists for millennia. Relying on a model of movement—away from a past and toward a future—the question necessarily arises: at what rate does time move? The natural answer—time moves at one second per second—is necessarily unsatisfactory. As the earliest classical philosophers recognized, time as we experience it does not hold up to analysis, giving rise to the very different accounts of time offered by Parmenides on one hand and Heraclitus on the other. While their accounts of time could not have been more different—for Parmenides time is an illusion and only the *now* is real, while for Heraclitus, time is change and only *change* is real—both were premised on a similar revelation: time as we experience it simply does not make logical sense, therefore it must be either an illusion or a window into the divine (that is, the Truth).[4]

More than two millennia of scientific and philosophical inquiry have resulted in remarkable transformations in our understanding and perception of the world, but the conundrum of time confronted by Heraclitus and Parmenides remains. Despite numerous experiments and theories arguing for the incoherence in our "natural" sense of time, we continue to experience time in "tensed" terms, as a *moving* Now ceaselessly carried toward a Future and away from a Past, or, alternately, as a *fixed* Now toward which a moving Future relentlessly rolls while the Past recedes behind us. Time moves at one second per second, because, science and philosophy notwithstanding, this tautology continues to describe our *ex-*

perience of time (even if our experience is *not* in fact scientifically "true"), allowing us to coordinate an increasingly complex, networked society.

It is useful here to recall, as historians of time have demonstrated, that while time has troubled philosophy in changing ways, our *experience* of time has not been static. For example, Jacques Le Goff influentially described the shift in the late Middle Ages from "Church time" to "merchant's time."[5] Later, Niklas Luhmann argued that our modern conception of the future emerges only with the rise of bourgeois society in the seventeenth century and the newly found model of historical progress.[6] And with the *series rerum* as a model for temporal progress, we see the rise of racial pseudo-science, the modern nation state, and global capitalism. Print facilitated the imagination of a new experience of serial time, culminating in the rise of the novel and the emergence of its industrial—and serialized—forms (Dickens, the story paper, the dime novel) in the nineteenth century.[7]

Thus since the "discovery" of the future, storytelling has devoted itself to reinforcing a causal-temporal model of serial progress. As will be discussed below, film, one of the two new narrative media of the twentieth century, would ultimately prove a most powerful ally of serial time. Although born of experiments that might have led the medium in radically different directions, film in the early years of the twentieth century began exploring its ability to re-create time as we experience it—that is, as a series of events witnessed from the perspective of a moving now.

Simultaneous

If seriality describes our experience of time, the model of time premised on simultaneity is one that is seemingly beyond our experiential capacity. This model of time had circulated in philosophy and at the margins of theoretical physics long before Einstein, but it was his *annus mirabilis* that would provide the foundation for the first time for experiments that would prove this model's accuracy.

Einstein's thought experiment famously imagines two lightning strikes and two observers, one in a moving train and one on a platform.[8] For the observer on the platform, standing directly between the two strikes as they hit, the strikes are perceived as simultaneous, as the light moves toward the observer at the speed of light. For the observer in the train, moving forward

in space toward the strike on the front of the car, the strikes are perceived as *serial*—lightning first striking the front of the train followed by the rear of the train. Science requires that we know which of the observers is right; the scientific answer, Einstein assures us, is that they both are true.

Einstein's special theory of relativity was conceived while he was working in a Swiss patent office, looking at countless new inventions for ever-more accurate clocks and related technologies designed to coordinate time across increasingly complex networks of trains, cities, and commerce.[9] What emerged was a new conception of time. Contrary to Newton's classical mechanics, and in violation of our faith in time as a universal measure, Einstein described how a body's movement through space impacts its movement through time. Ironically, it would be the atomic clock—the most accurate timepiece to date—that proved his theory. In 1971, two of the devices were flown around the world; when finally compared to devices safely on the ground, the clocks recorded different times.[10] No longer was time a universal constant: it was relative.

Volumes have been written about the philosophical and scientific work that laid the groundwork for Einstein's breakthrough,[11] but less recognized is the impact of an earlier but related shift growing out of optics, another field where Newton had long had the last word. Jonathan Crary has described the phenomenological adjustment that resulted from the displacement of the long-held "camera obscura" model of vision with one that acknowledged the idiosyncrasies of individual eyes and perspective.[12] It is from these insights that film and sequential comics were born at the end of the nineteenth century; moreover, this changing vision of vision has proved foundational for new representations of time in the twentieth and twenty-first centuries. As Arthur J. Miller has argued, Picasso's cubism and Einstein's relativity both were generated from a newfound need "to confront the concept of simultaneity."[13] But such experiments were not the province of science and high art alone, as related investigations in the popular arts would come to shape the arts of the present still more profoundly over the course of the next century.

Here we might begin, for example, with Muybridge's famous 1878 experiment with a series of sequential photographs capturing the running of a horse, designed to settle a bet, or so the legend has it, that all four of the beast's legs do indeed leave the ground simultaneously while in full stride:

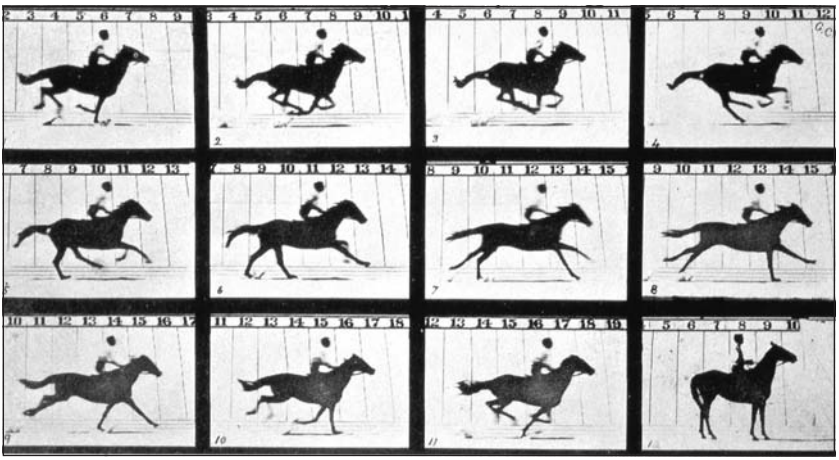

Figure 9.1. Muybridge's sequential photographs of a horse in stride

As with Einstein's theory a generation later, this work served not to fulfill the Enlightenment promise that objective observation of reality was possible, but instead demonstrated the gap between our perception and the world itself. The demonstration, moreover, turned on a serial representation in search of a potentially simultaneous act in nature.

Narrative film as we know it—and, at least as we experience it within the traditional cinematic apparatus, with its powerful reification of tensed time—would famously emerge from this moment over the course of a generation, but in fact Muybridge's experiments initially made a more persuasive case for a very different model, as the sculptor Auguste Rodin recognized in denouncing Muybridge for attempting to make time "stand still."[14] Indeed, it is perhaps ironic that Muybridge's legacy would be the development of a cinema that prosthetically reinforced conventional time, when his experiments resulted in a representation of time that in many ways supported those—from Zeno to Einstein—who argued that our experience of time was not in fact the thing itself.

However, a different and new narrative form actually followed through on the latter possibilities. In comics, the individual moments of time are *not* projected at twenty-four frames per second to create the illusion of movement, but instead, as Scott Bukatman puts it, "time in comics is represented as territory in space."[15] From the start, comics laid

bare the fault lines in the way we experience time—in our faith in a meaningful distinction between past, present, and future. Much as Hoffmann and Poe described the unconscious well before Freud mapped it, comics had been exploring this version of time before Einstein had a theory (or Picasso an aesthetic) to describe it.

Within its dominant traditions, we experience film not as narrative—the telling of a past event—but as an event unfolding in the present. The traditional cinematic apparatus is designed to reinforce the illusion of being strapped to the theater seat in the dark, moving inexorably forward in time. Film and comics might share the genetic code of sequential images epitomized by Muybridge's horse, but film after 1905 worked to make that code invisible to the viewer. Comics was the first narrative medium dedicated to imaginatively exploring a model of time that allowed for the past, present, and future to exist simultaneously. The reasons for this were primarily formal. For example, the space between panels is known in comics as the "gutter"; in film it is not known at all, because it is not visible once the film is projected. Thus in classical Hollywood cinema the frame effectively disappears from the viewer's focus, while it remains visible in comics, often penetrated or fractured in ways that serve only to call further attention to its material boundaries. And then of course there is the fact that sequential comics largely involve multiple panels laid out on a single page, or on a double-spread of pages in a longer narrative, such that we speak of *mise-en-page* as opposed to film's *mise-en-scène*.

Perhaps no distinction between film and comics better underscores the fundamental differences of their approach to storytelling than does the question of time. The time between film frames is fixed—conventionally twenty-four frames per second. But what of the time between panels on the sequential comics page? In the gutter between each panel we must measure time relative to the information presented in the two juxtaposed slices of time (each panel itself, as Scott McCloud has demonstrated, often requiring further determinations as to how narrative time passes within each panel).[16]

To read comics is to engage, at least on the level of the page, with tenseless time. After all, to read comics is always to see past, present, and future in a glance—whether via the initial navigation of the page layout as a whole or via the more focused reading of a single panel, which always brings with it visual information from the panels preceding and

succeeding the panel we are reading—the "present" that here never can entirely command our complete attention. We always inhabit multiple temporalities when reading comics—not just imaginatively, as when a film or novel encourages us to imagine what will happen or to recall an earlier event. We actually see past, present, and future laid out before us in space-time with every page.

It is no coincidence that special relativity—and indeed all attempts to explain time as *simultaneous*—so often requires a turn to the comics form for its representation. Here, for example is how Einstein's thought experiment is conventionally represented:

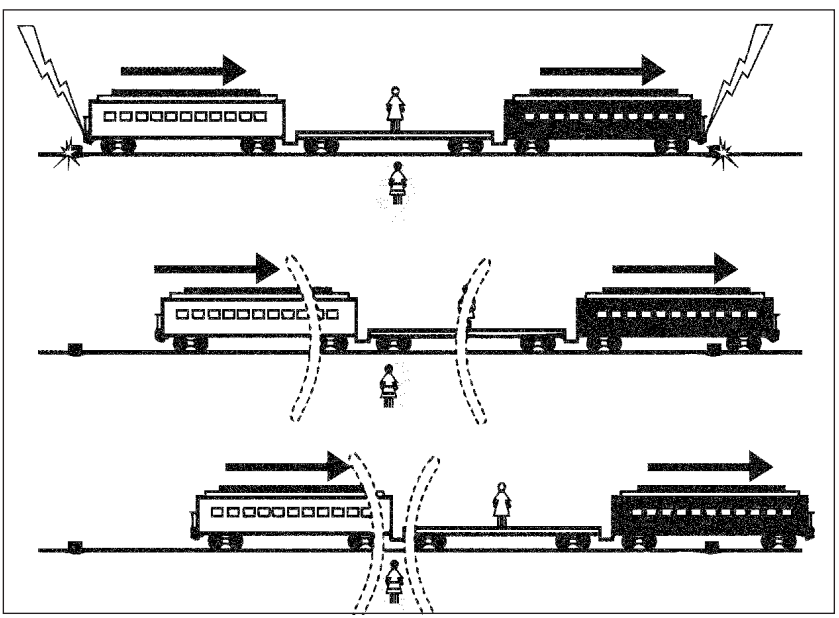

Figure 9.2. Graphic representation of Einstein's special theory of relativity

In three sequential images we can see how the observer on the train experiences the lightning flashes (serially) and how the observer on the platform experiences them (simultaneously). In film, the same information requires a minimum of two retellings of the event, one in which we are presented the flashes from the point of view of the observer on the platform and another in which we see from the perspective of the observer on the train. In comics, past, present, and

future can coexist and two different points of view can be mapped simultaneously.

In tenseless time, past, present, and future are simultaneously real, and time is mappable, like space. That we cannot visit the past or the future should in this model be no more troubling than the fact that we cannot at this moment visit Mars. Of course, a century after special relativity, our inability to travel to the past or future remains deeply troubling to our belief in this model of time in a way that the inaccessibility of Mars never is to our sense of space. But however glacial our progress toward an ability to conceive of time as simultaneous might be, there is evidence that we have been moving slowly in that direction over the course of the last century, guided first and foremost by the seemingly marginal cultural form of comics.

However, just as Einstein's thought experiment ultimately illustrated that the observers' experiences of the lightning strikes as serial and simultaneous were *both* true, so is it important to recognize that special relativity does not make obsolete serial, "conventional" time. The three panels above *do* allow the reader to see the past, present, and future of the event at once, and as we cannot in our conventional time, we are here able to move backward and forward in time as we make sense of the information being presented. However, serial time remains necessary to meaning: the story being told ultimately would not make sense were the panels to be reordered. Although aligned with scientific leaps forward in physics, advancing to an understanding of time as simultaneous does not superannuate serial time. Comics is the first medium, therefore, to attempt to represent time as both simultaneous *and* serial. If film reinforces our tensed model of serial time, comics from early on explored how both models of time can be deployed at once.

Serial-Simultaneous

As David Wittenberg suggests, time-travel narratives emerge almost simultaneously with Einstein's theories and intensify in complexity over the course of the twentieth century. Wittenberg compellingly reads time-travel stories as laboratory experiments with narrative time itself, as a way of thinking about how *all* narrative involves a kind of time travel.[17] However, as the century progresses, the creation of and audience for

increasingly complex (and time-consuming) imaginative exercises in time travel outstrips such explanations. Time travel may indeed be fundamental to all narrative, but the vast majority of narratives—like the vast majority of commercial narrative film—have not asked us to move beyond our conventional temporal models. Increasingly, and especially beginning in the second half of the twentieth century, we find narratives that take decades to produce *and* consume and that tell stories that cross millennia and numerous parallel timelines.

Here I am thinking, for example, of the extended and profoundly intricate experiments with the multiverse that begin to take concrete shape in the pages of superhero comics in the early 1960s—eventually culminating in a storyverse that covers numerous "earths" at different times and with different outcomes imagined from identical events, across which characters travel seemingly effortlessly in narratives that cross or overlap in byzantine ways. Or, beginning at almost the same time, we have the elaborate time games of *Doctor Who*, a story told over the course of a half-century in a range of media, about a time traveler who brings his companions and audiences from the dawn of time to the heat death of the universe and everywhere in between. Both of these examples, and the intensely committed fan cultures that have grown up around them, underscore the cognitive and collaborative pleasures in working through not only narrative threads and plotlines that often require intense untangling, but also what Doctor Who refers to as the "wibbly-wobbly, timey-wimey stuff" of nonlinear, tenseless time.[18]

The twentieth-century exploration of "timey-wimey stuff" started with comics, and a significant reason for the growing visibility of comics in recent years after a century on the far side of cultural respectability is the growing desire for and sense of familiarity with the kind of temporal navigations the form engages. As Bukatman puts it in *The Poetics of Slumberland*, "Modern culture from the late nineteenth century forward oscillated between the sense of time as unbound, mutable, and multiple, and time as rigid, deterministic, and most insistently bound to linear coherence," and it was comics that first followed the radical possibilities of modeling time as irrevocably bound to space.[19] However, comics was not dedicated exclusively to a mappable, simultaneous time model—what Bukatman describes as the new "mutable and multiple" model of time and what Einstein calls "space-time." What comics explored were not ar-

guments for choosing one model over the other but strategies for navigating storyworlds using both in concert. From the early experiments with open-ended seriality—beginning with the weekly serial *Little Nemo* in 1905 and taking off fully with the daily serial comic strip a couple of years later—the comic strip began some of its most radical experiments in negotiating time complexly across multiple frames. The daily serial strip from the start established a syncopated temporal structure: on the one hand, the daily rhythm of the newspaper in which the day's panels would appear; and on the other hand, the stagger-step rhythm of the panels themselves, which each day needed to establish connections to the previous day's events (past), move the story forward (present), and bait the narrative hook for the next day's events (future)—all times simultaneously (if not equally) present and accessible on the page.

Of course, the newspaper comic strip was just one of several forms comics has explored over the course of a century, each with its own temporal affordances. The double-time of the daily comic strip itself would give rise to the comic book (birthplace of the multiverse), in no small measure because of the scrapbooking habits the open-ended serial strips inspired (and often explicitly encouraged), as readers sought out more complex and long-ranging temporal maps than the daily installment provided. The comic book itself inspired new kinds of reading practices. As Fredric Wertham, the form's most infamous early critic, declared in *Seduction of the Innocent*, comic book readers would spend "an inordinate amount of time" with their comic books, engaging in a practice of compulsive rereading that Wertham found at least as disturbing as the often sensational subject matter of the comic books themselves.[20]

With the rise in the last generation of the so-called "graphic novel," it might at first appear that comics has moved to emulate the narrative conventions and temporal disciplines of the traditional novel. But comics' obsession with modeling and navigating seemingly incommensurate models of time is as pronounced in today's graphic narrative as it was a century ago. A quick survey of those texts that have been canonized in the syllabi of the emerging field of comics studies illustrates ongoing and even intensifying interests in such navigations of time as *both* tensed and tenseless, serial and simultaneous: Alan Moore and Dave Gibbons's *Watchmen*, Art Spiegelman's *Maus*, Chris Ware's *Jimmy Corrigan*, Alison Bechdel's *Fun Home*—all of these require of the reader (as

they surely did of their creators) the ability to read through both tensed and tenseless time in order to navigate and participate in the necessarily collaborative work of meaning making.[21]

Richard McGuire's six-page story "Here" (1989) perhaps best represents the coalescing of the experiments with time in the comic strips and comic books of the previous generations and the new temporal experiments of the comics of the present.[22] In this story, over the course of thirty-six panels, one corner of a room is represented across millennia of time, with multiple moments of time frequently layering one on top of another within the crowded panel:

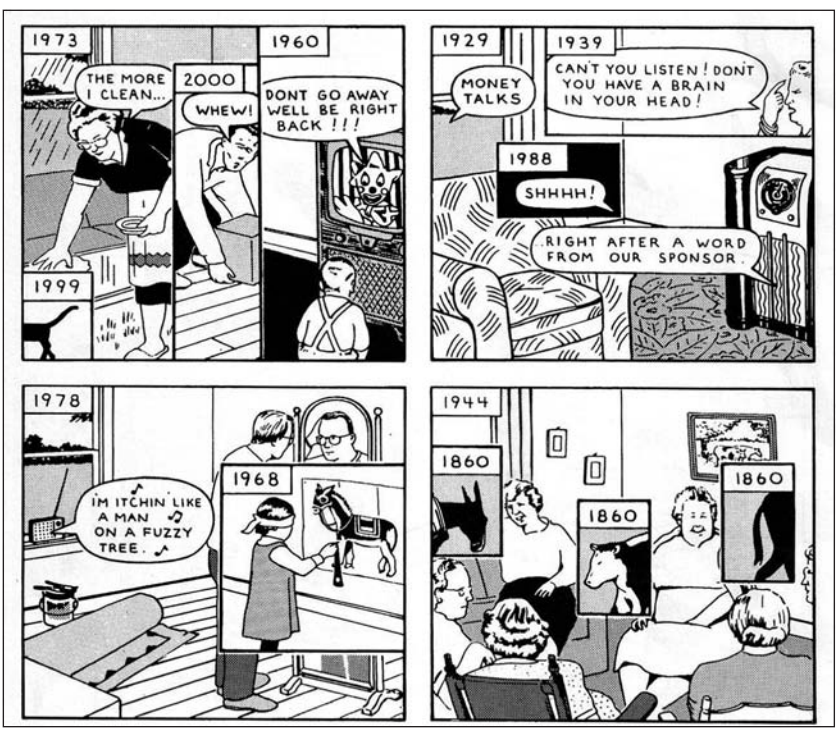

Figure 9.3. Illustration from Richard McGuire, "Here," *RAW* 2, no. 1 (1989): 70

The story represents time as *both* serial and simultaneous, as the panels are laid out in a conventionally arranged six-panel grid, beginning with an undated panel in the empty corner of the room and ending with a panel that represents "here" simultaneously at 500,957,406,073

BC—when the earth is a swirling mass of molten metals and gasses—and 1945 AD—when a sailor home from the war sits reading a paper in his living room.

Of course, it is not only alternative comics that have been doing this work. So-called mainstream superhero comics have continued their own explorations, as repeated attempts to collapse the multiverse back to a singular narrative timeline give way to a seemingly inevitable return of the multiverse, one that has today survived repeated crises on infinite earths. In addition to superheroes, the long-running zombie comic book *The Walking Dead*, created by Robert Kirkman, has spawned a parallel storyworld in the AMC TV series where similar characters make different decisions and experience different outcomes. The effect is to allow audiences consuming the transmedial story to engage in complex acts of travel across parallel worlds not so very different from the DC superheroes crossing from Earth-1 to Earth-2 and back again.

In the digital age, the temporal powers and challenges comics first opened up a century ago are now a regular feature of popular storytelling, requiring the user to embrace competing models of time simultaneously, often across different media. For example, narrative video games almost always require replayings, as the player navigates the storyworld in different ways until achieving the desired outcome—and with it, the movement to the next level or stage of the game. Today we might overhear conversations that would be unimaginable a generation ago: "I died thirty times yesterday before I finally beat the boss" or "I needed to go back to the previous day's save in order to finally progress to the next level."

The stories we tell about video games involve the mapping of seemingly contradictory modes of temporal narration. There are "speedrun" videos, for example, designed to show off the fastest way through a video game; "let's play" (LP) videos designed to share one user's subjective experience of a videogame's gameplay (often with audio commentary from the player); videos that warn of glitches that trap users in an "eternal present" from which the only way to "progress" into the "future" is to return to the "past" (in the form of a save from an earlier point in the gameplay). And there is "glitch art," which treats these ruptures in narrative time as an end in itself. More recently we find a growing library of video games—from *Prince of Persia: Sands of Time* (2003) to *To the Moon* (2011)—in which navigating serial and simultaneous time is in-

tegral not only to the gameplay and the narratives the play inspires but also to the narrative of the game itself.[23]

Similarly, we also see in the twenty-first century the rise of so-called puzzle films, movies that invite—even require—the viewer to watch in tensed time and then again, remote in hand, mining pockets of time available simultaneously in the digital age for clues.[24] With *Memento* (2000) and *Mulholland Drive* (2001), we see the emergence of a cycle of films that not only explicitly invite users to deploy the active reading affordances of the new DVD technology, but that explicitly make nonlinear time sampling central to the story being told.[25] Increasingly as the cycle progresses, time theory moves to the center of the films themselves, as in *The Butterfly Effect* (2004), *Primer* (2004), *Los Cronocrímenes* (*Timecrimes*) (2007), and *Looper* (2012).[26] In all of these examples, the audience is essentially left with a film that remains incomplete or "unsolved" if experienced only serially via the conventional moving present that the cinematic apparatus had reinforced for a century. Instead, like comics, these films now require rereading using an alternative approach to time in which past, present, and future are simultaneously accessible (and remixable).

Perhaps nowhere today do we see the growing market for opportunities to straddle these two models of time than in long-form serial TV. In the digital age, viewing practices have changed dramatically, from being bound to the synchronized time of national syndication schedules to twenty-first-century practices that include a wide range of consumption rituals. Even while watching "live TV," many DVRs offer the opportunity to "rewind," to recover a "past" that had been historically lost in live broadcast television. And most visible in our current moment we see the shift from traditionally chronometric consumption to "binging"—the practice of consuming serial TV as quickly as possible.

Finally, we must look to the language of contemporary fandom, and particularly the practice of fanfiction. For example, we can examine alternate timeline fanfiction that eschews "canonical" storytime in favor of "what-if elseworlds." If certain events or pairings happen with sufficient frequency, they can and often will enter the "fanon," an alternate timeline agreed upon by fans that exists in parallel with the officially authorized "canon." Recognized genres of fanfiction include "backstory" (devoted to filling in past history not developed in the authorized storyworld),

"vignette" (focused on a particular slice in time), and most famously "ships" (in which characters not in sexual or romantic relationships in the authorized storyworld are paired up). The lexicon used to categorize these engagements with "canonical" popular culture texts demonstrates that fans are increasingly able to navigate and create within multiple timelines, but it also reveals that opportunities for such creative engagements are a key source of what organizes these fan communities. All describe the desire to have (and preserve) *both* serial "continuity" and the demand for simultaneous access to past, present, and future as navigable spaces always open to reimagining. At the heart of the practices and communities forged initially out of comics and increasingly found in a diverse range of media in the twenty-first century is the power of storytellers and audiences to travel from present to future to past as easily as traveling from New York to Baltimore.

Key to these fantasies are the pleasures and rewards of imaginatively inhabiting a tenseless time without surrendering the conventional models of time upon which our social and psychological fabrics depend. Instead of serving as the *prosthesis* that film sought to be in the wake of discoveries of the fallibilities of human vision and our experience of time, comics and the storytelling practices to which it has given birth in the arts of the present have worked to make accessible and available Einstein's impossible insights into time as *supplement*. Today we increasingly seek out narrative that offers us both ways at once—tensed, serial time *and* tenseless, simultaneous time. We spent the last century preparing ourselves for this moment, in the highly complex laboratories of quantum physics and the relatively marginalized laboratories of narrative comics. But the arts of the present suggest that we are eagerly seeking out opportunities to explore tenseless time serially, and serial time simultaneously. And if the past is any promise of the future, the arts of the present will lead us to discoveries and insights we haven't even begun to imagine yet—even if, as we surely will, we find out we have been drawing, playing, and remixing them for years without knowing it.

NOTES

1 Tom Gunning, *D. W. Griffith and the Origins of American Narrative Film: The Early Years at Biograph* (Urbana-Champaign: University of Illinois Press, 1994), 77.

2 For a discussion of the emergence of open-ended seriality, see Jared Gardner, *Projections: Comics and the History of 21st-Century Storytelling* (Palo Alto, CA: Stanford University Press, 2012), chapter 2.

3 J. E. McTaggart, "The Unreality of Time," *Mind* 17, no. 68 (October 1908), 458.

4 See Ronald C. Hoy, "Heraclitus and Parmenides," in *A Companion to the Philosophy of Time*, ed. Heather Dyke and Adrian Bardon (West Sussex: Wiley-Blackwell, 2013), 9–29.

5 See Jacques Le Goff, "Merchant's Time and Church's Time in the Middle Ages," in *Time, Work & Culture in the Middle Ages* (Chicago: University of Chicago Press, 1980), 29–42.

6 Niklas Luhmann, "The Future Cannot Begin: Temporal Structures in Modern Society," *Social Research* 43 (Spring 1976): 130–52.

7 While Benedict Anderson has popularized the association of the rise of the realist novel with the rise of the modern nation through their shared investment in the simultaneity of "meanwhile time," of course it is *seriality* that was the necessary precondition for both nation and realist novel. From the *American Magazine* in 1741 through the Federalist Papers of 1787, it was in periodical, *serial* print that the modern nation came first to imagine and define itself. And of course the first Anglophone realist novels were originally conceived and consumed as serial texts in serial forms.

8 From early on, this thought experiment has been rendered in sequential images, showing the natural affinities between comics and theoretical physics, especially in relationship to nonlinear representations of time.

9 See Walter Isaacson, *Einstein: His Life and Universe* (New York: Simon & Schuster, 2007). Bern was unparalleled at the turn of the century for its obsessions with time and its synchronization, possessing arguably the most sophisticated urban time networks of the age. As Isaacson points out, "Einstein's chief duty at the patent office . . . was evaluating electromechanical devices. This included a flood of applications for ways to synchronize clocks by using electric signals" (126).

10 See Paul Davies, *About Time: Einstein's Unfinished Revolution* (New York: Simon & Schuster, 1995), 57.

11 Especially relevant for this volume, see Peter Galison, *Einstein's Clocks and Poincaré's Maps: Empires of Time* (New York: W. W. Norton, 2003).

12 See Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the 19th Century* (Cambridge, MA: MIT Press, 1992).

13 Arthur I. Miller, *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc* (New York: Basic Books, 2001), 239.

14 Rebecca Solnit, *River of Shadows: Eadweard Muybridge and the Technological Wild West* (New York: Penguin, 2004), 196.

15 Scott Bukatman, *The Poetics of Slumberland: Animated Spirits and the Animating Spirit* (Berkeley: University of California Press, 2012), 31.

16 See chapter 4, "Time Frames," in Scott McCloud, *Understanding Comics: The Invisible Art* (New York: Harper Perennial, 1994).

17 David Wittenberg, *Time Travel: The Popular Philosophy of Narrative* (New York: Fordham University Press, 2013).

18 The quote is from the 2007 episode "Blink" in which the Doctor attempts to explain how he sees time: "People assume that time is a strict progression of cause to effect, but *actually* from a nonlinear, nonsubjective viewpoint—it's more like a big ball of wibbly-wobbly, timey-wimey . . . stuff."

19 Bukatman, *The Poetics of Slumberland*, 31.

20 Fredric Wertham, *Seduction of the Innocent* (New York: Rhinehart & Co., 1954), 11.

21 Alan Moore and Dave Gibbons, *Watchmen* (New York: DC Comics, 1987); Art Spiegelman, *Maus* (New York: Pantheon, 1991); Chris Ware, *Jimmy Corrigan, the Smartest Kid on Earth* (New York, Pantheon, 2000); Alison Bechdel, *Fun Home: A Family Tragicomic* (New York: Houghton Mifflin, 2006).

22 Richard McGuire, "Here," *RAW* 2, no. 1 (1989): 69–74. In 2015, McGuire published with Pantheon a full-color, book-length reimagining of *Here*.

23 Jordan Mechner, et al., *Prince of Persia: The Sands of Time* (Montreal: Ubisoft, 2003); Kan Gao, et al., *To the Moon* (Toronto: Freebird Games, 2011).

24 See Warren Buckland, ed., *Puzzle Films: Complex Storytelling in Contemporary Cinema* (West Sussex: Wiley-Blackwell, 2009), and Graeme Harper, "DVD and the New Cinema of Complexity," in *New Punk Cinema*, ed. Nicholas Rombes (Edinburgh: Edinburgh University Press, 2005), 89–101.

25 *Memento*, directed by Christopher Nolan (Los Angeles, CA: Newmarket Films, 2000); *Mulholland Drive*, directed by David Lynch (Universal City, CA: Universal, 2001).

26 *The Butterfly Effect*, directed by Eric Bress and J. Mackye Gruber (Los Angeles, CA: New Line, 2004), *Primer*, directed by Shane Carruth (New York: ThinkFilm, 2004); *Los Cronocrímenes,* directed by Nacho Vigalondo (Bilbao, Spain: Karbo Vantas Entertainment, 2007); and *Looper*, directed by Rian Johnson (Culver City, CA: TriStar, 2012).