

After publishing his results in a 1936 paper, “On Computable Numbers,” Turing decamped for Princeton. **ALAN TURING’S SYSTEMS OF LOGIC: THE PRINCETON THESIS** (ed. Andrew W. Appel, Princeton, \$24.95, press.princeton.edu) contains, after its sheaf of explanatory material, a facsimile of the document that earned him his doctorate. “Systems of Logic Based on Ordinals” addresses “incompleteness,” a suggestive concept in Turing’s sad life but one that, in a Gödelian context, deals with sequencing propositions that can be “intuitively,” as opposed to only logically, derived. Turing hazarded an audacious hypothesis: Although intuition itself might never be computable, the appearance of intuition was. With this, Turing was able to imagine a humanoid computer, possessed of an “artificial intelligence.” In his formulation—eventually codified as the Turing Test—this computer would become human if and only if another human recognized “him” as such. (It would seem that, in Turing’s milieu, gay men couldn’t hope for a similar dignity.)

A last book, a last poignancy. **ALAN M. TURING: CENTENARY EDITION** (Cambridge, \$29.99, cambridge.org), by Sara Turing, could only have been written by one type of human—a mother who’d outlived her son. First published in 1959 and since fallen out of print, this memoir of a genius who was also a champion marathon runner, cyclist, and rationalist eccentric (wearing a gas mask to protect against pollen) is now reissued with an essay by Turing’s elder brother, John. Until Turing’s arrest John had never suspected his brother’s homosexuality; Sara seemed, or attempted to seem, never to believe it, just as she never believed that his death was a suicide.

Her recollection concludes:

Many friends, either by reason of his temperament and recent good spirits, or because of his “unlimited flow of ideas and great enthusiasm for putting them into practice,” have been led to believe that his death was caused by some unaccountable misadventure. Besides, his inadvertence alone had always involved the risk of an accident.

“Inadvertence”: she is referring to Turing’s fussing with cyanide. Yes? No? Or undecidable? ■

ALL OVER THE MAP

A revolution in cartography

By Joshua Jelly-Schapiro

Discussed in this essay:

Maphead: Charting the Wide, Weird World of Geography Wonks, by Ken Jennings. Scribner. 304 pages. \$15 (paper). simonandschuster.com.

Infinite City: A San Francisco Atlas, by Rebecca Solnit. University of California Press. 167 pages. \$27.95 (paper). ucpress.edu.

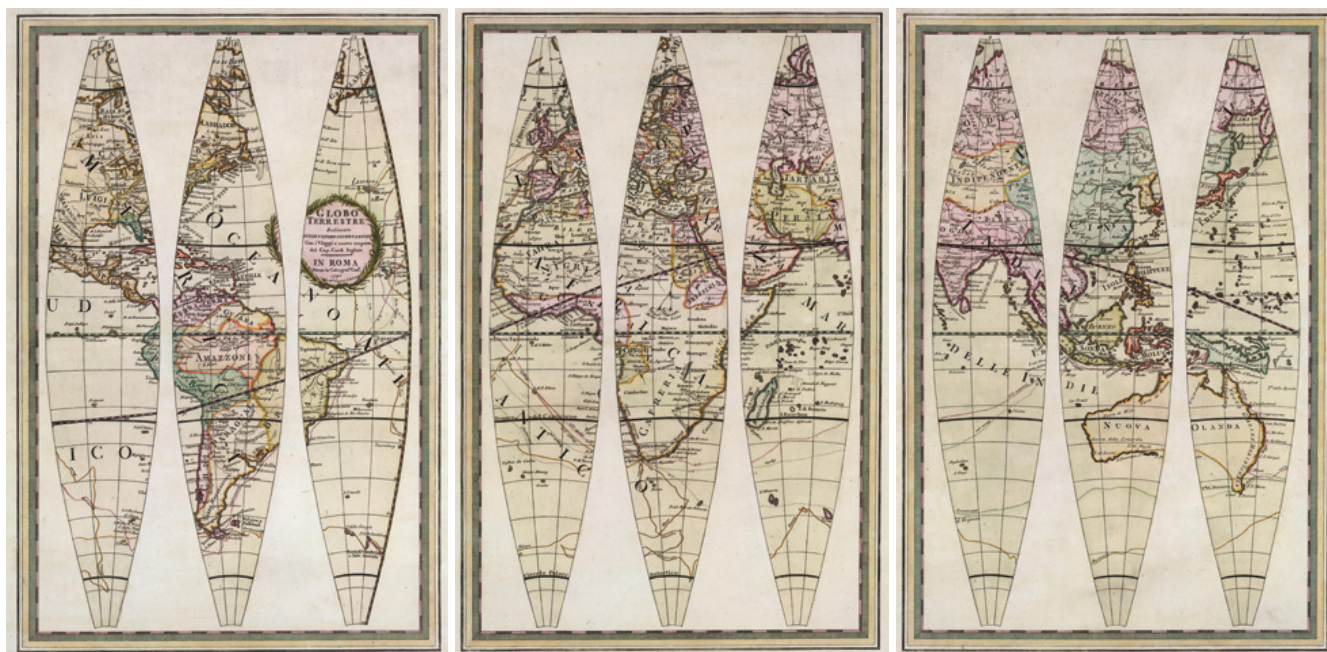


On a warm afternoon last winter in San Francisco, the kind of day when the weather is so perfect that it seems like there is no weather at all and the pink-haired Burners and tattooed programmers bring their MacBooks outdoors, I tapped an address into my iPhone and let it guide me to a quiet street near Golden Gate Park. I was there to visit David Rumsey, a retired real estate developer who, after earning a fortune reshaping San Francisco’s skyline in the 1970s and ’80s, began collecting antique maps. “Me and the UPS guy got real friendly,” Rumsey said, showing me down the oaken stairs to his library, which holds some

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150,000 pieces of cartographia, making it one of the finest private collections in the world.

Inside, the library was a shrine to ordered knowledge. Arrayed on a wide wooden table beneath a wall-size 1733 “Map of the British Empire in America” were narrow charts of the Mississippi unspooling from Torah-like scrolls; a yard-long leather-bound atlas from Spanish Mexico spread open to a chart of the nation’s capital adorned with intricate drawings of city scenes; antique globes stacked like snowballs around a yellowed map, circa 1883, of California’s Yosemite Valley stamped with the U.S. Army Corps of Engineers’ ornate seal. Rumsey showed me his newest prize, an 1837 atlas of the United States made for the blind—the rivers and lakes were rendered as bumps—and then he beckoned me



toward his most surprising cartographical treasure: a computer nestled in the sanctum's back corner.

Rumsey is perhaps most notable among collectors for having joined his love of the antiquarian with an enthusiasm for technological change. Since 1996, he has turned some 33,000 of his maps into high-resolution scans available on his website. Users can overlay the maps onto current satellite imagery, comparing older mapmakers' skills and biases against the best projections of modern science. His site has become a crucial resource for scholars and map enthusiasts at a time when paper maps are rapidly disappearing. Computers are now our primary tools for navigation—altering, with the help of the ever faster microprocessors in smartphones and tablets, how we imagine our environs. That change, Rumsey told me, has led to a surge of interest in cartography: the prices and market for printed maps have doubled several times over in recent years, as has the number of books and exhibitions tied to them. And Rumsey—who in 2009 agreed to donate his maps to Stanford University, and has partnered with Google Earth to make many of them available to users of the program—has emerged as a signal figure in the cartographic revolution centered, in many ways, in the Bay Area.

Rumsey doesn't feature in Ken Jennings's *Maphead*, apart from a one-line mention of "the *real* elite West

Coast collectors," but he might as well have. Jennings is the single longest reigning champion of *Jeopardy!*: he lorded over the show for six months in 2004. In his best-selling first book, *Brainiac*, he explored how training your brain to win at trivia seventy-four games in a row has much to do with training your associative memory to retain new facts and retrieve them, by analogy or topic, from wherever you've installed them in your memory palace. Little wonder, then, to read in his journey through "the wide, weird world of geography wonks" about how, as a boy, he liked to memorize the place-names and data in the atlas he slept with, and entertained himself by hunting down territories with similar shapes (Tanzania and Wisconsin, for example). He developed such an attachment to these mapping "rhymes" that after a while he couldn't see the outline of British Columbia and not think of it as "a more robust, muscular version of California."

"When I was a little chap I had a passion for maps," Joseph Conrad writes in *Heart of Darkness*.

At that time there were many blank spaces on the earth, and when I saw one that looked particularly inviting on a map (but they all look that) I would put my finger on it and say, When I grow up I will go there.

Jennings uses Conrad's quote to suggest one way in which maps, feeding wanderlust and curiosity about the

world, excite our minds. But his book also makes a larger claim about the grip they have on our cognition. At his grandest, Jennings seems to be arguing that maps, by improving our capacity for spatial reasoning and helping us organize information, make us smarter. It only follows that the disappearance of traditional maps in the last decade may be making us dumber.

Jennings calls the present time "a geographic renaissance," but his spirited layman's history of cartography also echoes a principle sacrosanct to academic geographers, who use maps to study the societies they depict: Even as we progress toward objective accuracy, our maps still express the subjective aims of their makers.

In the late sixteenth century, the Flemish cosmographer Abraham Ortelius compiled what is generally regarded as the first modern atlas, a "theater of the world" that drew on travelers' charts and tales from that age of exploration. Ortelius's friend Gerardus Mercator devised the Mercator projection, a method for rendering the spherical earth on a flat surface still in common use today (though it distorts the polar areas, depicting little Greenland as roughly equal in size to colossal Africa).

Other highlights in the history of cartographic innovation include Giovanni Cassini's perfection, in the 1670s, of a trigonometric surveying system that he used to chart France; the advent, with hot-air balloons, of

Gores forming part of a globe showing Captain Cook's three voyages. Published in Giovanni Maria Cassini's *Globo terrestre delineato sulle ultime osservazioni con i viaggi e nuove scoperte del Cap. Cook, inglese*, of 1792. Courtesy David Rumsey Map Collection



aerial photogrammetry (a technology used during the Civil War, when a young West Point grad named George Custer went up in a silk inflatable to map Confederate lines); and Rand McNally's epoch-making invention, after the spread of the horseless carriage, of a new kind of road map. The company, confronted with the challenge of guiding motorists around an American road network that lacked consistent signage, began by publishing "Photo-Auto Guides"—compendia of driver's-perspective photos with arrows showing the way. But then one of its draftsmen seized on a plan: label the nation's highways with route numbers painted on telephone poles, and print millions of maps propagating the system.

The government—and the oil companies—soon followed suit. From the dawn of the automobile age to the zenith of the space age, when John Glenn gazed out his Mercury capsule's window and radioed home that he could see Florida

"laid out like a map," the road map dominated cartography. Between 1913 and 1986, 8 billion of them were printed for handing out at service stations; Jennings calls it "the biggest promotional giveaway of the twentieth century." Then, in the 1970s, came geographic information system software. GIS lets users feed any kind of data—whether tied to the behavior of criminals or to the frequency of moose sightings—into programs that render it in cartographic form. It has made electronic maps a fixture in corporate boardrooms and home offices, reshaping the decision-making of everyone from telemarketers to cops.

In cartography's recent history, however, no technology has been more transformative than the Global Positioning System. GPS, which uses satellites to triangulate a precise location for receivers on the ground, was created at the height of the Cold War arms race, when the Pentagon began spending billions of dollars in

the search for new defense technologies. The Defense Department launched its first navigational satellite into medium earth orbit in 1978; fifteen years later, with a fleet of twenty-four active satellites, the system became fully functional for military users. Any G.I. in Afghanistan or midshipman in the North Atlantic, if equipped with a GPS receiver, could know precisely where he was on the earth's surface.

The military's first extensive combat use of the system came during the Gulf War, when ground troops used GPS to invade Iraq under cover of night and amid swirling sandstorms, routing Saddam Hussein's Republican Guard. By 1994, sailors and geography wonks could buy commercial GPS units like the Magellan 2000—but the U.S. military, concerned that its technology could be hijacked by hostile forces, rigged its satellites to emit faulty signals to civilian users, providing them with locations accurate only to hundreds of feet. Then, in the late

1990s, the military worked out a method of scrambling GPS signals exclusively around high-security sites. President Clinton ordered an end to “selective availability,” and, at exactly midnight on May 1, 2000, people the world over suddenly gained access to the full capabilities of GPS.

After Clinton’s order took effect, Dave Ulmer, a Portland-based computer consultant who had seen the change on his Magellan 2000, drove into the woods and hid a bucket into which he had placed, among other items, a Ross Perot book, a can of beans, and a notebook in which finders could sign their names. Back at home, he posted his stash’s coordinates to an online newsgroup for GPS buffs. David Teague, a man from across the Columbia River in Vancouver, Washington, took the bait, finding his way to Ulmer’s bucket and signing his name in the log. When he reported his find on the Internet, he birthed a worldwide community of “geocache” enthusiasts who spend their leisure time hunting for plastic boxes containing trinkets, and whose most ardent champion—Lee van der Bokke, a retired engineer near Oakland—had by this spring found about 64,000 caches. Jennings is, naturally, a geocache nut himself, and in his chapter on the latest in geogeekdom, titled “Overedge,” he calls Dave Ulmer in an RV in Arizona to hear the man’s story. Later, he recounts using his handheld unit to visit the crossing of geodetic lines nearest his home: a wooded yard north of Seattle whose owner, when asked by Jennings how it feels to own the spot where latitude 48°00’00” N crosses longitude 122°00’00” W, sagely replies: “It’s a two-edged sword.”

GPS has become a critical tool for hikers and snowmobilers, jetliner pilots and 9-1-1 operators. It undeniably gets us where we want to go, but it doesn’t do what maps are best at: providing context. Beyond simply getting us from one appointment to another, old-fashioned maps express what the geographer and emeritus professor at the University of Wisconsin–Madison Yi-Fu Tuan calls *topophilia*, our innate love of place, often shaped by sense and by memories

of the environments we navigated as kids. And these are the preoccupations informing a spate of recent books that seek to wrest modern cartography from the military logic of “precision targets.” Such books—from *The Map as Art* and *Maps Are Territories* to *An Atlas of Radical Cartography*—instead focus on what the geographer Denis Wood, in a provocative atlas of his North Carolina neighborhood, *Everything Sings*, calls writing “poems in maps.” These are *objets d’art* as much as catalogues of fact, documents of subjective experience rather than of authoritative precision.

Take, for example, *Infinite City*, a San Francisco atlas compiled under the aegis of one of the city’s leading essayists, Rebecca Solnit. It was born of the idea that every one of the city’s 800,000 residents, from day laborers to caffeinated geeks, lives in a personal city—and that each could map it in a different way. The atlas includes maps of playful juxtaposition. One, “Death and Beauty,” charts murder sites along with magisterial Monterey cypresses; another, “Monarchs and Queens,” maps butterfly habitats as well as the gay bars in which cocoons of another sort were shed. Last year the book (to which I had the pleasure of contributing) was everywhere in the Bay Area.

It is perhaps unsurprising that *Infinite City* struck a chord in a region that has so many poets and programmers in such close proximity, but the concerns it raised about the demise of the traditional map are widespread. The day I finished reading Jennings’s book, an article on the *New York Times* website recounted how Julia Frankenstein, a cognitive scientist in Germany, conducted an experiment showing that Tübingen’s residents, when placed in a scale model of their city facing north—the orientation of most maps—fared far better in pointing toward landmarks than residents not given map-based positioning. Old-fashioned maps, Frankenstein concluded, can serve as crucial aids in building spatial intelligence. Citing additional findings that London black-cab drivers add great amounts of gray matter to their brains’ hippocampal areas when learning the paths through the city’s labyrinth—a process that in-

volves constantly synthesizing personal experience with how London looks in its atlas—Frankenstein concluded that “the more we rely on technology to find our way, the less we build up our cognitive maps.” It has been suggested that outsourcing one of our brain’s key functions—memory—to machines has led to increased rates of dementia and Alzheimer’s. One can’t help but suspect that the outsourcing of our spatial intelligence will soon have similar consequences.

Today, Google is our chief provider of electronic maps and images—its mission, as the company says, is “to organize the world’s information and make it universally accessible and useful.” Google’s entry into mapping began when it purchased a program developed by two Danish brothers, Lars and Jens Rasmussen, and turned it into the Web-based application that became Google Maps. In 2009 Google Maps knocked the early Internet’s mapping leader—MapQuest—from its perch, and became what it is today: a huge moneymaker. Jennings writes that 90 percent of retail spending takes place not on the Internet but in actual stores, to which people, once they click one of the ads by which Google makes its billions, need directions. Google Maps is by far the most widely used service in Google’s Geo division, the practical workhorse. But with its stodgy template, based on a variant of the old Mercator projection (you can’t use Google Maps near the poles), and its fuzzy aerial photos, Google Maps feels creaky next to its marvelous 3-D cousin, Google Earth.

Like many projects unfolding under the we-hope-benevolent leadership of Messrs. Page and Brin, Google Earth got its start outside their company. In 1996, a group of engineers at SGI, a Silicon Valley graphics outfit, produced a demo video to highlight their powerful new “texture rendering” capacity for building virtual worlds. The video zoomed in from outer space to the peak of the Matterhorn and alighted on a Nintendo console on the snowy slope whose innards con-

tained an SGI chip. That video became the seed for a new company focused on the potential geographic applications of SGI's software. The company, called Keyhole, attracted funding from the CIA but idled for a time, struggling to monetize its advances—and then it caught a break. In March 2003, the United States invaded Iraq.

Brian McClendon, one of Keyhole's founders, was childhood friends with a CNN engineer, and the network purchased the software to use in its coverage of the campaign. Viewers watching the evening news at home were taken swooping over 3-D desertscapes; a year later, the firm demoed a version of the software for Google, which bid on it the very next day and released it within months as Google Earth. Demand was so intense that Google more than once had to disable the free download, lest it crash the company's vast server farms.

In the eight years since then, Google Earth has been downloaded more than a billion times. Its photographic data—which comes from an array of airplanes, satellites, and hot-air balloons owned by subcontractors—takes up *hundreds* of terabytes. (For comparison, scans of all the books in the Library of Congress would take up about twenty.) It's of course entertaining to zoom past the skyscrapers of Manhattan or through the canyons of Arizona, but making millions of never-before-seen images available to millions of eyes has also had some more-than-recreational results. Web surfers, parsing pixels at their desks, have found a previously unknown meteorite crater in Australia and the ruins of an Amerindian city in the Amazon. Whereas old-fashioned maps fed our dreams of distant exploration, this next-gen atlas, as Google's publicity materials crow, has allowed discoveries to be made without the discoverers leaving home.

In *Maphead*, Jennings reports that “there were probably plenty of weekends when I spent more time on Google Earth than I did on our Earth.” His book reaches its climax when, after meeting McClendon at the National Geographic Bee cham-

pionships, he accepts a casual invitation to stop by Google for the “nickel tour,” which feels to him like winning a golden ticket to Willy Wonka's chocolate factory. McClendon's custodianship of “his own planet,” as Jennings puts it, apparently comes with a few perks: when you load Google Earth and zoom in toward its seemingly arbitrary center, it's actually telescoping in on the apartment building in Lawrence, Kansas, where McClendon grew up. In his interview with Jennings, McClendon reflects on Google Earth's ultimate goal, which he says is to reach “the end of resolution”—a virtual planet whose images blanket the globe at a scale of one pixel for each square centimeter of Earth's surface. Given that many remote areas on Google Earth today exist at a resolution of no better than fifteen square meters a pixel, that aim, McClendon says, is probably a couple of decades away.

In the famous short story “On Exactitude in Science,” Jorge Luis Borges described a map as large as the empire it charts. Umberto Eco, in a wily riff on Borges's fable, wrote an essay describing how the emperor's cartographers, after completing their map the size of his territory and spreading it out, run into a problem: wherever the map's dark lines hover over the ground, they block the sun and rain, altering the flora beneath and rendering the map inaccurate. Keeping the ultimate map current, Eco suggests, will be a Sisyphean task. Or is it Orwellian? The Swiss court that recently ruled that Google Maps's street-view photos overstep citizens' privacy rights might say the latter. The company's unofficial motto is “Don't be evil,” but its official charter prevents it from doing much that doesn't grow its stock. And for those with misgivings about Google's ultimate map, it will be worrying to read McClendon's comments to Jennings. “Google Earth,” he says, “is not someone's version of reality. It is reality.”

You don't need to be a Bolognese semiotician to be stopped short by that statement. Google's maps, like all maps, are not neutral. Whether by leading pilgrims to Mecca or by pointing the way to Starbucks and

other retail spots, from basic choices about color tint to deeply contentious decisions about how Taiwan or the Golan Heights are labeled—to map is to adopt a point of a view. It is also, potentially, to create conflict, like the border skirmish set off in 2010 by a Nicaraguan military commander who, citing the authority of Google Maps, occupied a riverine island belonging to Costa Rica. Google has sought to head off these problems with “primary local usage,” which allows for multiple place-names to be attached to contested areas. It has also added a Map Maker function, which allows anyone with a Google account to “add a place,” edit roadways, and create trails—with the convenient benefit, for the company, that once your changes are ratified Google owns the information you've obligingly donated.

This movement toward user-made maps has also led to a fully crowd-sourced map site, one without the “find businesses” tab front and center. OpenStreetMap has emerged as Google Maps's chief rival; this spring it was adopted by Wikipedia and Apple for some applications. But it seems clear that Google Earth will still shape our cartographic future. This June, Apple announced it was launching its own map service for iOS, and Google's Geo division held a San Francisco press conference showcasing new 3-D plans for major world cities. Google Earth has ambitions to devote thousands more terabytes to up-to-date aerial photos, and it is moving to use its virtual planet as an armature for the world's information: by affixing “geotagged” photos, documents, and books to its Earth, Google is organizing knowledge not by theme or time but by location.

Such developments may yet revolutionize the Internet, and they are naturally thrilling to Jennings and those who share his sensibility. But what Jennings's enthusiasm for these new technologies prevents him from seriously engaging are the deeper questions preoccupying many in the field. “All maps are stories,” David Rumsey told me the afternoon I visited his library, adding that now, using GPS, “we can *live* in them.” But he

concluded with a word of caution, one that *Maphead's* readers would do well to heed: as stories, all maps forge meaning as much by what they leave out as by what they include.

A few weeks after I went to see Rumsey, I received an email saying that some aerial photos he had shown me of 1930s San Francisco were now available as a historical layer on Google Earth, georeferenced and stitched together as one cogent image. Opening the application, I spent a half hour zooming over this San Francisco, looking for landmarks I knew, and dragging its “time bar” leftward to see how these landmarks looked on the eve of World War II—when, as the photos revealed, the piers were teeming not with tourists but with ships, and the site of the biotech research center by AT&T Park was still a huge roundhouse for the terminus of the Southern Pacific Railroad. The Googleplex, I found, now a sprawling campus of low-slung buildings, had until the 1990s been an undeveloped plot next to the military’s Moffett Field.

That afternoon, I went down to that campus to visit a friend who works with the Geo division. The drive from San Francisco to Mountain View, after I crossed the Bay Bridge from Berkeley, took about forty minutes, and it would have taken less time had my phone’s Google directions not mysteriously led me astray. Eventually I found my friend’s building and parked out front. While he rode a unicycle, I joined him on one of the colorful bikes that sit unlocked around the grounds, and we rolled toward a free canteen where young people in jeans sat at tables in the sun, lurching on organic sushi and jasmine tea. He described how the project he’s working on—designing Google’s self-driving cars—will soon hand off one more navigational task to machines. A Prius with rotating laser-radar gear on its roof hummed past. I asked how soon the vehicles, whose systems are being closely watched by the DoD, would be on the roads. He replied with the happy tone of one convinced he was serving technology’s forward march: “Soon.”

After lunch, I wandered the campus alone, and found myself next to

an eight-foot-tall inverted teardrop modeled to look like the “place markers” that dot Google Maps. Stopping for a moment to ponder the eerie quality of a campus whose flowers are kept in perpetual bloom, I walked back toward my car beneath a cloudless sky. It felt somehow fitting, when I pulled out my phone to find my way back to Highway 101, to discover that it was dead. It turns out that sense and memory still have

their uses: heading home without the help of science or satellites, I drove over the coastal hills on a small road that I’d been shown by a girl I loved, years ago, during my first visit to California. I stopped by a beach we’d visited together and, after pausing there to watch the breakers roll ashore, unsullied by pixels or place markers, I drove north as the sun dipped, over my left shoulder, into the blue Pacific. ■

FINGER IN THE FUSE

Becoming Pauline Kael

By Robert Polito

Discussed in this essay:

The Age of Movies: Selected Writings of Pauline Kael. Edited by Sanford Schwartz. Library of America. 864 pages. \$40. loa.org.

Pauline Kael: A Life in the Dark. By Brian Kellow. Penguin. 432 pages. \$18 (paper). penguin.com.

Lucking Out: My Life Getting Down and Semi-Dirty in Seventies New York. By James Wolcott. Anchor. 272 pages. \$15 (paper). anchorbooks.com.

For a few years in the 1970s Pauline Kael wrote with a finger in the fuse box. From her perch at *The New Yorker*, working the movie beat in rotation with Penelope Gilliatt, she reigned as the most visible film critic in America. Screenwriters sought her approval on scripts, directors on rough cuts; she hosted parties at her apartment on Central Park West during the New York Film Festival, established a voluble presence at industry screenings, and guided a bevy of critic acolytes eventually dubbed “Paulettes.” On a leave of absence from *The New Yorker* in 1979, she briefly joined Warren Beatty’s production company in Hollywood.

Kael considered the New Hollywood era that coincided with the peak of her influence “a legendary

period in movies.” McCabe & Mrs. Miller, *The Conformist*, *Sunday Bloody Sunday*, *The Last Picture Show*, *Murmur of the Heart*, *The Garden of the Finzi-Continis*, *Cabaret*, *The Godfather*, *The Sorrow and the Pity*, *Last Tango in Paris*, *Mean Streets*, *The Long Goodbye*, *The Battle of Algiers*, *The Godfather: Part II*, *Shampoo*, *Nashville*: even as these films came out, Kael wrote that she doubted “if at any other time in American movie history there has been such a close relationship between the life on the screen and the life of a portion of the audience.” The emergence of rock writing in the late 1960s and its struggle to devise strategies for responding to Dylan, the Beatles, the Kinks, the Rolling Stones, the Beach Boys, and the Velvet Underground provides probably the only comparable match of critic and circumstance. The wonder, though, is that Kael, unlike the music journalists Greil Marcus, Robert Christgau, Ellen Willis, and Paul Williams, wasn’t a firebrand in her

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