Anticipatory News Infrastructures: Seeing journalism's expectations of future publics in its sociotechnical systems

ABSTRACT

To understand news rhythms, scholars have primarily studied how the rituals and routines of news organizations align with the practices and expectations of audiences. The rhythms of today's networked press, though, are set not only by journalists and consumers, but also by largely invisible digital infrastructures: software, data, and technologies from outside newsrooms that are increasingly intertwined with journalistic work. Here, we argue that the rhythms of the contemporary, *networked* press live in the materials, practices, and values of hybrid, time-setting sociotechnical systems, a new concept we call *anticipatory news infrastructure*. We explicate this concept through a typology of sociotechnical dynamics, showing how the networked press is poised to sense events, structure journalistic work, predict and commodify traffic, architect audience relations, and categorize content. We argue that these infrastructures anticipate *possible* public life, thus creating *anticipation publics* through their largely invisible power to shape expectations of journalists and audiences alike.

KEYWORDS

Digital online journalism, news production, time, anticipation, infrastructure, sociotechnical public, press technology

INTRODUCTION

What news does digital journalism expect and how can we see these expectations in its infrastructures? Highlighted by an “infrastructural turn” in media studies (Plantin and Punathambekar, 2018; Braun, 2015; Parks and Starosielski, 2015), news is increasingly seen to emerge not only from the rituals and routines of journalism, but also from a mix of social and technological forces living in social media, platform designs, online participation cultures, content commodification, and debates about data, algorithms, and artificial intelligence (van Dijck et al., 2018). We know that the contemporary, networked press extends far beyond news organizations, but we know little about how its extensions change how it makes time. Here, we focus on one type of news time (anticipation), trace its articulation through an illustrative set of sociotechnical news-making infrastructures, and use these articulations to inductively develop the novel sensitizing concept (Blumer, 1954) of “anticipatory news infrastructures” that explains how the online press is prepared for certain kinds of news.

In years past, news emerged from a powerfully structured beat system. News happened where journalists were pre-positioned, publishers and advertisers had economic interests, and audiences expected news to be. This system manifested materially: the television camera’s “live shot” was ready to see news within its frame; White House correspondents were invested in seeing news come from the executive branch; newspapers’ business sections were poised to see stock markets, mergers, and economic debates (while few had labor sections covering workers’ rights, collective bargaining, or minimum wage debates). News happened where the press was *ready to see news*.

Such organizationally and professionally situated anticipatory journalism continues, but it has broadened. It is now *also* intertwined with computational architectures that are often invisible to audiences and journalists—engineering cultures, proprietary data architectures, algorithmic designs, and social media platforms. Journalism is ready for some kinds of news because human and nonhuman actors and forces converge: professional journalists, editorial standards, platform companies, algorithmic logics, machine learning patterns, advertising economies, reader attention, brands and reputations, legal interpretations of free speech, and norms of political participation all converge. Together, this mix of forces creates the conditions under which online news is defined, produced, circulated, interpreted, and acted upon (Ananny, 2018; Deuze and Witschge, 2017; Chadwick, 2013; Carlson, 2015a; Ananny, 2013; Anderson and Kreiss, 2013). It is materially predisposed to see—*literally* able to anticipate—some kinds of news and some kinds of public life.

We are only beginning to understand how these sociotechnical forces anticipate news, but we argue here that they are *infrastructural*. They intertwine computational processing, journalistic judgment, socially constructed expectations, and normative assumptions about what public life *should* concern. In the traditions of interpretive social science that invert and interpret material infrastructures (Bowker and Star, 1999; Star, 1999) and “black boxes” (Anderson and Kreiss, 2013; Steen, 2014) in order to discover practices and forms of power that span human and nonhuman action, we analyze meetings among computation, journalism, temporality, and publicness to build the “sensitizing concept” (Blumer, 1954) of *anticipatory news infrastructures*. A sensitizing concept does not “prove” a theory nor stand as a “definitive concept.” Rather it “yields a meaningful picture” of a social world by giving “apt illustrations”

of “empirical instances” that a community of interpretation agrees is a useful way of orienting people to a phenomenon. When aspects of the picture are judged to be wrong, irrelevant, or “not covered adequately by what the concept asserts and implies,” the concept is revised to be more analytically useful and give a better picture of empirical dynamics (Blumer, 1954).

We see anticipatory news infrastructures as a sensitizing concept that explains how the networked press expects, classifies, shapes, and assembles some kinds of news. As our typology shows, the concept defines a new way of understanding news beats as sociotechnical arrangements that sense events, structure journalistic work, predict traffic and commodification, architect audience interactions, and categorize content. To be sure, the concept will no doubt require revision as new sociotechnical forces of journalism emerge, but the concept offers a way to see what the networked press sees—to know how it is ready for news and, thus, what kinds of public life it prepares people for.

NEWS TIME

People's shared senses of time have both biological and sociological rhythms, reflected in and structured by time-keeping technologies. Although each person's physiology is unique, our common biological features—our bodies rest, heal, age, and die—define a shared foundation for social time (Flaherty, 1999). Our individual experiences of time are tensions between an individual drive to define time and the collective power of time-making forces beyond our control (Flaherty, 2011).

Social understandings of time are reflected in, and structured by, time-keeping technologies that Peters (2015) calls “logistical media.” Such calendars, public clocks, and

watches denote and connote time, marking its passage and signaling its meaning. They help us keep time, impose time upon us, and show how people structure and understand time differently. Calendars are allowed to interrupt to remind us of appointments. Clock towers broadcast time and convene people with their chimes. Eschewing a wristwatch might suggest our freedom from time-keeping—a mark of social privilege or a relationship to a physical world—but when we replace it with a cell phone, we show how persistent time-keeping technologies are, and how hard it is to escape technologically mediated time. People's relationships to time-keeping technologies show how social, political, economic, and technological forces create time, and which kinds of time—and sociotechnical forces—people wish existed (Sharma, 2014).

Journalism scholars (Gans, 1979; Schudson, 2000; Tuchman, 1973; Usher, 2014) suggest two broad types of time in news work: inside-out time and outside-in time. Inside-out time shows journalists own priorities and might include the decision to issue a breaking news alert, conserve resources and halt a long-term investigation, accelerate reporting to avoid being scooped by a rival, or update a story to maintain the appearance of novelty (making news look fresh to advertisers and search engines alike). Outside-in time comes from beyond the newsroom. A government's morning press briefing can drive a day's news cycle; a natural disaster may reorient coverage for days or weeks; election campaigns reorient news organizations toward politics for months; quarterly reports, monthly employment statistics, and State of the Union addresses are all highly anticipated, ritualized staples of journalism that set reporting rhythms.

Tensions between inside-out time (a deadline) and outside-in time (a crisis) surface when news organizations need to coordinate labor, maintain revenue-earning rhythms, and manage

audiences' expectations. The press's collective focus on recency and novelty (Bell, 1995) can make journalists feel a constant pressure to work faster, produce more stories, and stay connected to more information sources in case one sparks a story. Among "digital first" journalists, this "intensification" (Cohen, 2018: 10) manifests as an expectation to constantly monitor social media and create a personal system of alerts, to guard against the fear that something newsworthy has escaped attention. Reporters say they feel pressured to extend their work hours, blend their personal and professional information practices, and have content constantly visible and circulating online (Cohen, 2018; Usher, 2018; Bødker and Brügger, 2017; Örnebring, 2010). Journalists need to set time for audiences and give them a constant sense of novelty, but they also need to be ever-ready for news that might come from an increasingly large number of places—they need temporal coping mechanisms to organize time, set expectations, and anticipate news.

ANTICIPATORY NEWS

News both marks time (yesterday's news is old, today's news is relevant, year-end reviews define eras) and manages expectations (journalists guess and predict what might happen tomorrow). But managing beliefs about future events creates thorny conundrums for journalists schooled in traditions of objectivity. If they use their *own* judgments of importance, relevance, and likelihood to get ready for news that has not yet happened, how can they claim to be neutral observers of worlds that contain truth? Where do journalists get their authority to report on the *future*? Anticipation shows journalistic values. Tracing journalists' assumptions about the future is a way to see journalists *own* interpretations of which past events they think were most significant and might recur. Gauging journalists' expectations about the future is a way to see

what kind of autonomy they think they have from the past and the future—how they see their freedom from history and expectations as they try to focus on present news.

Neiger and Tenenboim-Weinblatt (2016) show how journalists anticipate by making three kinds of future: updating, analysis, and projection. Grounded in a sense of the immediate future, *updating* concerns events that have just happened, that currently hold journalists' and audiences' attention, and that beg the question "what happened next?" *Analysis* is similarly rooted in past events, but it focuses on the potential significance of events, on what power an event might have to shape future events. *Projection* is the most precarious genre of future, relying on journalists' own judgments about long-term trends, how events can exemplify or challenge trends, and what kinds of analogies or comparisons audiences see as plausible. In each genre, journalists ground speculations both in the past and in norms about which futures they *and* audiences see as reasonable, significant, likely, or publicly relevant. Together, they are a "subjunctive voice" (Zelizer, 2010) that strays from simply reporting on past events and invites audiences to ask "what if?"

Anticipation genres are *publicly* powerful when they help audiences imagine some futures over others. Sonnevend (2018) sees journalistic imagination in reporters' willingness to elevate mundane moments into journalistic *events* that sustain ongoing reporting. If audiences see these speculations as relevant, they give journalists, public officials, and advertisers permission for anticipating (Neiger, 2007). Journalists can prepare audiences for futures that *they* see as relevant to *their* vision of the public and its needs. Such power can have limits, though. When journalistic anticipation prevents audiences from seeing or feeling any other futures than those that the media predicts—such as the press's inability to imagine anything other

than a US-led war following the 9/11 attacks (Grusin, 2010)—journalism shows how its anticipations can help to *create* outcomes. If people cannot imagine being a member of any public other than the one that the press *expects*, then journalism exerts a power to create social life, not just report on it.

ANTICIPATION AS SOCIOTECHNICAL INFRASTRUCTURE

In an essay analyzing time in professional journalism, Schudson argues that

‘timeliness’ in news is defined in practice not only by the recency of a reported event but by its coincidence with the searchlight of the journalistic institution. ‘Timeliness’ operates not by Greenwich mean time but by a cultural clock, a subtle and unspoken understanding among journalists about what is timely and what events are genuinely ‘new.’” (Schudson, 1986: 82)

This “cultural clock” reflects journalism’s temporal investments. As it organizes audience attention and ritualizes its own production practices it makes stable ontological categories like “breaking”, “old”, or “public” that become inseparable from journalism’s sociotechnical infrastructures. For example, television journalism’s “live shot” (Katz, 1992) trains a camera somewhere that may not be newsworthy at precisely that moment, but it points somewhere journalists *expect* news to be. Its assemblage of cameras, satellites, cables, camera operators, journalists, subjects, and competitors is organized to anticipate news—to see potential, novelty, suspense, and newsworthiness *there* and *then* (Tenenboim-Weinblatt and Neiger, 2017). This infrastructural encoding of journalistic anticipation reframes the press’s traditional beat system as a sociotechnical assemblage. News appears not just where reporters and sources are positioned, but where news *infrastructure* is trained to look. Beats and infrastructures can defend journalists against charges of bias—it is the *world* not reporters that triggers stories and

holds audiences—but, when viewed critically, they can also reveal patterns of interest, systematic inclusion and exclusion, and habits of expectation that elide unchallenged assumptions about what news might appear if beats and infrastructures looked elsewhere and otherwise.

What does it mean for sociotechnical phenomena like anticipatory journalism to be infrastructural? Star and Bowker (2006) define infrastructure as enabling, networked, routinized, and often invisible relationships among people and materials that are embedded in culturally maintained practices. Infrastructures ensure that particular kinds of work can be coordinated, standardized, and relied upon, and they do so with an understanding that our perception of infrastructure always depends on our position within a network of people and materials. Depending on your view, expertise, and investments, infrastructure is something that is foregrounded and struggled over, or backgrounded and assumed to function. Infrastructure “is both the thing and the story. It is the transparent and the spectacular. It is seamless in its operation and can be disastrous in its failure.” (Parks, 2015: 115)

Infrastructures that appear to be seamless often only become visible and salient when they break down. Unless you are a computer technician, facilities supervisor, or train engineer, the relationships among people and machines that sustain servers, furnaces, and railroads are largely invisible to you, and very likely part of a sociotechnical environment you assume exists and works reliably. These assumptions are rich starting points for learning about sociotechnical power—for doing “infrastructural inversions” (Bowker, 1994) that turn infrastructures inside-out, question the assumptions that built them, highlight the practices and values that maintain them, and illustrate the types of power they advance (Larkin, 2008; Nye, 2007).

Infrastructures are simultaneously social processes, materialized images of the future, and strategies for managing possible outcomes. By creating stable, invisible, assumed relationships between people and materials, infrastructures anticipate, enabling some practices and outcomes. Jasanoff (2015) sees anticipation playing out in *social imaginaries* that “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology.” Performing and animating such imaginaries appears in seemingly mundane *anticipation work*: “practices that cultivate and channel expectations of the future, design pathways into those imaginations, and maintain those visions in the face of a dynamic world.” (Steinhardt and Jackson, 2015: 443) And controlling this dynamic world is a key motivation of anticipation; envisioning and preparing for futures is a key “strategy for managing uncertainty.” If work, materials, expectations, and outcomes can all be aligned through stabilized, predictable relationships, those relationships become a type of disciplinary power that curbs desire and makes repression unnecessary (Foucault, 1980). People will “internalise regimes of anticipation through technical practices” (Mackenzie, 2013: 391) and self-police the radical, chaotic, unpredictable forces that challenge expectations. Subversive forces can be blunted with “hope(s) for a future conceptualized, produced, distributed, consumed, *and* invisibled.” (Clarke, 2016: 86)

Such anticipation work is political and affective because it shows which kinds of freedom, self-realizations, and security people *can* imagine, what kinds of influences they expect to be under, what they can reasonably expect, and what they must guard against (Adams et al., 2009). Affective anticipation is a particularly powerful stance that plays out in emergency

preparedness and planning as centralized powers inculcate in people “anticipatory states” (Choi, 2015) that teach them how to imagine governing themselves in a crisis. Drills create “atmospheres and sensibilities” that move people “outside of their comfort zone,” (Anderson and Adey, 2011: 1101) force the “suspension of normal habits,” (1102), and create an emotionally charged “interval” or “tensed time-space where disaster is not-yet, action is demanded, decisions are weighted with consequence, and action is animated by necessity and urgency.” (1105) Planning tries to create “*affective equivalence*” (1105, italics in original) between a drill and an imagined future. Anticipatory infrastructures are successfully when they can create this equivalence, making futures that can be imagined, felt as real, and governed.

DIMENSIONS OF ANTICIPATORY NEWS INFRASTRUCTURES

With these understandings—that networked news time is a sociomaterial negotiation between outside-in and inside-out forces, that news anticipation reveals journalism’s temporal judgements and investments, and that anticipatory power can be read through infrastructural relations—we now present an emerging typology of anticipatory news infrastructures and conclude by reflecting on their public significance.

We build this typology as a way to develop the sensitizing concept of anticipatory news infrastructures by analogizing across cases (Vaughan, 2014) and building concepts through abductive analysis (Timmermans and Tavory, 2012). Our empirical work is based in a corpus of trade press discussions of digital journalism practices and innovations (from 2010-2018) that Carlson (2015b) defines as “metajournalistic discourse,” preliminary semi-structured interviews with journalists and news organization technologists, and our own close readings of news organizations’ infrastructures—our own effort to conduct an “ethnography of infrastructure” by

“inverting” sociotechnical relationships (Star, 1999) and purposefully attending to the “wider relations” that uniquely characterize *digital* objects of study (Marres, 2017), instead of prematurely limiting their roles. To “un-blackbox” the closed, commercial infrastructures we aimed to explain, we drew upon the innovative frameworks of the “walkthrough method” (Light et al., 2016), algorithms as culture (Seaver, 2017), and algorithmic audits of journalistic systems (Diakopoulos, 2015). These methods of “seeing” infrastructure helped us to identify and understand the logics of the temporalities at work in digital journalism.

We see five anticipatory dynamics in the systems news organizations use to create, interpret, and circulate news: event sensing; work structuring; traffic and commodification prediction; architecting audience interactions; and content categorization. We briefly summarize each dimension and illustrate its articulation through news infrastructures.

Sensing Events

News organizations imagine and prepare to attend to events through computational, data-based relationships to non-news organizations. That is, journalism defines “events” through a constellations of actors, relationships, data, thresholds, and imagined consequences that, together, determine whether a context is newsworthy enough for reporting resources, advertising investment, and audience attention. News organizations create assemblages of human and nonhuman actors—including data from other organizations—to read signals thought to be potentially relevant, derive events from those signals, and translate those events into traditional, human-readable news stories.

For example, the *Los Angeles Times*'s QuakeBot system is primed to generate news stories on California earthquakes that have been sensed by the United States Geological Survey (USGS). When the USGS's statewide network of geo-sensors (sensors it maintains in partnership with CalTech and University of California Berkeleyⁱ) detects a seismic event, it sends an email to its subscribers, including the *Los Angeles Times*. The *Times* parses the USGS email for the quake's time, location, magnitude, and impact area, and uses this information to populate the fields of a pre-drafted story template and publish the story to its website and Twitter feed. QuakeBot's rules assign "adjectives like 'powerful' or 'weak' depending on magnitude and 'shallow' or 'deep' depending on depth." (Meyer, 2014). The *Times*' infrastructure—servers, software, reporter labor, publishing platforms—are only engaged when the USGS's infrastructure—sensors, scientists, alerts, email list—is triggered. What results is an article that quickly tells the *Times*'s audiences what the *Times*-USGS data assemblage knows, in the familiar language of an event-driven news story. The result looks simple, but it depends upon a complex and mutually triggered set of sensors, alerts, thresholds, and pre-determined journalistic judgments that has been trained to anticipate a data context as a newsworthy event. Los Angeles public radio station KPCC maintains a complementary website "Earthquake Tracker" that, similarly, draws on USGS data (through application programming interface instead of an email) to catalogue and visualize seismic events that KPCC's programmers have decided are significant and relevant to its audience (Take Two, 2014). Like QuakeBot, in conjunction with USGS data sensors and information stores, Earthquake Tracker anticipates events and creates publicly familiar news stories.

Relying on different data assemblages, other systems like CityBeat, Tracer, and NewsBot similarly anticipate and detect newsworthy events. Designed through collaboration among journalists, user interface designers, and data scientists, CityBeat monitors Twitter and Instagram for data signals that journalists see as potentially newsworthy: text and imagery, particular keywords, geotags of certain areas, and posts that have been shared or commented upon rapidly in a short period of time. The system creates a “detected events” list where journalists can get ideas for stories, sources, and interviewees (Schwartz et al., 2015). By algorithmically reading social media data for patterns that journalists define as newsworthy, CityBeat formalizes and automates the anticipation of events that *might* be relevant and worthy of reporting time and audience attention.

Similarly, Reuters Tracer system was designed “to automatically detect global breaking news.” (Liu et al., 2016: 216) It monitors English-language tweets for 16 topics that the International Press Telecommunications Council defines as newsworthy.ⁱⁱ It then ranks and clusters tweets, assigns newsworthiness and verification scores (based on Tracer’s operationalizations of journalists’ news judgments), and extracts what it defines as newsworthy, verified events. Like CityBeat, Tracer embeds journalists’ *expectations* of high-quality, newsworthy events that might emerge from social media, creating an infrastructure for anticipation.

Finally, Quartz’s NewsBot is a Slack-based platform that news organizations can customize to detect newsworthy events. NewsBot monitors any data stream for pre-determined key words and patterns that journalists see as potentially newsworthy. Instead of centralizing event prediction within a single event-detection algorithm (like CityBeat and Tracer), NewsBot

lets news organizations create their data monitors, decide what they see as relevant, and set their own thresholds and patterns for detecting events.

Taken together, these systems—QuakeBot, Earthquake Tracker, CityBeat, Tracer, and NewsBot—show a data-driven approach to sensing newsworthy events that extends far beyond any single newsroom. The predictive capacity of these systems depends on the stability of myriad data sets and platforms not intended to be part of news work, and on relationships, sensors, patterns, and thresholds that collectively formalize and codify journalistic anticipation.

Structuring Journalistic Work

Some anticipatory news infrastructures are designed not only to sense events, but to organize and report on events that have already been identified. They work *within* events to structure engagement, offering evidence of what journalists expect to happen and what roles they see themselves playing. Three fact-checking infrastructures designed for news events in which sources are expected to state misinformation illustrate the infrastructural dynamics of anticipated event engagement.

For example, NPR created an infrastructure to fact-check the 2016 US presidential debates in real-time. They used a real-time transcription service (Verb8tm) to generate text of the candidates' statements, populated a Google doc with this text, and created and pretested a workflow to coordinate 18 fact-checking reporters annotating a single document in real-time. NPR published its fact-checking in near real-time: after copyediting the transcript and annotations, and with editorial approval, the fact-checker's annotations were converted to

HTML, and published not only to NPR's own website but also to the websites of member and partner stations across the country (Fisher, 2016).

Inspired by NPR's live annotation of President Trump's press conference, Vox Media also designed an infrastructure to fact-check the president's 2017 State of the Union address in real-time, though they published their annotations shortly after the event ended. Using the OpenCaption system—a service that instantly shares CSPAN event transcripts over the web—Vox engineers automatically populated a Google Doc with a transcript of the president's speech as it was delivered (not the prepared text). Vox journalists designed and practiced a workflow they expected to follow during the address—how to annotate, what terminology and identifiers to use, which team members would play which roles—so multiple journalists could simultaneously annotate the Google Doc (Passarelli et al., 2017). The Vox and NPR infrastructures anticipated the news: work practices were encoded and coordinated through technologies; hybrid communities of journalists and engineers formed communities of practice that standardized workflows and set success expectations; the systems were extensible beyond a single event; and other sociotechnical contexts (e.g., transcription services and Google docs) were enrolled into the systems. News organizations imagined an event through these intertwined, infrastructural materials and practices which structured their coverage, reduced risks of error, bounded work within a time period and set of events that they expected would need fact-checking, and invested in sociotechnical relationships that could be reused for future, similar events.

Another approach to anticipatory fact-checking infrastructure builds upon these two. Envisioned by Duke University's "Tech & Check Cooperative," and led by PolitFact founder Bill Adair, the FactStream system combines and leverages existing fact-checking systems into a

“holy grail” of real-time, automated claim verification. Though not yet fully operational, FactStream combines ClaimBuster (a tool that “mines lengthy transcripts for claims that fact-checkers might want to examine”), the Internet Archive’s “Talking Point Tracker” (that flags claims repeatedly made by particular politicians), TruthGoggles (a system to automatically evaluate the veracity of online news articles), Digital Democracy (a project to extract claims from government videos), and a proprietary database of claims and fact-checks that the partnership does not disclose (Schmidt, 2018). Although it still needing manual processing by fact-checkers, FactStream debuted a prototype at the 2018 US Presidential State of the Union address, as a first attempt to knit together various fact-checking architectures and practices. It shows how an assemblage anticipates and structure works by enrolling (Callon, 1986) humans and nonhumans into a network of relations.

All three systems make assumptions about where misinformation originates, the events that amplify it, countermeasures needed, and the effect of fact-checking on audiences. No system, for example, involves audiences or crowdsources fact-checking, anticipates or incorporates campaigns’ responses to fact-checking, or questions the idea that fact-checking improves political discourse. These anticipatory news infrastructures see and define misinformation events in particular ways, creating a scope of sociotechnical action out of which solutions are expected to emerge and be successful.

Predicting Traffic and Commodification

Although many online news organizations earn revenue through a mix of subscriptions, memberships, grants, and crowdfunding, publishers largely agree that the economics of online news require them to aggressively pursue, retain, and predict audiences’ attention, both on their

own websites and in larger social media environments of platforms and apps. To varying degrees and through different methods, news organizations monitor and try to predict audiences' preferences—tracking what they like, share, comment on, and spend time with—so that they might identify potential markets for personalized coverage and targeted advertisementsⁱⁱⁱ. Such modeling can then drive myriad decisions. News organizations can better guess which topics, headlines, ledes, media, and publication rhythms will translate into reader loyalty, new subscribers, and advertiser value.

Analytics dashboards produced by companies like Google, Adobe, Omniture, and Chartbeat now populate many newsrooms and are key sites of prediction. Journalists' relationships to such dashboards reveal newsroom expectations about which stories are expected to trend, which traffic predictions can be trusted, which patterns fail to materialize Petre (2015); Petre (2018), and how resistance against dashboard algorithmic predictions show journalists own understandings of audiences and their professional ethics (Christin, Forthcoming).

While newsrooms often use dashboards to understand their sites' past traffic flows and patterns (Petre, 2015) they also use analytics predictively. They use traffic data infrastructures to guess how traffic *might* flow if they were to make some publishing decisions versus others. An early example of this was Visual Revenue^{iv}, software that tracked “story views and headline clickthroughs in real time and compare[d] them to historical benchmarks.” It would recommend to editors the “best stories to put in each page position for optimal traffic in the near future,” promising to “take any piece of content created over the last day or 2 days...and model how well that's going to perform in any given position about 15 minutes into the future.” (Sonderman, 2011) Similarly, JumpTime's “Traffic Valuator” system finds the path through a website that is

most likely to generate the greatest amount of advertising revenue. By anticipating which pages a visitor is likely to view, and in which order, advertising can be dynamically displayed and updated to generate the best advertising exposure and the most website revenue (Sonderman, 2011). Combining this power to predict traffic and direct click-paths with the dynamically written headlines and ledes that generate views, what emerges is a network of code, prediction models, advertising valuations, and user actions that, together, create an anticipatory news infrastructure that can optimize the commodification of news website traffic. The *Washington Post* even recently disclosed that it had run a “popularity prediction experiment”: it built regression models to learn which story features and website conditions^v, for which readers, correlated with the most popular news stories. It then used this model to predict which stories were likely to attract reader engagement, helping editors to “more efficiently allocate resources to support a better reading experience and richer story package.” (Wang and Han, 2017)

As with architectures for sensing events and prefiguring engagement, systems for predicting traffic and commodification are infrastructural. They are software codifications of operationalizations that automate analysis, often with little oversight or understanding of the automation. They are not simply neutral tools but are inextricably intertwined with journalists' senses of what it means to know an audience and predict its preferences, while still retaining editorial autonomy and doing more than responding to audience expectations. And they show how a community of practice—a newsroom—is actually a convergence of practices and values that originates outside of journalism from companies like Google and ChartBeat, while ultimately aligning with and seamlessly routinizing within journalistic work.

Architecting Audience Interactions

There are also aesthetic and experiential aspects to anticipatory news infrastructures that publishers use to create user experiences and nurture relationships with audiences. In these dimensions, news organizations imagine and predict which interactions will sustain audience engagement, embedding into infrastructure the relationships that publishers think audiences will want, need, or value.

For example, news organizations use interface design techniques to sense whether a reader is about to leave their site, intervening before she (and her advertising revenue) can exit. Holding a reader's attention amidst a surfeit of potential information attractions is a general challenge, but the specific goal of sensing a reader's wandering gaze leaves clues about how news organizations anticipate and codify engagement. Time.com, NBCNews.com and LATimes.com, for example, used a "continuous scroll" design to ensure that users would never experience an end. Instead, after finishing an article, they would immediately be shown the next story, and so on, in the hopes that an unbroken trail of content without boundaries from one story to the next would build *readers'* anticipation and dissuade them from leaving. Time.com reported a drop in its "bounce rate—the percentage of visitors who leave the site after viewing only one page"—of 15% (Kirkland, 2014: , np). The "continuous scroll" becomes an infrastructural element—grounded in a material design, a model of human practice, and a desired outcome—that makes the story a site of anticipation and blurs its beginning and end, delicately recasting it as something that both satisfies and promises more to come. *The New Yorker* takes a complementary approach, but accepts the inevitability of user departures and tries to make it easy for them to come back. The site tries to guess when a user is about to leave the site--e.g., if a user stops scrolling down a page, or starts quickly scrolling back and forth—and intervenes

with either another story that designers hope might retain their attention, or a pop-up notification (Lichterman, 2015a: np)

In contrast, the *Economist* aims to give readers a “sense of completion” that calms their fears of not “being completely informed.” By not linking to other news sites within stories, clearly visualizing an story’s end, and publishing dense articles meant to convey gravitas and exhaustiveness (Ingram, 2015: np), it tries to *counter* a reader’s expectation that there is more to be learned beyond what The Economist has told them. The Economist designs *toward* the point of completion, anticipating what is needed to make readers *feel* sated. The more successfully it can predict what satiation feels like, the better it can make readers expect and want nothing more.

Two other architectures show how news sites try to anticipate and satisfy readers. First, knowing that they would make future errors in their stories, the NPR created a feature for its mobile app that informs listeners of corrections. When a correction was significant enough—significance being an editorial judgment that had to be anticipated and codified—the app “determined who had heard the original segment...[and] emailed the correction to that list of users.” (LaFrance, 2017: 23) NPR wanted an ongoing relationship with listeners, anticipated that they could earn listeners’ trust by planning for a moment it considered likely (issuing a correction), and encoded that anticipation in an architecture (significance thresholds triggering corrections and messages to a dynamically updated email list).

Another class of anticipatory interactions are emerging around news alerts (Brown, 2017). In 24/7 online news cycles with few regularly scheduled convenings—most people no longer gather around any version of the six-o’clock news—and itinerant online traffic spanning global time zones, news organizations must plan when to interrupt audiences with breaking news

alerts. Planning interruptions entails some version of the following: publishers identify a class of topics or events that may warrant a breaking news alert, they build infrastructures and practice workflows for producing alerts, they issue alerts, gauge audience reactions to them, and adjust their technologies and practices according to how well they have anticipated people's sensitivities and thresholds for newsworthiness in crowded and noisy online news environments.

Nearly every online news organization has some version of an alert infrastructure that represents what they expect to happen, and what they anticipate audiences wanting. NBC's "Breaking News" combined editorial judgment with social media observation to issue mobile pre-alerts that "notify users that a story could evolve into a major story," (Lichterman, 2015b) in part by sensing a user's location and guessing whether the event is close enough to be of interest (Ellis, 2014). The *Washington Post* designed a system to anticipate what *other* news organizations will do, algorithmically judging the similarity and quality of competitors' alerts to help guide their own reporters' work and their own audience's expectations. The Guardian's Mobile Innovation Lab experimented with an alert system tailored to readers' interests and emotional preferences. They automatically detected the sentiment of future events, aligned those sentiments with user preferences, and dynamically adjusted the language and frequency of their alerts (Bilton, 2016). Though they differ in their approaches to timeliness, automation, thresholds of significance, and definitions of success NPR (Jensen, 2018), the *New York Times* (Spayd, 2016), BuzzFeed (Lichterman, 2017a), and the *Wall Street Journal* (Lichterman, 2017b) all have similar teams anticipating the contexts and preferences of readers, building infrastructures that can automatically alert and orient audiences to events that journalists expect to be newsworthy.

Categorizing Content

Finally, a seemingly innocuous but significant dimension of anticipatory news infrastructure entails managing indexes that refer to news and stabilize its circulation. Most story indexes are static and stable (web address that do not change and always point to the same story), but some anticipate changes and point to different content at different times. When journalists expect updates and when ledes are unstable, web addresses become places to see which events news organizations anticipate responding to, and how stories are expected to change.

For example, if a reader went to the *New York Times* URL <https://www.nytimes.com/2016/08/31/us/politics/donald-trump-mexico.html> at 9:33am PT on August 30, 2016, she would have seen a story headlined “What to Watch For on Donald Trump’s Visit to Mexico and Immigration Speech” with speculations on “what is expected to be the most frenzied—and perhaps the most important—day of his campaign.” If she revisited the *same* URL at 8:44am the next day, she would have seen a story describing what happened on the visit, how the speech had been received. The earlier story anticipating the visit had disappeared, replaced with an account of what happened. Rather than being a stable index to a story, the URL became a more dynamic referent—a single container for what journalists expected, and then an account of what happened. The counter, though, only referred to one time period or another—there was no relationship between the anticipation and the reporting.

Partly as a response to the expectation that publishers change articles without warning or documentation, the NewsDiff (2012) system was designed to monitor news websites for story changes and show users story versions. But NewsDiff is not indexing all news, it anticipates salient or track-worthy changes coming from a small set of five publishers—it only anticipates

important changes coming from those sites. By giving a consistent URL to a changing story that itself is anticipating a future event, journalistic institutions encode assumptions about story arcs into technical infrastructure. Projects such as NewsDiff *anticipate* that a URL's content will change and try to guard against invisible updates by documenting story variations.

The Sunlight Foundation's (2016) Politwoops system is premised in a similar expectation of change, and preserves politicians' deleted tweets for the public record. (The URLs of deleted tweets would simply show that a tweet was deleted, but its content would be lost if not archived.) A seemingly simple goal—maintaining URL content—reveals both an expectation (that politicians regret and delete tweets) and a normative goal (that regretted and deleted tweets should be archived and available). Just as the stability of the *Times*'s URLs show whether journalists see updates as significant enough for a new URL—making it impossible for readers to see afterward what the *Times* thought Trump was *going* to say, without using NewsDiff—Politwoops sees *all* URLs as worthy of preservation and anticipates index instabilities. Politwoops expects online change and tries to stabilize sources so that they might be reliable resources for future journalists.

CONCLUSION

Today's news happens not just where journalists are ready to see news happening, but where news infrastructures have been designed to look. Part of appreciating the myriad forces and values of the contemporary networked press means understanding how infrastructures of humans

(journalists, designers, audiences) and nonhumans (data sets, algorithms, interfaces), together, construct ways of seeing social worlds and translating those visions into familiar forms of news.

We suggest a new concept—*anticipatory infrastructures*—as an analytical and empirical container for understanding how future imaginaries are embedded in sociotechnical infrastructure. *Anticipatory news infrastructures* in particular articulate where news comes from by encoding—in intertwined materials, practices, values—ways of seeing, interpreting, interacting with, and resisting the contingencies of the networked press. These infrastructures model online attention, prepare for outcomes, prefigure engagements with events and audiences, and show how the networked press tries to navigate an uneasy balance of reporting on worlds that are versus preparing for worlds that might be.

Although not an exhaustive typology (future infrastructures will undoubtedly reveal new anticipatory dynamics), we suggest that the networked press anticipates events, event engagements, online traffic and commodification, user experiences and relationships, and news content variations. Together, these modes of anticipation show how journalism: continues to see the world in terms of beats (now situated in organizational routines and infrastructural designs); manages uncertainty and mitigates risk by using infrastructures to organize its labor and allocate its resources; and, most fundamentally, creates new kinds of *anticipatory publics* by predicting—through infrastructure—information flows, social entanglements, and normative priorities.

That is, infrastructures do not just circulate news, they assemble publics (Ananny, 2018; Finn, 2018)— subjects are imagined and publics are convened *through* modes of anticipation. The five modes of anticipation we describe here draw on and articulate different imaginations of “anticipated publics.” By expecting and planning for relationships between people and data, practices and values, anticipatory infrastructures can be future-oriented

conventions that make it more or less possible to see some social relationships and some collective issues over others. As Grusin (2010) showed how premediation can make some futures more or less imaginable, anticipatory infrastructures suggest how some publics—convened, for example, through anticipatory news infrastructures—may be more or less realizable.

Anticipatory news infrastructures seem to see publics in two ways. First, they see readers as attention that can be captured, investments and connections that can be convened and oriented toward some issues, relationships, and outcomes versus others. Second, anticipatory news infrastructures try to stabilize and fix news, expecting that there are pre-existing publics that need to be informed, nurtured, and reassured in online environments that are dynamic, not always truthful, and intertwined with cultures and practices of social platforms driven by values other than journalism. If news organizations can know audiences well enough—through infrastructures—to trace them and their desires, then they can do the *public service* that normatively set them apart from other information organizations: they can show support democratic self-governance, show people which goods and challenges are inextricably shared, and what kinds of interventions need collective action – the journalist-technologists building the networked press can help turn audiences into publics. This kind of value-driven infrastructure design may take journalism away from its familiar terrain of objectivity and distanced reporting, but a networked press that has encoded its anticipatory infrastructures with public values has the potential to create publics.

The key, though, is to know the logics of anticipatory news infrastructures, what futures they see and create, and which sociotechnical interventions steer infrastructures closer to or further from ideal publics. As new types of technologies continue to emerge—artificial

intelligence, virtual reality, Internet of Things—and journalists take up these technologies, it will become imperative to interrogate their role within news infrastructures, to understand what kinds of events and outcomes they see, and what kinds of social relations they create. In proposing the general idea of anticipatory infrastructures—and anticipatory news infrastructures in particular—our aim is to suggest a concept that might become a diagnostic, a way of understanding anticipation as a *publicly* powerful idea.

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ⁱ The USGS also has a worldwide network of seismic sensors it maintains through international partnerships.

ⁱⁱ <https://iptc.org/standards/newscodes/>

ⁱⁱⁱ For example, a body of work among computational data scientists is focused on building anticipation models that produce reliable predictions of news story engagement given the least amount of time and the smallest number of previous engagements with similar content Tatar A, #233, #233, et al. (2011) Predicting the popularity of online articles based on user comments. *Proceedings of the International Conference on Web Intelligence, Mining and Semantics*. Sogndal, Norway: ACM, 1-8, Liu C, Wang W, Zhang Y, et al. (2017) Predicting the Popularity of Online News Based on Multivariate Analysis. *2017 IEEE International Conference on Computer and Information Technology (CIT)*. 9-15.

^{iv} Later acquired by Outbrain and rebranded as a “discovery platform” for general web analytics.

^v Signals analyzed for the regressions included, for example, an article's category and publication date, an author's name, the text's sentiment, the time between story publication time and its appearance on social media channels.