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Following the Fukushima Disaster on (and against) Wikipedia: A Methodological Note about STS Research and Online Platforms

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Abstract

Science and technology studies is famous for questioning conceptual and material boundaries by following controversies that cut across them. However, it has recently been argued that in research involving online platforms (Wikipedia, Facebook, Twitter, etc.), there are also more practical boundaries to negotiate that are created by the variable availability, visibility, and structuring of data. In this paper, I highlight a potential tension between our inclination toward following controversies and "following the medium" and suggest that sometimes following controversies might involve going "against platforms" as well as with them. I will illustrate this dilemma through an analysis of the controversy over the coverage of the Fukushima disaster on English language Wikipedia, which concerns boundaries

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between expert and lay knowledge but also the social and technical functioning of Wikipedia itself. For this reason, I show that following the controversy might mean making use of less formatted and less obvious data than Wikipedia normally provides. While this is not an argument against the use of automated digital research tools such as scrapers, I suggest that both quantitative and qualitative researchers need to be more willing to tweak their approaches based on the specificities of the case.

Keywords
ANT, controversy, platforms, digital methods, Fukushima, Wikipedia

Introduction

One of the main tenets of actor–network theory (ANT), and approaches inspired by it within science and technology studies (STS), is the questioning of conceptual and material boundaries. According to ANT, there is no inside or outside of science, no inherent divisions between nature and culture, experts and laypeople, scientists or journalists, or even the micro or macro scale. The fundamental dictum to "follow the actors" insists that researchers trace the movement of entities that constantly crisscross institutional divides and traverse nominal categories in the everyday work of network building—though they may attempt to reassert the inviolability of these boundaries or categories after the fact. In more practical terms, this might mean following scientists outside the laboratory walls as they connect far-flung research teams, enroll government agencies and funding bodies, and encounter concerned publics.

These ideas are especially interesting to revisit, as ANT-influenced scholars within STS have started to study online platforms (Wikipedia, Facebook, Twitter, etc.). Firstly, because these platforms, at least in theory, appear to break down some of these taken-for-granted boundaries *empirically*: institutionally defined expertise becomes hard to maintain when everyone potentially has a voice and, when nongovernmental organizations, hackers, and concerned publics take on issues such as genetically modified foods and nuclear power using social media. Second, these platforms are interesting because the easy availability and connectedness of data on the web, and especially, so-called "open" platforms (Tkacz 2014) should make the task of following actors easier than ever before. Today, researchers are no longer confined to traditional off-line settings such as the laboratory,

consensus conferences, or public hearings; they can, in some sense, trace empirical objects wherever they lead.

However, some argue that online platforms may exert an inordinate force in the research process, in perhaps less obvious ways than off-line research settings and materials (Driscoll and Walker 2014; Marres 2017; Marres and Moats 2015). Twitter, for example, heavily limits nonpaid access to Tweets and restricts the extent to which researchers can access historical events. Many social media platforms may incline researchers to pay attention to popular or trending content at the expense of other content. Platforms also constrain research in more subtle ways through the variable availability and formatting of data.

While these boundaries, silences, and resistances may be empirically interesting and are often reflected on in STS research, the question becomes: when do these boundaries need to be traversed? This paper suggests that sometimes the dictum to follow the actors might be in conflict with analogous strategies to follow the medium (Rogers 2013). This is because using scrapers, crawlers, and various tools built on top of platforms for *either* qualitative or quantitative research may entail certain assumptions about how platforms work—either technically and/or socially—when this basic functioning of platforms and their interpretation by the community of users may be *at stake* in the interactions being analyzed, particularly in heated controversies. This might require following the actors *against* platforms as well as with and through them. I will illustrate this methodological dilemma, practically speaking, with a case study: a controversy over the coverage of the Fukushima disaster on English-language Wikipedia, drawn from a larger Economic and Social Research Council–funded PhD project about the role of online platforms in debates about nuclear power. This is a case that concerns how boundaries between expert and lay knowledge are negotiated in unfolding disasters. Wikipedia is an interesting setting through which to view these debates because, in theory, it might allow lay actors more voice in such debates and because, unlike other popular platforms that restrict access to data, Wikipedia is "open" and extensively documented. However, because the controversy involves transgression of normal Wikipedia policy, the subtle formatting of the data and architecture of the platform impede one's ability to follow the actors, as I will show.

First, however, I will remind the reader of some basic tenants of ANT arising from studies of laboratories and some recent critiques of these approaches. Then I will describe how these challenges are both helped and hindered by online platforms, in the form of virtual both ethnography and digital methods approaches.

Following the Actors Online

The frequently invoked dictum to "follow the actors" has been one of the most enduring methodological slogans of the past thirty years of science studies, even as STS researchers have questioned other aspects of classical ANT (Law and Hassard 1999). Among other things, this demands a certain commitment to the empirical and to the complexity of social interactions that always overspill the structures and devices erected by actors and institutions and that may also exceed our own social science attempts to capture them. However, the elegance and simplicity of this statement sometimes belies practical and methodological challenges in its implementation.

It should be understood that the dictum to "follow the actors" has been more or less explicitly connected to a particular sort of analytic object: controversies, first in the sense of knowledge controversies over matters of fact and later controversies over the definition and ontological enactment of more complex and distributed "matters of concern." In the first instance, researchers are told to follow whomever is most consequential for the settlement of the controversy, be they human, nonhuman, animal or mineral, devices, or texts. In the latter instance, matters of concern are harder to settle, and so researchers are encouraged to consider the heterogeneous actors, objects, and settings that gather around them and have a stake in their settlement. Crucially, many matters of concern are not grounded in a particular geographic location but circulate globally. In either case, these "hairy objects" (Latour 1999) do not respect conceptual domains, or geographic boundaries, let alone the relatively contained space of traditional ethnographic research settings. Even if a researcher starts to apprehend such a controversy through some officially sanctioned venue such as a consensus conference or public hearing, the possibility must be entertained that the most relevant actors are elsewhere (Marres 2005).

However, these institutional boundaries and the boundaries of material settings are not merely brushed aside as fictions but rather investigated as empirical topics: for example, one might ask how divisions between good and bad science or between scientific and popular media representations (Hilgartner 1990) are produced as an effect of sociotechnical processes that are sometimes referred to as "boundary work" (Gieryn 1999). So the laboratory, in Latour's (1988) iconic example of Pasteur, gains its power precisely by bringing in the outside world, in contained form, and circulating laboratory conditions outward—all the while enforcing the sanctity of the laboratory after the fact.

These insights have their roots in ethnographic investigations of laboratories, but such forms of in-person participant observation, strictly speaking, have not proved the most appropriate tool for the task of following controversies. Latour's (1988) Pasteur study, for example, was conducted through historical, document-based research. More recently, as I will discuss, STS researchers have turned to the Internet and digital tools to map controversies that transcend particular locales. However, to the extent that ANT is rooted in an ethnographic sensibility, it is worth pointing out that ANT researchers in their focus on distributed case studies sometimes downplay the mundane practical constraints faced by researchers. Garforth (2012) points out that one of the most emblematic laboratory studies (Latour and Woolgar 1979) relies on a fictional anthropologist to reflexively draw attention to the author's own work of knowledge construction; however, this occurs at the expense of discussing some of the practical/methodological issues, such as access and ethics, encountered by flesh and blood ethnographers.[1]

Garforth argues that some of the most important aspects of scientific work, such as moments of inspiration, are solitary ones that happen in lonely offices or at home where researchers may be denied entry; in other words, they are invisible to ethnographic investigation. Of course, "visibility" is never either-or but a sliding scale in which silences, closed doors, shy scientists, encrypted files, and legal obstructions impede our ability to follow the actors and raise the costs of witnessing. Even more perniciously, particular settings, archives, or empirical materials incline researchers toward certain methods and ways of seeing at the expense of others. These resistances are often worth reflecting on empirically: the secrecy of scientists, their orientations to ethnographers, or the extent to which institutional accounts of public controversies are often cleaned up (Hilgartner 2000) can all tell us something interesting about the practice of science and the politics of knowledge. But sometimes these impediments simply need to be traversed: researchers need to gain access to privileged spaces, find alternative archives, or track down informants who are excluded from certain settings (Star, 1990). There are ethical questions to be raised with respect both to the extent to which empirical researchers can or should be granted access to certain spaces and to the extent to which researchers can ever presume to know informants' mental states or emotions, but it is certainly true that following actors and tracing controversies often mean transgressing or bypassing the constraints introduced by empirical settings and materials.

Virtual/Digital Methods

STS researchers have embraced the possibilities of online digital data because in some sense, there are fewer closed doors: they can now map controversies and issues that have a global reach, even though this comes at the expense of richer empirical detail attainable through in-person interactions. Hine's (2002) *Virtual Ethnography* was a reflexive answer to how to proceed in these new settings. In a similar way to the ANT focus on controversies, she recommends defining the object of study in terms of media events (see also Moats 2017): take, for example, the very public trial of Louise Woodward, an event that spawned countless web pages both advocating and condemning her. Hine argues for a process of tracing web links in much the same way as connecting research sites in multisited ethnographies (Marcus 1995; see also Hine 2007). However, she draws attention to the extent that search engines such as Google and other web technologies might overdetermine one's search for what is important to study. In other words, a researcher's access to a particular event or controversy is mediated by various actors and technologies that have their own ideas about what is relevant.

In the follow-up edited volume of *Virtual Methods* (Hine 2005), an entire section is devoted to the problem of defining the boundaries of a study, and, from the very beginning, quantitative techniques and tools have played an important role in this. Dodge's (2005) contribution to this section, for example, proposes that various "mapping" techniques offer strategies for qualitative researchers to grasp larger patterns and make sense of formations not visible through individual postings or pages. These techniques, such as network graphs, are not necessarily leveraged to make statistical inferences or determine causality as they are in more quantitative social science traditions; they are rather used in *exploratory* ways, following work in STS that attempts to "pursue the qualitative by other means" (Callon, Law, and Rip 1986). Another famous STS intervention in online research was Rogers and Marres's (2000) work on the Issue Crawler, which uses networks of hyperlinks to map the actors assembled around public issues. But, in a similar way to Hine's work above, the software is also used to *topicalize* the extent to which hyperlinks and search engine such as Google may define for us what is more or less relevant to a particular controversy or issue.

So the same sorts of questions about access, boundaries of the study, and variable visibility are still part of ANT-inspired studies online (Jensen 2010; both quantitative and qualitative), but this has become complicated by the

rise of "platforms" (Helmond 2015), a term which commonly refers to massive websites (such as Wikipedia, Slashdot, etc.) and social media like Facebook and Twitter (van Dijck 2013). Platforms are often driven by user contributions, one of the key features of the so-called Web 2.0 (O'Reilly 2005), and they make available more *structured* data than web data as such (Marres and Moats 2015): not just hyperlinks but full conversation threads, tweets, likes, rankings, and so on, can be leveraged for research.

These "natively digital" objects have been repurposed for research using digital methods (Rogers 2013), for example, to graph Google rankings over time or create networks of Wikipedia articles or hashtags on Twitter. Their dictum is sometimes phrased as "follow the medium" because they make use of the data structures, formats, and methods embedded in platforms, which then become part of the topic of investigation. While there are some related approaches that use quantitative tools to detect controversies, Marres (2015) argues that many of these approaches assume that controversies exist independently of or are not radically influenced by platform activity, whereas digital methods approaches explicitly acknowledge *how* platforms format or shape interactions.

For example, Weltevrede and Borra (2016) use a "device perspective" to construct a tool called Contropedia, which is built on top of Wikipedia. It uses specific formats such a "reverts" (when a contributor reverses the contribution of another) and key words, hyperlinked to other articles, to detect when controversies flare up and around content. The authors are keen to point out that these device formats are both technical and social accomplishments, related both to the architecture of Wikipedia and to the culture of its many users. They, like Anders Koed Masden (2015) and Bucher and Helmond (2017), speak of these features in terms of Gibson's (1979) affordances to signify that while these technologies do not have inherent properties, they have certain capacities *in relation* to particular tools and visualizations; in other words, they set constraints on what is possible to do with them.

While the concept of affordances provides a convenient shorthand for those features of a technology that both enable and constrain social research, it may be exactly such taken-for-granted features that may be upended in volatile controversies. As Rappert (2003) has argued previously, speaking of affordances seems to assume consensus over the meaning of a technology or over material properties, when how such a consensus over what a technology does or what are its stable features is arrived at, is precisely what needs to be explained.[2] The constraints or norms platforms place on activity are an accomplishment of local interactions not given

beforehand. Putting to one-side debates about this concept, the point I wish to make is that building tools and gathering data through online platforms *may require* making some assumptions about the capacities or stable features of platforms, which one might otherwise question empirically.

Marres (2015) similarly cautions against the tendency to assume that controversies play out on platforms in predictable ways (platforms have certain affordances vis-à-vis controversies). If one were researching a controversy on Twitter, it might make sense to assume that robots and fake accounts are incidental to the controversy, just promotional noise to be filtered out. But sometimes this seeming spam is consequential when, for example, bots are leveraged for activist campaigns (Marres and Moats 2015). If one assumes that controversies and other social interactions play out in predictable ways, one might miss how they sometimes overspill technical capacities and social norms. Marres thus recommends focusing on the point at which more indeterminate issues form in the first place and on the various ways they *become* controversial rather than taking this for granted. This might involve what she calls "going against the platform" (see also Gerlitz and Weltevrede forthcoming). But what is the difference between working "with" or "against" platforms, given that digital tools and even data collection are so dependent on platform data structures and Application Programming Interfaces (APIs)? In the remainder of this paper, I will think through what it would mean to go against, as well as with, an online platform in pursuit of a controversy, using both qualitative and quantitative techniques.

Wikipedia and Fukushima

The details of the Fukushima disaster are relatively well known, but to briefly summarize, on March 11, 2011, an earthquake and tsunami rocked the Japanese coast causing a blackout and damage at the Fukushima Daiichi nuclear plant. Over the coming days, there were explosions, radiation releases, and meltdowns. The case is interesting from an STS perspective because the Japanese Government and Tokyo Electric Power Company (TEPCO), the plant operator, were criticized for initially downplaying the severity of the incident and allegedly "losing" some key radiation readings (Slater, Keiko, and Kindstrand 2012). In the absence of expert accounts, citizens turned to social media (Morita, Blok, and Kimura 2013) and the Internet to post their own ad hoc radiation readings and contest industry figures. So both knowledge about the incident and what *counted* as expert knowledge were being debated in the controversy.

If you were to google Fukushima today, the first two results (depending of course on your browsing history and many other factors) would probably be a World Nuclear News (WNN) report drafted by a nuclear industry regulator and the Wikipedia article "Fukushima Daiichi Nuclear Disaster." The WNN article, in a very dispassionate tone, attempts to allay fears about the incident and its wider effects. In contrast, the Wikipedia page "Fukushima Daiichi-Nuclear Disaster" highlights the severity of the incident (level 7 on the International Nuclear Events Scale, making it the same level as Chernobyl). The particular configuration of actors, institutions, fuel rods, valves and counters, and regulatory documents presented in the article frame the disaster as a result of incompetence by TEPCO in the design, sighting, and, later, disaster communications.[3] This is in sharp contrast to the WNN report, which frames the disaster as an extreme event that overwhelmed perfectly reasonable safety protocols and procedures.

Bubbling behind both articles is a controversy over what happened. But how does one account for the differences between the WNN and Wikipedia accounts? It should be said that neither of these texts represents a straightforward reality; both are a precarious balance of multiple enactments of the disaster, including silences, uncertainties, and complexities (Gad and Jensen 2010). That the WNN article is more moderate in tone overall is perhaps unsurprising, but traces of its construction are not accessible to us (a familiar practical constraint). However, one *can* ask questions about how the community of Wikipedia contributers arrived at their particular account. Do platforms such as Wikipedia allow so-called lay actors to contest expert accounts, which are normally privileged in the immediate aftermath of disasters (Farías 2014)? Can they upend downstream models of science communication in which scientific facts are delivered to journalists and then to passive publics (Hilgartner 1990)?

As is also well known, Wikipedia is a free online encyclopedia that employs collaborative Wiki software and is editable by anyone—in fact, all users are referred to as "editors"—with no priority given to expertise or qualifications (Sanger 2005). Wikipedia editors, in the English language version, have produced more than 5,000,000 articles, and Wikipedia is, according to its "About" page, one of the most visited websites. Wikipedia is interesting for STS scholars because it works without clearly defined hierarchies between experts and laypeople (König 2012). In an analysis of Wikipedia policy, Tkacz (2012) explains that the central tenant of neutral point of view (NPOV) was intended to allow editors with very different perspectives to collaborate without agreeing on what is true. In the page

describing NPOV,[4] which is also written collaboratively by the community, NPOV is defined as:

> [R]epresenting fairly, proportionately, and as far as possible without bias, all significant views that have been *published by reliable sources.* (emphasis in the original)

This suggests that Wikipedia will only represent what "reliable" sources have claimed. According to their guidelines, this means peer-reviewed scientific articles and books and, if these are not available, then articles in reputable newspapers. The related policy of "verifiability" also states that online versions of these papers or articles are preferred, so that editors can check each other's work. If reliable sources disagree, then both positions must be presented as an *open controversy*. These policy pages, however, represent an idealized explanation of how controversies should be settled. In practice, debates about what is true are often displaced into debates about what sources are reliable. As discussed earlier, one should not assume that these technical and social norms hold fast in any given case. So the question becomes, how does Wikipedia function in relation to this particular controversy?

Returning to the Wikipedia article, there are three tabs running across the top: "Article," "Edit History" and "Talk." The Article is the current text of the article itself, including links in the text to other Wikipedia articles, references with hyperlinks that are gathered at the bottom, and links to external sites for more information. The Edit History page is a collection of every edit logged with a time stamp and the name of the user making the change, along with optional explanatory comments. When disagreements overspill the brief notes on the edit history page, they are generally dealt with on the discussion or "talk" page where editors create headings for particular problems and have extended threaded discussions below them.

For the present discussion, it is significant that these different tabs represent differently formatted data and thus suggest different analytic approaches: they are more or less amenable to quantitative analysis, close reading, and to being linked to other sorts of data. So even though all these data are generally available and accessible to us, one may be inclined to approach them in ways which may not be aligned with the particular controversy.

The Article Text

The Wikipedia article text lends itself to an analysis like a scientific paper in terms of the sorts of actors mobilized and the rhetorical strategies

employed. For example, the introduction describes the multiple core meltdowns and hydrogen explosions and then quickly moves into various speculations about health effects, in particular, thyroid cancer, and the continuing radiation leaks. These future consequences are currently given weight by their placement at the front of the article.[5]

The body of the Wikipedia article starts with safety concerns about the plant, highlighting how energy company and plant manager TEPCO falsified safety records and ignored tsunami warnings, which sets up TEPCO as the villain of the story. This is followed by a forensic detailing of the events in each of the three affected reactors, which, as indicated by live links, also get their own Wikipedia articles. This extreme level of detail and references to reliable sources seems to accumulate around past sites of controversy such as scabs protecting a wound. For example, the controversial assertion that plant manufacturer General Electric was previously warned about possible design flaws requires not one but three references and much exposition.

This brief analysis gives a sense of what is at stake in the editors' negotiations, but to understand the article "in action" (Latour 1987), rather than as a ready-made product, it is important to look back in time, something Wikipedia allows us to do with its extensive documentation (Wyatt et al. 2013).

The Edit History Page

To follow the controversy as it is played out within the setting of Wikipedia, it is first helpful to determine where the controversy was "hottest" (Venturini 2009). One could, time and energy permitting, read through every one of the thousands of edit comments and corresponding versions of the article, playing "spot the difference," but instead the edit history page allows for a quantitative analysis.

To get a sense of what is going on, one can start with a rather blunt measure of frequency of activity: one of the ways Wikipedia editors themselves profile articles and locate controversy is through edit counts and size. These can be visualized with Wikipedia's built in tools such as Wiki "page statistics," but for more fine-grained analysis, I used the Digital Methods Initiative's Wikipedia "Edit Scraper Localizer" tool, which downloads the entire edit history page of an article as a .csv spreadsheet.

For the page "Fukushima Daiichi Nuclear Disaster," Figure 1 shows the cumulative edits to the article (red) and the size of the article (blue) in bytes over the course of a year.

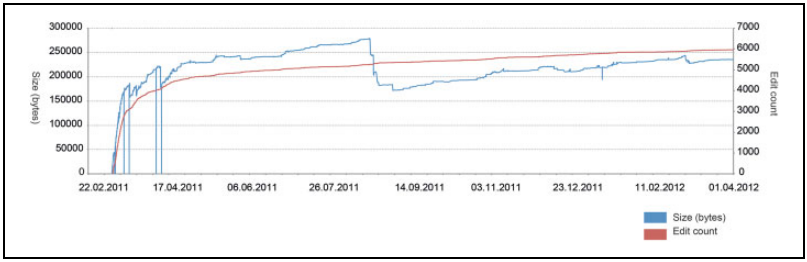

Figure 1. Edit counts versus size: Cumulative edits and total size (in bytes) of Fukushima disaster article.

First, this simple graph (Figure 1) shows that much of the article was written, while the event was unfolding. There is a rapid pace of editing and expansion in size in the first week, both of which plateau in the ensuing months and years. This is in sharp contrast to the often methodical pace of constructing articles about settled historical events. But what is particularly interesting about the article size are the noticeable dips to zero bytes (the vertical lines). These show when the article was temporarily deleted (making it zero bytes) and its contents reemerged back into a different article "Fukushima Daiichi Nuclear Power Plant," where the discussion first started as a subheading before spilling out into its own page. This is an important point in that it shows how the controversy is not contained by any particular page, which might be the assumed unit of analysis for many Wikipedia scholars (see also Weltevrede and Borra 2016).[6]

The flurry of initial activity, depicted in the graph, invites us to ask how the issue formed and became controversial. However, Marres and Weltevrede (2013) argue that many platforms steer researchers toward using frequency measures, such as edit count, which measure what is popular or trending. These measures, which they refer to as measures of "*liveness*," are not necessarily the most interesting sociologically. They argue that researchers also need to think about the dynamics of shifting content, which they refer to as "liveliness." Textual content is hard to parse quantitatively, but one can certainly investigate the texts qualitatively.

I started by locating the first glimmer of activity on the original "Fukushima Daiichi Nuclear Power Plant" page, where the issue was first mentioned but was not yet controversial. A lone anonymous editor adds the following sentence to the preexisting article:

> NHK broadcasing [*sic*] reports: Nuclear Emergency was declared reactors were all shut down but reactor 1 had cooling problems "cooling pumps" were non-functional . . .

Notice the very unencyclopedic sounding lead in "NHK reports." NHK is a media source but generally regarded by editors as a "reliable" one, the equivalent in Japan of the public service BBC in the UK. A half hour later, another editor adds a qualifying sentence: "However, there is no evidence of any radiation being released" and references it to a story in *Business Insider*.

In the first few hours of the nascent controversy, two things become clear. First, there are (at least) two sides to the debate, editors playing up the severity of the crisis and editors playing it down. Second, these editors are dependent on the mainstream news for information, and thus, much of the activity, cosmetic edits aside, is structured around incoming references.[7]

In following the actors, one can also trace these claims back to their source. The *Business Insider* article, which is used to temper the original claims about radiation and back up several further statements, is interesting in itself. Not only is *Business Insider* an odd choice of publication to cover this particular event, it is also, in fact, a "live blog"—a common format in online news sites. When an event is transpiring in real time, rather than craft separate finished articles, the same permalink can be updated with paragraph-sized morsels in reverse chronological order (newest on top).

Scrolling all the way down, it appears that the first claim about the incident is sourced by *Business Insider* to *Kyodo News* with a hyperlink. The claim about there not being any evidence of radiation leakage is sourced to Twitter, to the Sky News Account, which is in turn quoting a government official in a press conference.

> Japan government official says technicians are currently unable to pump water to cool the reactor at a nuclear power plant in the country. @SkyNewsBreak

Following the chain of transformations (Latour 1999) from Wikipedia through different platforms and sources, the trail leads to a physical press conference in Japan.[8] The irony is that despite the plethora of different sources in the early stages of the Wikipedia article, most of these journalists are in fact referring to *the same source*, the government spokesperson, who is in turn relying on energy company, TEPCO, for the latest information.

The References

So, sticking with the controversy led me outside the nominal boundaries of Wikipedia to the collection of news sources, press releases, and documents (the reliable sources) that inform it. This would be a problem if one assumed the platform as the natural boundary of the study. These sources largely set the tone for the debate and limit what can be said in the Wikipedia article. However, it is hard to get a sense of the overall composition of the references without reading each version of the article individually. Just because the references are documented and stored as digital data does not mean they facilitate easy analysis (Venturini et al. 2014).

Wikipedia's referencing system is fully integrated into the interface—users enter them with a <ref> tag in the text, and they are automatically collected at the bottom, but there is not a universally recognized format for the citations. Some references include a published date but not an accessed date; some do not have authors or even hyperlinks. These inconsistencies are exacerbated in fast-paced events where some users may place a bare hyperlink as a reference in the hopes that another user will clean it up later. This makes the references hard to scrape or analyze, and there are, at the time of writing, no existing tools for analyzing them. Yet why should one let the research priorities be set by the data that are easily available? Ethnographers would not encounter shy informants or closed doors and give up so easily. The references seem to be a crucial influence on the content of the article, which may reveal patterns over time, so it seems pertinent to try and map them—to go somewhat *against* the formats supplied by the device.

The below visualizations were created by scraping different versions of the article "Fukushima Daiichi Nuclear Disaster" for the URLs contained in references at the bottom. Due to file size constraints, I was only able to scrape one in ten versions of each article, but in future, this could be made more granular.[9] For each version, I collected each of the references and parsed the host domain from each full URL (e.g., "bbc.co.uk" from "http://www.bbc.co.uk/news/world-asia-pacific-13678627"). References that did not contain a link, or for which the scraper failed to obtain one, were labeled "No Link." I then visualized the composition of sources (host domains) for each article version using a "stream graph" provided by Density Design's RAW platform (Mauri et al. 2017) (available from https://rawgraphs.io/.). I began with the first four days of the article where the activity was most concentrated according to the frequency diagrams.

In Figure 2, the *x*-axis represents time, and each vertical slice represents an individual version of the article. Because each vertical slice represents every

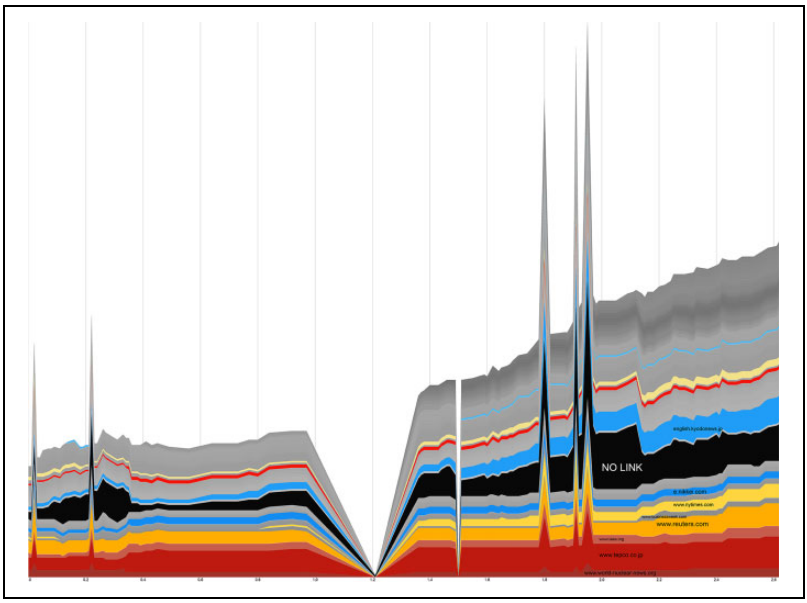

Figure 2. "Fukushima Daiichi nuclear disaster": composition of article references March 11, 2011 - March 18, 2011.

tenth edit rather than a regular time interval, the slices get closer together when editing frequency increases and further apart at slower times. Each domain (e.g., www.bbc.com) was first given a grayscale strip and sized according to the number of individual references originating from that domain at a given time.[10] Following RAW's conventions, the stripes in the top image are ordered from largest to smallest, largest on the bottom, starting from their position in the first slice. Select domains were manually colored to highlight different types of sources: red = nuclear industry sources, blue = Japanese news sources, yellow = Western news sources, and including wire services.

This graph does manage to flesh out and qualify the frequency graphs, revealing how the composition of references is potentially skewed. Normally, Wikipedia articles are supposed to be based on books and scientific articles, but this graph clearly shows a focus on mainstream, Western news organizations, particularly news agency Reuters. This is not uncommon in Wikipedia articles about breaking news stories, but more striking in this case is the amount of reliance on self-reporting by TEPCO in the form of press releases. Also playing a significant role was the International Atomic

Energy Agency (an international UN-based agency for nuclear safety). This speaks both to the lack of independent information on the ground and to the homogeneity of voices.

So what are the sharp spikes? By examining the article versions, one can see that they mostly correspond to particular events or announcements in the news, such as the explosions in reactors 1 and 3. Sources and information are first gathered, creating an expansion in the graph, and then reduced as the significance of the event becomes clear and references are pruned. Facts require fewer qualifications as they become settled (Latour 1987). The massive gap in the middle of the graph represents one of the attempts by editors to move the page back to the "Power Plant" page (temporarily deleting the references along with the page text). It could be suggested that a sharp increase or decrease in sources is an indicator of controversy, but are these necessarily controversies about Fukushima? For example, around March 15, 2011, there is a sheer drop in sources, this time not driven by a news event but by a bot called DumZiBoT that is in charge of cleaning up references—converting bare hyperlinks (a placeholder, normally) into full citations. The bot also merges duplicate references. This is why the "no link" bar noticeably contracts, that is, because some broken references have been fixed. While it is important to entertain the possibility that these platform-specific practices may be consequential for the controversy, not all of them are (Marres 2015).

Now, what happens to the article over a longer period of time? Figure 3 utilizes the same approach but each slice corresponds to 1 in every 100 edits and spans the first year of the "Disaster" article.

This graph (Figure 3) gives a longer but less granular view of the dynamics of references. The time span of the previous graphs is here represented in the flurry of activity at the left, where the time slices are denser—the pace of editing slows considerably as the months go on. Now if Wikipedia references functioned like scientific citations, as Kildall and Stern (2011) have suggested, then one might expect a process of black boxing, that is, the gradual *removal* of sources as facts become broadly accepted. The primary documents (press releases) and wire services should be replaced by the ostensibly more detached mainstream news, which would, in turn, be replaced by more comprehensive scientific and historical papers and books. While around August 2011, there is a systematic culling of sources and cleaning up of the article, which was also visible in the frequency graphs, it is interesting that the primary sources and wire services have not been replaced but merely built around. The original Reuters and TEPCO stripes remain largely intact as other less prominent sources were

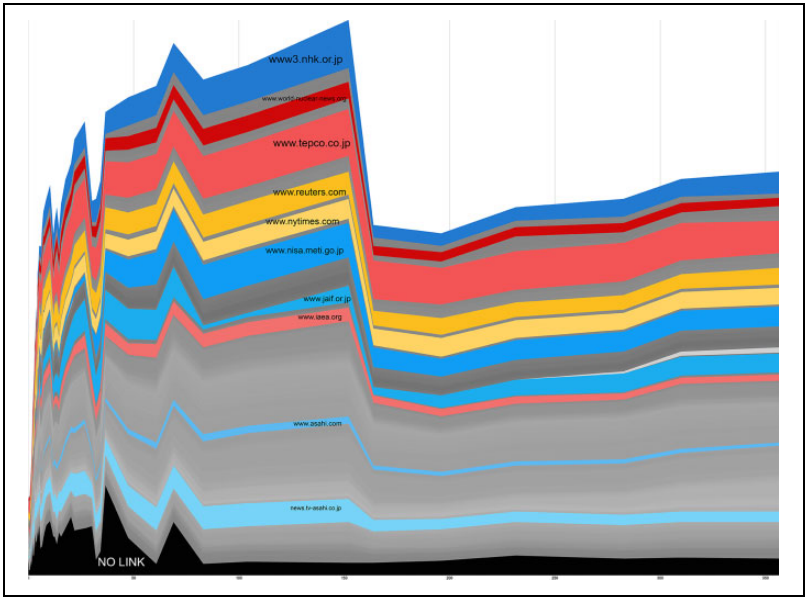

Figure 3. "Fukushima Daiichi nuclear disaster": composition of article references March 2011 to March 2012.

pruned around them. This pruning of sources, as mentioned earlier, happens in the heat of the moment but less so as the article becomes more stabilized.

This approach at least seems to suggest that the primary sources, mainly from the government or TEPCO, were in a position to set the tone for the ensuing discussion. But this visualization cannot on its own explain the influence of these references on the content of the article. If the sources often come from TEPCO, then how does the article maintain such a critical stance on the company?

In this section, I have used digital methods style techniques to repurpose the natively digital objects of the medium. But this was not exactly the same as "following the medium" because Wikipedia does not make it particularly easy to repurpose these particular traces. My solution was rather rough and ready, but by purposely not reducing or simplifying the data, and by including the "no link" strip, I could keep in view some artifacts of the graph's creation and also what might fall outside the graph (other articles and unformatted sources).

This graph suggests that references are not being used in the ways one would expect from Wikipedia's policy or from analogous work on scientific references. It also highlights a potential power asymmetry in the settlement

of this controversy on Wikipedia (and beyond), in which certain types of sources are privileged over others. But to stop here would mean accepting a certain determinism to this asymmetry (or a conspiracy on the part of TEPCO). In order to complicate this stance, one needs to dig deeper, and examine different data, to get at the practices and less formal "shop talk" that inform the selection of these references.

Talk Page

I will now turn to the other tab on Wikipedia, the "Talk page," where problems that could not be resolved in the edit page are discussed in more detail. The discussion section is arranged in headings with posts under them, which are time stamped and "signed" by a user or anonymous accounts (identified by an IP address). Replies are denoted by an indentation under a comment. The talk page, like the references, is a textual artifact, but it is not as easily scraped or analyzed.[11] So following the controversy might involve trying to manually reconstruct the temporal order of decidedly asynchronous interactions.[12]

Again, I focused on the first few days because this is where the most enduring references first became stabilized and when the controversy was still emergent. One common criterion for source selection hinges on the tension noted earlier between Wikipedia as an encyclopedia and Wikipedia as a news medium. Starting on March 11, 2011, with the branching of the article from "Fukushima Daiichi Nuclear Plant," the "Disaster" article is quickly beset by complaints about Wikipedia's role in relation to the news. For example, one of the editors raises the following complaint under a new heading:

> The article is full of the latest information, appropriate for keeping on top of things . . . this site is supposed to be an encyclopedia, which is appropriate for getting to the bottom of things.

This editor wants the article to be more encyclopedic and rely on less current news sources, but a few days later, another user in the same discussion thread defends what Wikipedia is doing:

> This is the only location on the internet I'm aware of that consolidates the facts of this ongoing event in a concise and complete way. News stories from the standard sources are actually a poor way to follow what is happening,

> because each story is 95% the same content as the previous, with only a few new facts added as events unfold.

As one can see, debates about what Wikipedia is for and how it should be used are far from settled, they are leveraged as part of the controversy. This positioning of Wikipedia as a news source might explain the prevalence of news references, but how did the editors justify the use of primary, industry sources? Partially, this has to do with a perceived lack on the part of mainstream news. Because the editors do not trust the mainstream media's ability to parse information, they first consider reports from the WNN but are concerned that its specialist language will be too rarefied for their readers. The editors are making judgments about appropriate language, in the same way that scientists make judgments about "appropriate simplifications" in media (Hilgartner 1990). The same editor then offers the TEPCO press releases, which he correctly notes are the source for most mainstream news anyway. One editor, an "administrator" (an experienced editor with special privileges for dispute resolution), doubts some of the language in the TEPCO press releases but still thinks the official statements are safer than most news reports.

> We should restrain anyone's going beyond official statements and reliable press coverage, in the article text.

> So Wikipedia editors decide to rely on "official sources" against the standard rules of reliable sources, but they are doing so ambivalently and strategically.

Another way of deciding between sources in this article also stands in sharp contrast to the account of NPOV and reliable sources given in the policy pages: through the (performed) expertise of the editors.

> There is another error: "electric power for the cooling turbine" is clearly wrong as the turbine is the passive element and does not generate heat. It is the fuel rods or elements (mostly uranium oxide packed in zirconium capsules that are packed into hollow tubes that are mechanically adjusted to get criticality) that need cooling.

This editor is contesting the reference's wording, not based on another source, but on her or his implied expertise. She or he is presenting a version of the world with which the article is at odds, ushered in on the back of some technical terms and an assured tone. Because of the anonymity of editors, it is unclear who is "an expert" and who isn't, so this must be rhetorically

performed. So rather than reliable sources and scientific experts being used to arbitrate truth disputes between editors, authoritative sounding editors seem to be able to decide what counts as a reliable source based on what they consider to be "true."

The traditional expertise of scientists and officials is in some cases undermined, but this is replaced by other sorts of distinctions between editors (self-proclaimed experts and administrators). However, Wikipedia has other sociotechnical boundaries, such as between backstage discussions on the talk page and the audience-friendly article itself. While the talk page is full of transgressions of news and scientific norms and expert and journalistic roles, these messy exchanges, much like scientific "shop talk," must be somewhat sanitized before crossing over to the "Edit History" page, under the watchful eye of bots and other monitoring devices, in order to change the article text. While the editors may select references based on their own outside knowledge, they must *account* for their choices through conventions, policy, and technologies that reassert distinctions between different types of media.

This most obviously involves the policy of "reliable sources" and the preference for books and scientific journals over blogs, but it also involves the policy of "verifiability." Sources must be in English, so they can be confirmed by the average editor, which in this case necessarily excludes some local Japanese news sources, but not, interestingly, TEPCO's press releases, where these conventions are somewhat malleable, at least in unfolding events. In fact, some of the most consequential reasons for citing or challenging a source have to do with their seemingly incidental technical features. Below two editors argue over the reliability of a BBC story.

> I removed a reference to the BBC "live blog," since I think it's unverifiable. I notive [*sic*] 5 more references to it. Thoughts?
>
> BBC is always reliable
>
> Unverifiable is different from unreliable. That link is unverifiable because it is dynamically updated.

Although the BBC is one of the most vetted sources, as the anonymous editor alludes, live blogs are frowned on because their content is dynamically updated and may not always contain the referenced information—or that information will become hard to find, buried in new material.

Overall, one might conclude that policy and technical features of websites limit the overall spectrum of sources to the official sources and

established news sources—reinforcing the hierarchies between online news and say, blogs. However, as we have seen, editors can transgress these norms and sidestep technical features, so long as these actions are accounted for, the boundaries put back in place after the fact. This is the sort of observation that might be missed if one takes for granted that Wikipedia works in a particular way or relies on data sources or tools that are premised on the "normal" functioning of Wikipedia.

It is also important to consider that some of the social and technical properties of Wikipedia, such as the formatting and different norms and conventions between the talk page and the edit history page, are empirically interesting, while other features such as the unformatted references may impede our ability to follow the actors. One can of course reflect on these practical constraints, but they can also be traversed by resisting some of the ways platforms may steer the research process.

Conclusion

In this paper, I explored the tension between the dictum to follow the actors, linked to the object of controversies, and the inclination, or practical necessity, to work with device perspectives in either quantitative or qualitative studies. The availability of digital data through online platforms makes this task of following the actors more feasible in the first place, but it also constrains and directs our attention. Following the controversy over the Fukushima disaster on Wikipedia allowed me to show how boundaries between experts and laypeople, news and official sources are negotiated by the editors involved and some of the politics and power asymmetries implicated in this process. Because this controversy unexpectedly focused on the selection of nontraditional sources (news and official sources), this also required taking in some less formatted data and trying to link together different methods (literary/rhetorical analysis, participant observation, frequency graphs, etc.) and data formats (article text, edit history, and talk page), which was not always easy.

When researchers align their qualitative or quantitative methods with platforms, there will always be a danger that they take for granted certain sociotechnical features of platforms or assume that controversies play out on platforms in predictable ways. Yet by tracing controversies, sometimes *against* the formats that platforms provide, researchers can distinguish what is *easy* to analyze from what is *important* to analyze vis-à-vis the controversy. What counts as following the actors or following the medium is very much up for debate. The ways platforms incline researchers toward certain

sorts of questions, like their "affordances" or capacities, are not given but relationally depend on the technical competences of researchers and the specificities of particular cases. One might say that Wikipedia's use of news sources is abnormal or normal depending on existing literature or studies, and one might find that scraping the references is easy or hard in relation to other sorts of methods. The difference between following the actors and following the medium is only perceptible within situated negotiations between the researcher, the platform and the controversy, not given in advance. "Going against platforms" often means being prepared to change tack and rethink our expectations and inherited ideas about platforms as the study progresses.

For some, this could be an argument against the use of quantitative tools and scrapers. If every controversy is by definition unique, then this implies that quantitative tools and scrapers need to be remade for each and every case. However, not all controversies or situated interactions upend the norms and functions of a platform so dramatically. Also, open-source tools such as Contropedia and other Digital Methods approaches often make these overspills perceptible in the first place. I argue that, in addition to tool building, researchers should be more willing to question, modify, and tweak existing tools to take in the odd accidents and outliers that are an important part of situated interactions. Such a critical orientation to platforms and tools will be crucial if qualitative ANT-inspired researchers are going to make digital tools that are more aligned with their principles and take STS research further online.

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Notes

1. This narrative is of course also a construct: even in my attempt to reveal the messy obstacles of research, I have necessarily cleaned up the process and

changed the order of events to make it comprehensible to the reader. (For example, the graphs reproduced here went through many iterations.) But it still should give a sense of the actual practical problems encountered in the research process.

2. He also cautions that what is stable may be sociologically uninteresting and also that taking for granted the taken for granted is insufficiently reflexive. Similarly, Woolgar (2002) has argued that affordances may introduce technological essentialism through the backdoor.
3. The version I analyzed was live on October 16, 2013, available here:http://en.wikipedia.org/w/index.php?title=Fukushima_Daiichi_nuclear_disaster&oldid=577437991.
4. The version I analyzed was live on January 4, 2013, available here: http://en.wikipedia.org/w/index.php?title=Wikipedia:Neutral_point_of_view&oldid=531272988.
5. It is also interesting to note that the scope of the Wikipedia article includes the distant future, while the World Nuclear News (WNN) report limits its speculations to the present. This seemingly incidental stylistic feature of the WNN article has consequences for the extent to which the long-term effects of radiation can be discussed in the report at all.
6. The Digital Methods Initiative has created a tool that visualizes the relational character of page-disputes (Currie 2012).
7. Something that is confirmed by a quantitative content analysis of the discussion page (Hara and Doney 2015).
8. To be truly imminent to the controversy, one might need to travel to Japan or interview survivors or declassify documents, and so on; so, clearly some practical boundaries cannot be traversed so easily.
9. This is another practical limitation. It would be preferable to use continuous data or at least group and subtotal the references from every ten edits. Sampling one in ten allows for the unlikely possibility that something catastrophic is happening between these edits that will not become visible.
10. This graph format is partially inspired by IBM's History Flow visualization (Viégas, Wattenberg, and Dave 2004), which uses colored strips to indicate the authorship of revisions. This tool does not focus on the references, however.
11. Laniado et al. (2011) and his coauthors analyzed the talk page in terms of the depth of indentations—the number of nested replies—as a way of locating controversy. This is a helpful visual guide when scanning the page, but here, I limit myself to qualitative textual analysis.
12. Since this is essentially a chat function for Wikipedia and often involves the temporal copresence of editors, I switched to a more participant observation inflected analysis (Hine 2000).

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