Moving Ethnography: Infrastructuring Doubletakes and Switchbacks in Experimental Collaborative Methods

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Abstract

In this article, we describe how our work at a particular nexus of STS, ethnography, and critical theory—informed by experimental sensibilities in both the arts and sciences—transformed as we built and learned to use collaborative workflows and supporting digital infrastructure. Responding to the call of this special issue to be "ethnographic about ethnography," we describe what we have learned about our own methods and collaborative practices through building digital infrastructure to support them. Supporting and accounting for how experimental ethnographic projects *move*—through different points in a research workflow, with many switchbacks, with project designs constantly changing as the research develops—was a key challenge. Addressing it depended on understanding creative data practices and analytic workflows, redesigning and building technological infrastructure, and constant attention to collaboration ethics. We refer to this as the need for doubletakes on method. We focus on the development of The Asthma Files, a collaborative ethnography project to understand the cultural dimensions of environmental health, and on the Platform for Experimental Collaborative Ethnography, digital infrastructure first built to support The Asthma Files but now available as a community resource for archiving, analyzing, and publishing ethnographic data and writing. A key finding is that different traditions and practices of ethnography require different infrastructures.

Keywords: ethnography, ethnographic methods, infrastructure, the Asthma Files, digital platforms, collaboration

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Ethnography as cultural critique and experiment

> What sociotechnical systems can support collaborative ethnography and how does their design make a difference?
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> What kinds of data—found, created, multimodal, big data and small—can ethnographers draw into their projects? What data can ethnographers give back, contributing to open ethnographic research commons?
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> Where in an ethnographic workflow does analysis happen? Where are there ethical decisions? How might these, too, be made visible and openly shared?
>
> What are the assumptions and ends of different forms of ethnography?

We are a group of STS scholars, styled within a particular strand of North American anthropology, that has stuck close to these questions in our collaborative ethnographic research projects and, conjointly, in our design and building of new open-source digital infrastructure to support the archiving of ethnographic data, its sharing, and its use and reuse in collaborative ethnographic analysis. We have also learned that such questions can only be answered through methodographical analysis of our own experimental practices, including the practice of software design and production. Experimental for us denotes carefully structured yet underdetermined and open-ended attempts to produce new forms of ethnographic expression responsive to ever-changing situations. Here we respond to Lippert and Douglas-Jones's (2019) call for methodography on data infrastructures and practices by reflecting on our work to develop the Platform for Experimental Collaborative Ethnography (PECE), an open-source software that provides digital space for sharing, collaborative analysis, and creative presentation of ethnographic data and writing.

Reporting on a series of workshops that became the motivation for the present special issue, Lippert and Douglas-Jones (2019) characterize their interest in methodography in and of STS as a way to understand "how methods [shape] the STS analysts' practices" or, paraphrasing John Law's keynote address during one of these workshops, "being ethnographic about ethnography." The reflexivity they seek to cultivate goes beyond introspective questions about the responsibilities of researchers, anxieties of description, and positionality to include "extrospection" that allows for "attention to performativity and materiality," accounting for what researchers actually do in the field (Lippert and Douglas-Jones, 2019). The 'field' for us is a doubled one, and the data practices we discuss here developed both through collaborative engagement with asthma and environmental health governance, and through studying digital infrastructures and data practices in the natural and human sciences; together these provided materials and motivations for designing and building digital infrastructure tailored to share ethnographic data and drive collaborative interpretive analysis. In our work, a key methodographic insight has been about the need to design research infrastructure that supports how experimental ethnographic projects *move,* changing as both research and worlds develop in twists and turns. Done collaboratively, this becomes especially messy; ethnography and infrastructure development become coupled experiments. Collaborating researchers need workflows and infrastructure to assess the multiple discursive terrains in which they operate together, constantly questioning what they are seeing, what questions extend from these insights, what additional data can be produced and drawn in, and how these data open more questions as well as possibilities for reframing and rearticulating questions posed previously. Questions—as we have foregrounded at the beginning of this article—are always at the fore. They are not answered sequentially but are continually returned to. The workflow involves many switchbacks, and constant double takes are important.

In this article we use *doubletakes* and *switchbacks* as analytics, developed out of collaborative research, that describe some of the movements of collaborative, experimental ethnography. Doubletakes are iterative analyzes of problems or data, the ongoing addition of new perspectives that are consequential and sometimes surprising. These takes, often generated by collaborative workflows and necessitated by the multiplicitous nature of

Figure 1. Switchbacks are often designed into steep terrain to make an ascent easier. Often seen in hiking trails or roadways, such as this image from Patratu, Jharkhand, India. (https://commons.wikimedia.org/w/index.php?curid=59833771)

any data or problem, may pull a project in new theoretical or empirical directions.

Switchbacks are built into our research infrastructure, much like they are built into trails or railroads traversing steep or difficult terrain. Switchbacks demand their own doubletakes as well. In one take, our platform design and development involved numerous switchbacks as we encountered limits or constraints that required us to shift our visions or goals and redirect our software development maze. In another take, we built switchbacks into the design of PECE to encourage researchers to zigzag in their workflows rather than follow a pre-planned direct path forward, to deflect a researcher's analytic gaze slightly off center from an initial intent (Fortun et al., 2021).[1] Questions, such as the ones that open this essay and those shared in the pages to come, drive ethnographic moves in these different directions. They are not just central to individual research projects and methodologies; as we detail below, we have come to see (partially) shared questions as a way to develop connectivity between researchers with different backgrounds, answers, motivations, commitments, and interests. Switchbacks and doubletakes (or triple, or quadruple takes for that matter) turn out to be much more common—even unavoidable—when working with diverse collaborators.

Our analysis of these movements is anchored in years of collective work on The Asthma Files using the infrastructures and workflows described in the following sections. This included focused meta-discussion on research practices, the development of workflow protocols, and collaborative research activities themselves. This analysis centers on the activities of The Asthma Files and PECE research communities between 2009 and 2020 and draws

on the weekly and monthly meetings of different working groups; group members' conference presentations and publications; ad hoc workshops hosted by members of the research community; and the different data sets specific to individual researchers or research collectives. Meetings, workshops, and presentations are recorded and archived along with collectively authored notes and sometimes further analyzed using 'structured analytics' of the kind we describe later in this essay.

In what follows, we first tell backstories about The Asthma Files and PECE, describing how their design and development extended from both critical theory and ethnographic study of the environmental health sciences. We then describe different stages and practices in a collaborative ethnographic workflow; the web science researchers we sometimes collaborated with taught us to think of these as 'use cases,' so that we too could design technical support for them. These stages and practices flow one from another, but with many switchbacks and constant double-takes. Support for continual movement between data collection, analysis, visualization, and project (re)design is built into our research infrastructure, scaffolding constant attention to the switch-backing, double-taking, and non-linear structure of ethnographic work and its movements and flow. In the final section, we briefly point to the ways collaborative, experimental ethnographic projects call for scientific selves largely at odds with conventional academic socialization. Suitably designed research infrastructure helps produce ethnographers for whom collaboration comes first, rather than a secondary interest or stage, and for whom analytical or topical changes are a given rather than a distraction or deterrent. The orientation we espouse, following Leandro Rodriguez Medina (2018), is 'transcendental' rather than 'strategic,' aiming to produce new research relations instead of seeking to better already existing ones. We also describe some of the challenges in sustaining such collaborations and some preliminary socio-technical protocols that we have developed to better move through and sustain these.

Backstories

Engendering explanatory pluralism

Central to both our research and infrastructural efforts has been a commitment to explanatory pluralism (Keller, 2002) and 'the multiple' (Mol, 2002). Noncommittal about locating multiplicity in either the epistemic register or the ontological, we have nevertheless worked with the clear sense that *one*—one explanation, one perspective, one world—is inadequate for the complex technoscientific challenges we want to analyze and address. Interdisciplinarity and collaboration are buzzwords for a reason—the worlds we work in demand them—and we wanted infrastructure that not only supported ethnography's tolerance and talent for difference in its many forms, but also furthered it.

Our work extends from what is variously referred to as the language, reflexive, or literary turn of the 1980s in anthropological ethnography, often condensed to the 'Writing Culture turn' in reference to a key text (Clifford and Marcus, 1986). This lineage itself extends from the critical knowledge experiments of figures like Theodor Adorno (Adorno et al.,1984), Walter Benjamin (1968), Gregory Bateson (1936, 1972), Margaret Mead (1928), and Zora Neale Hurston (1935). This lineage of ethnography foregrounds the significance of the discursive and literary forms through which knowledge takes shape, attentive to the play of form with/in content, in both the worlds researched and in scholars' own articulations.[2] In the 1980s, vibrant work in literary and language theory, semiotics, and feminist and poststructuralist theory drove this line of work forward, foregrounding the durability of colonial and patriarchal constructs of the world, drawing history and time into the present (Clifford and Marcus, 1986; Daniel, 1987; Ebron, 2001; Geertz, 1973; Kondo, 1990; Lamphere, 2004; Marcus and Fischer, 1986; Traweek, 1988). Key theoretical insights were drawn from the works of Gayatri Spivak (1987, 2012), Homi Bhabha (1994), Gilles Deleuze (1990), and Jacques Derrida (1978, 1998), among others, in a lively field of critical theory reference that crossed disciplines. The critique of universalized Enlightenment reason was central. This, in turn, opened pathways to STS focused on

how knowledge is situated, partial, often hierarchically organized, and has socio-political effects (Haraway, 1988; Harding, 1986; Keller, 1992; Martin, 1998; Traweek, 1988).[3] Our commitment to collaboration stems from this experimental, interdisciplinary anthropological tradition, striving to move beyond the world as currently ordered (conceptually, socially, geopolitically) and toward more just but as yet unknowable futures. Experimentalism, here, is like that explicated by Hans-Jörg Rheinberger (1997) in his studies of the biological sciences, involving partial-visioned movements through a self-projected emergent labyrinth, toward unknown truths and unprecedented entities (see Fortun 2003; Boyer and Marcus, 2021; Estalella and Criado, 2018; Fischer, 2007).

Our collaborative challenges began with The Asthma Files, a research effort begun around 2005 when we were students and teachers in the Department of Science and Technology Studies at Rensselaer Polytechnic Institute in Troy, New York, USA. The idea for The Asthma Files stemmed from a workshop that Mike Fortun and Kim Fortun helped organize, in part as fieldwork for ethnographic research on changing data imaginaries and practices in the environmental health sciences. The workshop brought together scientists from different disciplines to delineate new study designs for gene-environment interaction research that could best capture and explain persistent health disparities in complex conditions like asthma and obesity. The time was ripe: asthma rates were escalating, for reasons that escaped any unifying biological or sociopolitical causal logics, garnering increased attention in the media and national and international agencies like the American Lung Association and the World Health Organization. Understanding gene-environment interactions was a new scientific frontier, promising new ways to understand health from both the outside in and inside out. The Fortuns were impressed by many of the scientists involved and wrote about ways scientists working to develop new methods for understanding gene-environment interfaces could be cast as 'civic scientists' engaged with the political implications of their work (Fortun and Fortun, 2005).

It was also clear that what counted as 'the environment' in gene-environment interaction studies would be dramatically and predictably delimited. In one early scientific review article, for example, 'the environment' was almost entirely limited to measurable dietary influences like cholesterol or alcohol; ambient air pollution was literally nowhere on the horizon (Hunter, 2005).[4] The Fortuns wanted to be in the deliberations about how 'the environment' would be figured in genetic studies of asthma.

The 2005 workshop included geneticists, epidemiologists, and air quality scientists, among others, from both US universities and government agencies. Each presented their approach to understanding asthma or environmental health more generally. Quickly, it became clear how hierarchies of knowledge operate *within* the sciences. The geneticists defined and, in many ways, dominated the space. Available air pollution data sets (from community monitors, for the most part) were dismissed as too noisy or imprecise to use. The geneticists wanted much more controlled, close-to-the-body data, collected by expensive, wearable monitors. The fact that massive investment of public funds in genomic data and infrastructure was responsible for the well-controlled and well-characterized data geneticists had come to value and rely on, went unspoken. Approaches to asthma that were notably complex—with many stressors and end points, some very difficult to characterize (the immunological effects of economic and security threats in poor communities, for example, or the effects of neighborhood violence on cortisol levels)—also took hits for being too complex to control. Researchers developing such approaches were both epidemiologists and clinicians; most were women.

The contentious, at times condescending, exchanges between scientists of different fields at the workshop was palpable to the Fortuns as anthropologically observant participants. Nonetheless, the stated goal of the meeting was achieving consensus rather than exploring meaningful differences. By the end of these sessions, participants were supposed to agree on recommended best practices for study designs that could help explain disparities in asthma outcomes across diverse communities.

The Fortuns came away from the 2005 workshop impressed by the need and desire for collaboration in the environmental health sciences, but also struck by the quick tendency to hierarchically order different forms of expertise and the privileging of consensus as an almost naturalized organizing principle. They were reminded of anthropologist Laura Nader's (1990) work on how 'harmony ideology' operated in Mexican legal cultures, casting difference and conflict as necessarily unhealthy and dysfunctional. Some general agreements were certainly necessary to create a shared space of work. But it also seemed important to proactively acknowledge, value, and leverage different perspectives—anchored in different data types and infrastructures, in different ways of thinking about correlation and evidence, in different ways of thinking about what makes research findings robust, in different ways researchers 'perform' asthma (Mol, 2002).

Some health and pollution scientists in the mix seemed to agree with this, emphasizing the need to develop new ways of both organizing and talking about research. One senior scientist from the US Environmental Protection Agency's (EPA) Office of Research and Development, for example, pointed to the problems with evaluating research in generalized terms of 'accuracy' rather than 'requisite precision,' arguing that different levels of precision were needed for different purposes, and that strict *a priori* designation of the kind of knowledge needed would defer urgently needed environmental regulation and public health programming. It was hard for many geneticists not to hear this as secondary, and lesser, science.

The Fortuns thus began thinking about how collaboration could be configured differently, and how different knowledge forms (from different disciplines, from different lineages within disciplines, from different geopolitical positions, from different generations) could be proactively leveraged.[5] As the limits of established ways of conceptualizing and enacting collaboration began to preoccupy them, collaboration itself became an ethnographic concern, both in their studies of environmental health researchers and in their own practice.

Growing collaboration without consensus: the Asthma Files

From these origins in gene-environment interaction research and collaboration, The Asthma Files began as an ethnographic project to understand how differently situated people—scientists in different disciplines and geographies, clinicians and public health officials, environmental activists, individuals living with asthma and their caregivers—understood and acted on asthma. The Fortuns and a growing group of collaborators (including many students, some of whom are now faculty and co-authors here) began documenting and explicating asthma knowledges in all their variation. It wasn't long, however, before the research also became oriented around different asthmatic spaces (Houston, say, or rural Bavaria), and then around subjectivities, communications, and governance (and the thematic list continued to grow). Focusing on asthma expansively, the group began to collect many different kinds of data (audio recordings of ethnographic interviews, YouTube videos and other found media, pharmaceutical advertising, health education materials, government reports from different agencies, from different periods, etc.). In short, the project evolved to include multiple different researchers, studying environmental health from multiple different angles, generating multiple different data sets to be analyzed through multiple different theoretical apparatuses—"modeling the data in different ways," in the language of the data scientists that we were talking to and thinking with more and more frequently.

Drawing out different knowledge formations, in different settings, entailed working together, often side-by-side, but with separate interests and from different perspectives: collaboration without consensus. This in turn entailed paying more and closer attention to the workflows that make ethnographic research projects move, and especially those with such diverse aspects, goals, and users. As the diversity of projects and approaches within the Asthma Files grew, we had to attend to our own methods so that we could explain them to each other and build infrastructure to keep up with them. We learned about the forms and purposes of metadata, about the many kinds of 'data' ethnographers produce (including

analytic frameworks, interview protocols, found documents and images, annotations), and about the many moments of analysis, selection, interpretation, and ethical judgement that occur as ethnography unfolds.

Three very differently focused dissertations were written in the early years of The Asthma Files: Alison Kenner's (2011) dissertation focused on modes of asthma care (and became *Breath-taking: Asthma Care in a Time of Climate Change* (2018)); Brandon Costelloe-Kuehn's (2012) dissertation focused on two environmental modeling and mapping projects developed by the US EPA to help characterize air pollution and associated health effects; Tahereh Saheb (2015) focused on public perceptions of and responses to air pollution in Tehran. We did many of the interviews for these projects together, learning to share roles and responsibilities in the conduct of the interviews themselves. Sometimes we hosted groups of people to facilitate discussions; in these larger group meetings, we (selectively) presented what we were learning in the research to elicit further interpretation and dialogue among all participating. Each collaborator made their own notes, focused in ways keyed to their projects and interests, but these notes were routinely shared with others. The diversity of foci and approaches within our research group was animating and very generative. Everyone was free to use material produced both by the group as a whole and by individuals within it. It quickly became apparent that we would need to invent ways to credit each others' contributions—data, questions, nascent analyses—and also credit the overall collaboration. As was the case for the scientific communities whose changing data practices and complicated collaborations we were studying, standard protocols and infrastructures for such work were not yet available.

The award of a US National Science Foundation (NSF) grant in 2015, "Environmental Health Governance in Six Cities: How Scientific Cultures, Practices and Infrastructure Shape Governance Styles,"—later expanded into the 'Six+ Cities Study'—took The Asthma Files collaboration to a new level, and in multiple new directions. We borrowed the name from the influential 'Harvard Six Cities Study,' a longitudinal study started in the 1970s that connected air pollution to increased mortality (Dockery et al., 1993). The study was the basis of clean air regulation passed in the United States in the 1990s, sparking intense pushback from the fossil fuel industry through lobbying organizations like the American Petroleum Institute. The data, methods, and findings of the study and associated later studies have all continued to garner sustained collaborative attention among epidemiologists, pollution scientists, and economists. We wanted to explore what an analogous collaboration at the nexus of anthropology and STS would look like, how it would sustain its data collection and analysis over time, and how this collaborative work could be done as openly as possible.

The goal of our ongoing Six+ Cities study is to document and conceptualize different 'styles' of environmental health governance in different cities, accounting for the mix of actors involved, how they understand and act on the problem of air pollution, and how they work separately and together to improve air quality and access to appropriate health care and public health resources. Our conception of governance styles extends from Ludwig Fleck's (1979) conceptions of ways distinctive 'thought styles' characterize scientific communities, largely in positive, productive, but always limiting ways. Like Fleck and the many scholars who have been inspired by his work (e.g. Gaudillière, 2004), we work to understand how multiple actors in different communities identify problems, produce and use relevant data, interpret and think creatively about that data, and are moved to action. And we work to understand how distinctive thought styles also pose challenges for collaboration across these communities. We aim to characterize a city's air pollution governance style as an effect of how different communities (local and beyond, including city, state and national government actors, residents, environmental activists, and scientists in various disciplines) come together, prioritizing some lines of research and action while discounting others.

Funding from the Azim Premji Foundation in India allowed us to expand our work to four more cities (Hyderabad, Chennai, Pune, and Delhi) in addition to the original six cities of Albany, Beijing, Bengaluru, Houston, New York, and Philadel-

phia. Groups from Los Angeles and Ecuador and researchers in Germany and Paris have also joined on. The group includes researchers situated in vastly different geographies, at different career stages, in different disciplines, and both inside and outside the academy proper. Vinay Baindur, our lead researcher for Bengaluru, is a career activist with a wealth of knowledge about politics in the city, the state of Karnataka, and India writ large. Dan Price is a philosopher (of knowledge) with little inclination for empirical documentation but exceptionally astute understanding of what is wrong with 'the system,' which he puts into practice by putting students in the University of Houston Honors College in partnership with community health workers in nearby public housing. Price also led development of a web-based map of real-time ozone levels in Houston, designed to make air pollution a topic of everyday conversation and driver of cultural change. Aalok Khandekar, who leads our research in India, is an STS researcher specializing in Engineering Studies—with special interest in transnational flows of people, technologies, and ideas—including those focused on air pollution. Many of the undergraduate students who have worked on the project also have backgrounds in and special interests in engineering. At one point, we had about fifteen undergraduate research collaborators working alongside us, coming from many different engineering fields. The questions they contributed to the group as civil, mechanical, and biomedical engineers were critical, directing our attention to comparisons and variables that we had not previously considered.[6]

In these collaborations, there have been many challenges: the need to share extremely heterogeneous primary material in a manner that makes sense to diverse researchers; the need for analytic annotation of these materials and archiving of these annotations along with associated data; the need for new genres of writing through which interpretive scholars can share their analyses in the process of development; the need to constantly shift, as with a 'jeweler's eye,' between fine-grained and systems levels analyses (Marcus and Fischer, 1986); the need to describe a complex scholarly project and its findings to diverse audiences, articulated by researchers in different contexts and at different career stages; the need to figure out how to think and talk about collaboration so that we could infrastructure it. These needs became apparent to us through our shared work over time, some immediately obvious—such as the need to think together about what we mean by collaboration—others much later, including the need for analytic structures so that the archive is legible, more open, and in motion. As findings from our collaborative work, these insights have taken time. They have been coaxed out of the workflows—research analytics, archiving protocols, presentation formats—that we describe in the following section.

While the 'backstories' offered here may read as somewhat linear narratives, the paths to where we are today were far from straightforward, moving from the gene-environment interaction workshop, to the Asthma Files, and later to the Six+ Cities project involved frequent backtracking, problem circling, contradictory views and divergent analyses, dramatic shifts in interests and thinking, and the creation of experimental offshoots that sometimes came to blunt endings. Most importantly, we realized there was no available research infrastructure that not only tolerated these dynamics, but also encouraged them.

In one early research trip in 2008, for example, four of us (with two young kids in tow) conducted almost thirty interviews over a few days at the US EPA's Office of Research and Development in North Carolina. Driving down from New York, we sidetracked to witness the immediate aftermath of the Kingston coal ash spill, which had rolled over and washed away houses and filled Tennessee's Emory River with black sludge just a few months earlier. Asthma Files researcher Alison Kenner was based for six months in Knoxville—one of the American Lung Association's 'Asthma Capitals' for its high incidence of respiratory conditions due to burning coal for generating power and the lack of smoke-free laws—and began to study the response. For various reasons she, and thus our research effort, soon moved on.

Asthma Files researchers have not conducted field research in Tennessee since 2008, but the disastrous ash spill of four million yards of toxic coal ash (moved eventually from this mostly white

community to a strikingly poor Black community in a different state) still figures as a prominent case within the project as an early sign of a broad need for new digital infrastructures. These kinds of research switchbacks—sudden changes in research directions—happen frequently in ethnographic projects, and the materials collected and analyses begun usually get tossed in a file cabinet drawer or box, forgotten by the initial researcher and lost to potential collaborators. While our project design and ethnographic sensibilities encouraged such switchbacks, we still needed to build infrastructure that would support such halts and swerves in projects with variable and often unknown timelines.

Now, after designing and building the PECE platform described in the next section, multiple researchers can still keep their eyes on the Kingston coal sludge disaster, accessing related materials—news stories, documentaries, and environmental studies—and preliminary analyzes more than a decade later. The archiving of Kingston materials also supports teaching the case, helping us stay with the story, updating it and bringing in different kinds of analysis in keeping with the focus of different courses. At the outset, the Kingston coal ash could be cast as an 'extreme event;' over time it has become a slow disaster, productive of on-going, slow violence (Nixon 2013). The clean-up effort in Kingston eventually mobilized over 900 workers; today, many are sick and cannot pay their medical bills. Few wore protective respiratory equipment during the clean-up.[7] Recently, the region has also struggled with high COVID rates. The Asthma Files are designed to keep track of this kind of compound vulnerability, how it accumulates over time, and how it can be reinterpreted in light of new theories and new questions. Like our colleagues in the environmental health sciences (who we both study and learn from for our own practice), we have learned the value of returning to old data with updates, new analytic tools, and insight from other studies.

From flash drives to the Platform for Experimental Collaborative Ethnography

In the early years of The Asthma Files (2006-2010), we built 'files' in Microsoft PowerPoint, with every slide harboring a cluster of images and quotes that together indicated how a particular person (often some kind of asthma scientist) or organization (like the American Lung Association) articulated the etiology of asthma. Although proprietary, PowerPoint was a widely used software that allowed distributed collaborators to present collective work in a wide range of spaces independent of internet access. One slide presented the map by West Harlem Environmental Action, Inc. (WE ACT) demonstrating connections between bus refueling depots in Manhattan, emergency room visits for acute asthma episodes, and communities of color. Another slide depicted asthma scientist and physician Rosalind Wright, with a diagram from one of her grant proposals outlining her efforts to use biomarkers to link asthma to stress in low-income communities. Links to Wright's paper were in the notes. We interviewed many of the people we 'filed' like this and shared those recordings on flash drives along with the slide shows. But the image-heavy PowerPoint files soon grew so large they became very unstable, and we could not keep up with all the circulating flash drives and attachments (the files were too large for emailing at the time; cloud-based file-sharing services, if available, were still in their nascent stages). For some time, the group shifted its work to a wiki, which gave the project its first public face, but that platform, too, soon showed its limits: it did not handle large files well, and the benefit of its completely open editing capacity was also a fatal flaw when it came to handling materials that needed to be protected, and for security overall. We needed better infrastructure.

Of course, we also knew, from experience and as STS scholars, that infrastructure was anything but neutral. Thus began the saga of developing what would become the Platform for Experimental, Collaborative Ethnography (PECE), a digital research environment and publication platform, now freely available as an open-source download.[8] The platform still wobbles and squeaks a bit, but is reliable and available as a community resource. Today, there are about ten instances of PECE, supporting diverse STS projects.

PECE took a while to be named as such, and by then had its own collaborative research and design group—people with very different skills

that we had to learn to name so that we could credit them and apportion responsibility and decision-making authority among them. For example, Lindsay Poirier, trained in both ethnographic methods and information technology project management, became the lead 'Platform Architect,' with clear authority in software development decisions. With a background in OpenBSD software development and an education in STS, Brian Callahan (eventually) became PECE's lead 'Open Source Developer'—responsible for implementing evolving ideas about open source best practice as well as system administration. Alli Morgan and Kim Fortun continued leading The Asthma Files research and brought that experience and the problems they encountered back to the PECE Design Group; they took on the role of 'Project Coordinators.' Mike Fortun and Kim Fortun managed grant writing, budgets, and constant traffic between platform development and critical theory, acting as 'Research Director' and 'Development Director' of the overall effort.

A particularly formative influence on PECE was our involvement in the Research Data Alliance (RDA), an international organization "building the social and technical bridges to enable open sharing and re-use of data" (Research Data Alliance, 2016).[9] RDA was at first a fieldsite for our research on collaboration in the sciences, and the associated changes and challenges to data sharing practices and data infrastructures. Soon, however, we became active participants in the RDA, with our own commitments to more open sharing and re-use of qualitative data. We established and for many years led RDA's Digital Practices in History and Ethnography Interest Group. We also established and ran an 'output' oriented RDA Working Group focused on the special metadata needs of ethnography. Through our RDA involvement, we met and worked alongside people involved in a diverse array of digital humanities and social science projects; we also met people building data infrastructure in other 'domains' (from wheat science to transportation engineering) and with a wide range of technical expertise (in data standards, provenance, rescue, preservation, discoverability, and so on).

In the section that follows, we describe ways in which we have infrastructured and supported experimental and collaborative workflows and their subject effects in the Six+ Cities research project, in part through the design of PECE. PECE was first imagined, designed, and remains bound to particular kinds of ethnographic projects—projects especially concerned with phenomena involving tangles of scales (from the nano to the micro, meso, macro, meta, and deutero) and systems (ecological, biochemical, social, political economic, and cultural), thus calling for especially complex accounting, analysis, and accountability—usually beyond what established systems can support—while also calling for particularly complex interventions.[10]

Switchbacks and doubletakes in experimental collaborative ethnographic workflows

We often characterize the design of the PECE infrastructure as a triptych: three tightly linked digital spaces for collaborative archiving, interpretive analysis, and new forms of ethnographic expression. Here we highlight these three moments in the ethnographic workflow, and how we have come to understand them. We describe the building of ethnographic archives and the importance of thinking in terms of an economy of surplus; we also describe the 'light structures' necessary to build such archives and how 'structured analytics' produce, read, and undergird the expression of ethnography. Our descriptions of PECE genres—including photo essays, timeline essays, and what we call 'PECE essays'—point to the way genre formations have effects at many stages in ethnographic workflows. These genres in turn open up new possibilities of linking to source data in traditional publication formats (the journal article) thus extending back across the triptych and stitching them together. We close this section by reflecting on the (collaborative) subject effects that drive researchers to PECE, in turn producing a need for discursive, analytic, and ethical as well as technical support. Switchbacks and doubletakes, as we describe in the sections below, animate our work at every stage.

Building open ethnographic archives

> Social anthropology has one trick up its sleeve: the deliberate attempt to generate more data than the investigator is aware of at the time of collection. Anthropologists deploy open-ended, non-linear methods of data collection which they call ethnography…Rather than devising protocols that will purify the data in advance of analysis, the anthropologist embarks on a participatory exercise which yields materials for which analytic protocols are often devised after the fact. In the field the ethnographer may work by indirection, creating tangents from which the principal subject can be observed (through the 'wider social context'). But what is tangent at one stage may become central at the next (Strathern, 2004: 5–6).

Data collection for experimental ethnography needs to be assertively expansive, archiving much more than mandated by any particular focus. As argued by anthropologist Marilyn Strathern (in a kindred lineage of anthropology), a key trick is to generate more data than one knows one needs, "creating tangents from which the principal subject can be observed" (Strathern, 2004: 6). PECE is designed to support this expansive and ever-diversifying effort to create, through tangents and switchbacks, more and more data beyond any current project frameworks and goals. Our story above about the coal ash disaster in Kingston is one example of such a switchback, where Asthma Files researchers went off on a tangent, archiving those materials as data to be returned to, by the same or by other researchers, before setting off in a new research direction.[11]

Not everything becomes data, however; data collection results from a process of constant selection, and thus has been subjected to analysis even before analysis has properly begun. In experimental ethnography, the 'object' or data in many ways *is* the context; it is context that has to be (interpretively) documented; what constitutes the figure has to be drawn forward from its ground. This analysis *within* data collection usually happens tacitly; making that 'drawing forward' more explicit and documenting it keeps the productive ethnographic workflow visible while keeping it open to question (Fortun, 2009).

In PECE, it is documented when an artifact is uploaded in a field for 'critical commentary.' In this space, researchers are *required* to say why a given artifact—a government document, a found image or oral history, or an interview collected by the researcher—is, for them, significant. Why did they consider it to be data? What context, empirical and/or theoretical, made it meaningful? This documentation both personalizes the data and opens it up for use by others (who can work better with found data if given a sense of its origins). We stress again the *required* aspect of this: we knew from examining our own workflows and turning them into an ethnographic 'use case' that this process usually goes unnoticed and undocumented, so *why* a researcher thought this text or image should count or qualify as 'qualitative data,' is lost. PECE forces its users to make this process of making meaningful data more explicit by taking the Dublin Core metadata field named 'description,' re-naming it 'critical commentary,' and re-coding the user interface to make this a required field rather than an optional one. A researcher cannot contribute data unless they do this.

Figure 2 exemplifies the results of this ethnographic workflow.[12] Prerna Srigyan, an Asthma Files researcher working at the time in Delhi, contributed a graphic drawn from a (non-digitized) report from a Delhi-based NGO showing how they mobilized scientific data comparing the contributions to air pollution of compressed natural gas versus diesel fuel, for a public education campaign and for court proceedings. In addition to the standard metadata (format, date, etc.) both visible and undisplayed, the additional metadata in the 'critical commentary' field here provides information about the provenance and context of the document and image, including Prerna's recollection of stories told by an uncle about these events and air pollution in the 1990s. Qualitative data is made more qualitative from the bottom up, in effect, by further qualifying it with this added metadata.

PECE also infrastructures *comparative* generation of data. In some instances, collaborating researchers task each other to build, for example, a collection of media articles about air pollution for a delimited period, planning to analyze these

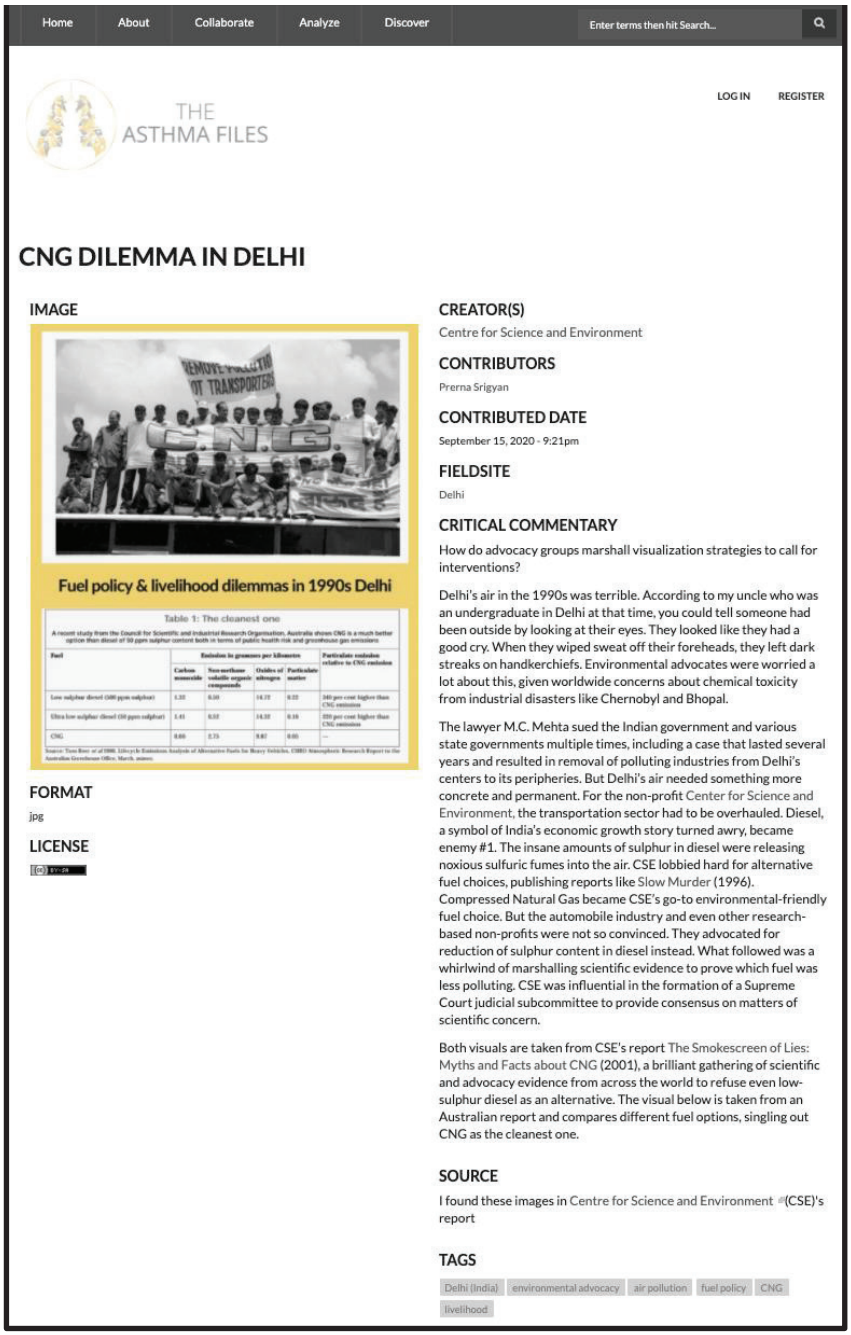

Figure 2. "How do advocacy groups marshal visualization strategies to call for intervention?" is the question opening this critical commentary added as metadata, and so creating new ethnographic data out of a 2001 NGO report.

both to compare discursive formations in different sites and to elicit feedback in subsequent interviews. Collaborating researchers are also encouraged to bring forward critical points of reference from their particular sites—to share what they have learned, but also to prompt consideration of dynamics in other sites. Sometimes this kind of analysis is achieved in the 'critical commentary' for an artifact, but it more often occurs through responses to 'structured analytics.'

Questions at every turn

Ethnography generates new questions at every turn: about how to draw figure from ground, about how to redirect data collection, and about ways to guide the writing and expression of ethnographic knowledge. On one hand, this is not surprising; it is routine ethnography. It becomes less routine when you try to infrastructure this generativity, capturing and codifying it so that it can be leveraged collaboratively.

In The Asthma Files, infrastructured by PECE, questions produced and responded to by different researchers at many stages in an ethnographic workflow are archived, like data, as 'analytic structures.' In The Asthma Files, this collection of analytic structures—to which any user can add—has become dizzyingly extensive; we have learned just how many different kinds of questions ethnographers ask through building technical means to preserve and display them. We are still working to understand how to name and categorize them in ways that keep them proliferating yet navigable. It is these questions that produce connections (another kind of metadata) between data artifacts. They are rhizomatic, working like the lungs of the system to continually breathe life into every data object and each expression of

ethnographic knowledge. The last thing we want to do is close them down or cut them out.

'Analytic structures' are sets of questions used to collaboratively examine and interpret data artifacts in the platform (Figure 3)—an image, a recorded interview, a grey document produced by a community organization, a scientific publication, even a 'PECE essay' (see below) about a whole project. Importantly, these question sets can be continually amended and extended, and users can read how others have responded to the same question that they are addressing. Interpretations are not bound by a coding schema; responses to an analytic can be in sync or divergent, shaped by interaction among researchers within the interpretive process, leveraging their differences.[13] The goal is not saturation, but to multiply and juxtapose interpretations, producing what we have come to call kaleidoscopics: the capacity to see the phenomena we are concerned with in many different ways, re-patterning objects by changing analytic frames.

PECE analytic structures expose routine moments in an ethnographic workflow that usually go unmarked, and scaffold analysis at different points in the research process. Some structures—sets of questions for interviewing differently positioned social actors, for example—help a researcher *produce* data. Other analytic structures scaffold researchers (individually or collaboratively) as they analyze and interpret an interview, found document, image, or other artifact. Still other analytic structures guide data *connection*, helping researchers pull from many sources to characterize a person, organization, or place; "Thinking With a Neighborhood," for example, is an analytic set used in The Asthma Files to compare asthmatic spaces (Figure 3).

Analytic structures also allow researchers to collaborate during (rather than after) the process of interpretation. And they continually decenter both data and project, nudging researchers to develop new angles on what they study, pose new questions, and build new relations to other researchers. These movements are not only tolerated but encouraged, animating the platform as a whole.

"This is an interesting question," reflects one Asthma Files researcher in her annotation of a map (Figure 4); beginning with a question not of her own making sparks an unexpected reading. By continually exposing researchers to long lists of questions they had not thought to ask—and encouraging them to add yet another one to the list—PECE infrastructure promotes doubletakes and switchbacking analysis, keeping both research

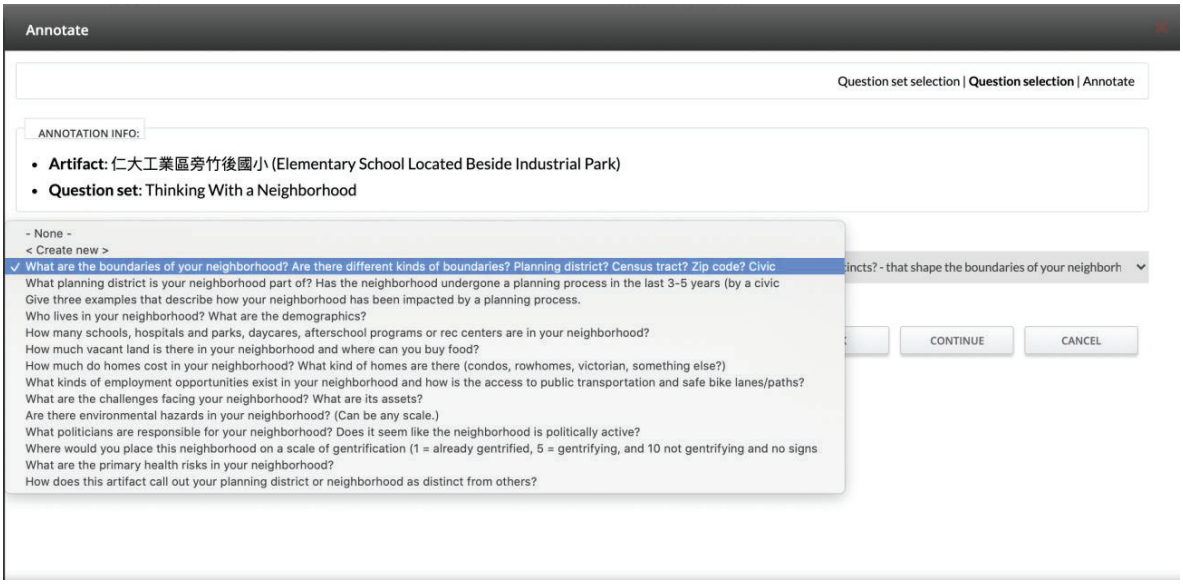

Figure 3. This screenshot shows an Asthma Files researcher going through the process of annotating an artifact. The researcher selected the "Thinking With a Neighborhood" question set and is now selecting a specific question to structure the artifact annotation (note, also, that the "<Create new>" question option appears at top). The researcher's annotation will then appear in a collection of all the annotations for this specific question, for this artifact and for all others. See Figure 4 below for an example.

and researcher moving in new directions, re-questioning and re-reading data rather than trying to place them into an established coding schema. Clicking on the question itself leads to further potential switchbacks, calling up all responses to this question by all researchers writing in response to other maps (Figure 4). Different researchers and their different readings of different data artifacts in

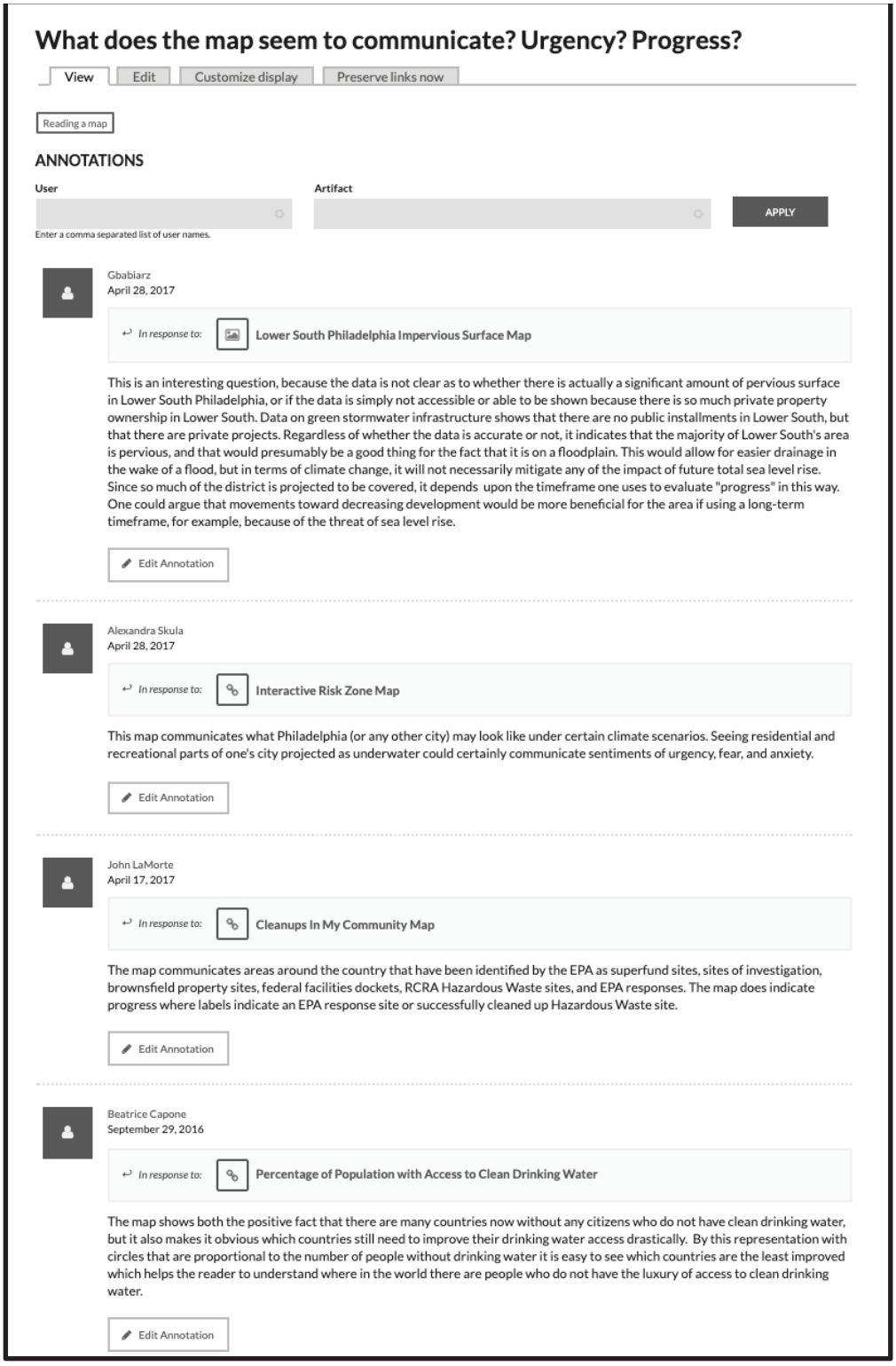

Figure 4. The above analytic question, "What does the map seem to communicate? Urgency? Progress?" is part of the "Reading a Map" analytic. The screenshot shows how different researchers have taken up the question to analyze different map artifacts.
(https://theasthmafiles.org/content/what-does-map-seem-communicate-urgency-progress)

response to different questions are handled by the system as forms of metadata for each other, able to be reorganized around each node, creating an emergent rhizome of questions, researchers, and data that switchbacks analysis.

Structured analytics have been a gathering place and generative apparatus for Asthma Files researchers. In our work on Houston, for example, we learned about the pressing significance of legal jurisdiction and the way it splits across the city and surrounding municipalities—many of which are home to and politically captured by petrochemical plants. These petrochemical plants of course pollute and pose explosive risks across jurisdictional boundaries. Power-laden play across jurisdiction is thus key to Houston's environmental governance style. Learning about this in Houston prompted the creation of new structured analytic about the significance of jurisdiction to ask in other sites. This, in turn, prompted questions about the key organizations in environmental governance in different sites, adding to the "Analyzing an Organization" question set. What came to the fore in Houston moved analysis at other sites.

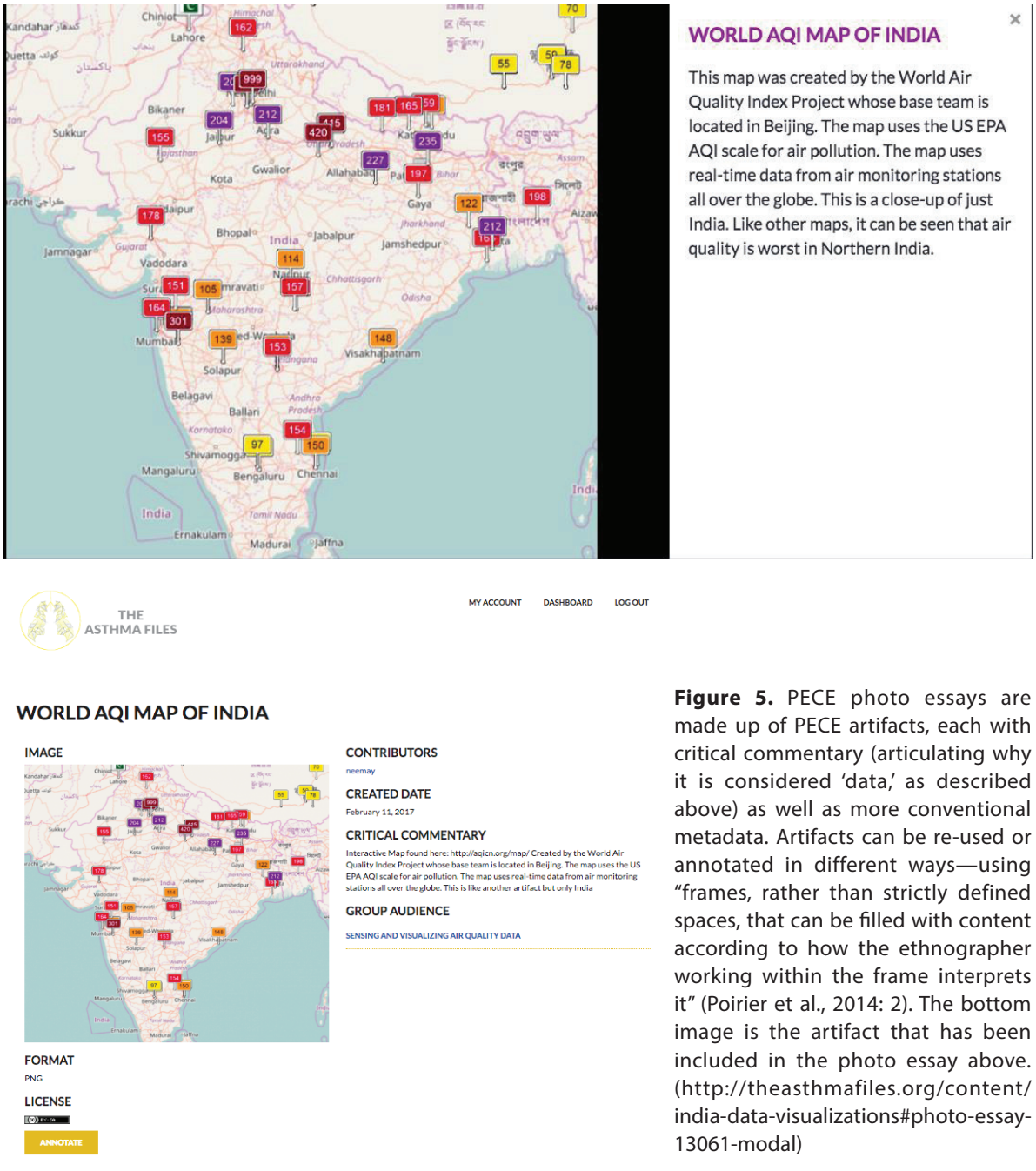

Figure 5. PECE photo essays are made up of PECE artifacts, each with critical commentary (articulating why it is considered 'data,' as described above) as well as more conventional metadata. Artifacts can be re-used or annotated in different ways—using "frames, rather than strictly defined spaces, that can be filled with content according to how the ethnographer working within the frame interprets it" (Poirier et al., 2014: 2). The bottom image is the artifact that has been included in the photo essay above. (http://theasthmafiles.org/content/india-data-visualizations#photo-essay-13061-modal)

Working on and through PECE has also keyed our attention to the ways data practices and infrastructure are part of environmental health governance. Across the cities we have studied, we have traced how people have created, accessed, and used air pollution data, debated its significance, and found ways to act on it. Collecting visualizations of air pollution has thus been an important part of our work, noting how the data was created, accessed, used, compared, acted on, and rendered into political claims. Some visualizations cast air pollution as leveling, impacting everyone; other visualizations draw out different impacts across neighborhoods, regions, and social groups. We pursue these differences in our effort to characterize distinctive styles of environmental health governance.

PECE's photo essay tool has helped keep up with and share these data visualizations. Researchers curate photo essays by pulling image artifacts from the platform, all with metadata, but add extended captions to contextualize and interpret each image (see Figure 2 for an example of captions). Readers of a photo essay can annotate it and the annotations are archived with the essay, or they can click through to the artifact itself and annotate it. In the essay in Figure 5, Prerna Srigyan compares visualizations of air pollution data in India produced by different organizations (the World Health Organization, Indian newspapers, etc.). Another photo essay by Srigyan is built around photographs she took at "Breathless," a popular 2019 gallery exhibition in Delhi.[14]

PECE's photo essays—and other genres, including a timeline and collage-like PECE essay—allow collaborating researchers to pull their data into forms that can be shared, analyzed and interpreted collectively and comparatively *early* in a research workflow, too. The data in these forms is neither raw nor cooked, so to speak, but 'lightly structured' (Poirier et al., 2014). Putting photo essays side by side, researchers from different universities, working on distinct projects can leverage contextual and visual details to suss out more general claims about environmental health governance. This work can also serve as a type of research protocol and analytic model for other researchers. The photo essays produced by researchers working in India, for example,

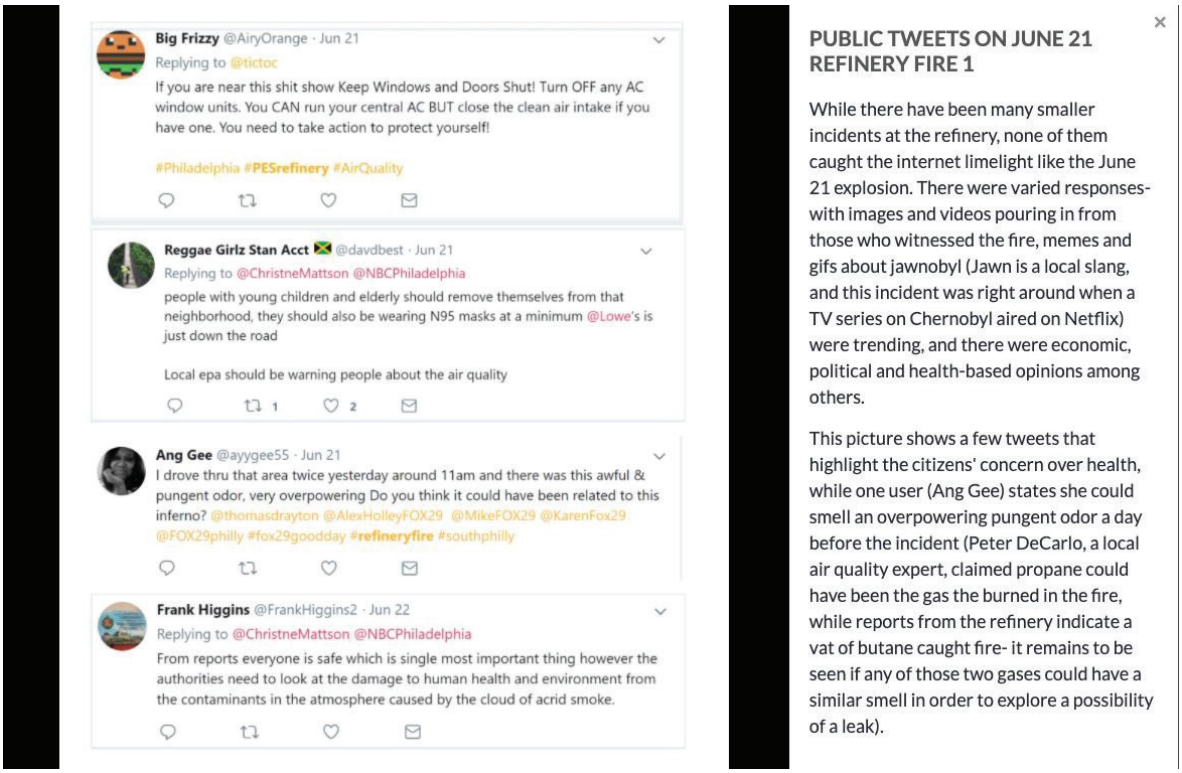

Figure 6. This slide from the photo essay "PES Refinery: Public Opinion on Tweets" shows Twitter users discussing how to stay protected from the unknown atmospheric harm. (https://theasthmafiles.org/content/pes-refinery-public-opinion-tweets#)

inspired the Philadelphia Six+ Cities team to attend to how various publics share experiences with air pollution when regulatory agencies are silent on the matter. The PECE photo essay became the model used to collect data and analyze public response to the 2019 Philadelphia Energy Solutions (PES) refinery explosion. Thinking with representations of air pollution in India using the photo essay in Figure 5, Philadelphia researcher Atharva Bhagwat looked to additional media outlets—Twitter and Facebook—to analyze public discourse around the explosion and its after-effects. Atharva collected dozens of tweets that documented different experiences with and perspectives on refinery air pollution, curating them as the event unfolded over several weeks in a photo essay modeled after the work of researchers working in India (Figure 6). The photo essay tool, in other words, provided a frame for researchers to quickly gather media responses, offer critical commentary, and share with the larger Six+ Cities research community.

PECE is designed to support this, helping move unstructured, largely inchoate data into spaces with just enough structure to be available to collaboration. The work done at this point in an ethnographic workflow is rarely conclusive; researchers constantly switch back to it, working simultaneously in a very empirically granular way and at many other scales.

Experimental expressions

The heart of The Asthma Files and the collaborations it supports is its continually growing, at this point overly unstructured, archive. This archive includes many kinds of data, from many stages of the research process, from many different projects. It feels excessive and beyond grasp—and this is its strength and promise. It is the surplus that makes experimental ethnography creative, interrupting obvious or habitual connections and continually offering unanticipated materials. It is not an economy of scarcity. Projects, interpretations, and arguments have to be drawn out, and can be evidenced in creative ways.

We are aware of the limits and often exclusionary politics of demands for evidence-based knowledge (Adams, 2016; Hodžić, 2013) while at the same time interested in how ethnographers can better show and share their data. The challenge is as much infrastructural as it is political or epistemological. To make a long discussion too brief: valuable projects like the Qualitative Data Repository support data sharing for the qualitative social sciences, but by design their infrastructure is purposed towards reproducibility, or the validation of existing hypotheses or knowledge.[15] PECE is designed to privilege the iteration of questions and knowledge, sharing data so that they are open to collective re-evaluation and reinterpretation. The data and analytic structures described above support this desire for iteration through collaborative analysis that runs by switchbacks and encourages doubletakes.

In experimental ethnography, objects of study and concern are not known in advance; they have to emerge through the research process through constant traffic between figure and ground (Fortun, 2015)—and then re-emerge again. The process is question driven, not hypothesis driven; it creates many partial knowledges and keeps them all in play; it is densely empirical but also discursive. We have called this the 'depositivist style'—a mode of research and style of thinking marked by the trace of scientific positivism but destabilized by the play of deconstruction (Fortun et al., 2021). It is a research style that privileges the depositing of data exceeding, in quantity and interpretability, what any one researcher or even collaboration needs or knows what to do with; it depends on infrastructure that endures, while ensuring openness to analytic switchbacks and interpretive doubletakes, movement and changeability.

Digital forms thus add considerably to the expression of ethnographic knowledge—saying much more than can be said on a printed page and depositing new materials to allow others to say even more. The Asthma Files and other PECE platforms and projects experiment with what this can look like, leveraging PECE functionalities. Text artifacts, photo essays, timelines, and PECE essays can be well used within a research process—to bring things together for collective consideration. They can also be considered finished products—publications in themselves (see Figure 7). We are currently extending PECE infrastructure to formalize their peer review, offer standardized

citations, and assign persistent identifiers (like Digital Object Identifiers (DOIs)) that will make them visible in the same register as academic journal articles.

The point is not to work around but to weave in and out of established modes of academic publishing. Digital forms open up new publication possibilities. Digitally infrastructured ethnography creates rich archives of shared source material from which interpretations and arguments can be built, evidenced, re-analyzed, and pushed further in multiple directions. Established forms of STS publication—the journal article, especially—can link to these archives, further substantiating the claims made in them. Equally important, however, is the way links to source material opens pathways for reuse and re-interpretation of materials in later projects, carried out by researchers in varied settings today and into the future. PECE sets up *future* collaboration.

Linking to source material in STS journal articles can help unsettle uneven access to and control over research data among scholars. The advantages of linking STS publications to source material are thus multiple: it would enable STS as a field to better *advance* knowledge, literally building on and extending the claims of prior publications. It also would create a research commons supporting a more diverse STS community. Perhaps most importantly, sharing and linking to source materials would upset the propertied figuration of the proper academic subject—the way academic authors are themselves cast as colonial figures: as masters of bodies of knowledge, as owners of their data, as entitled to hand over their (usually publicly funded) publications to commercial publishers, who put them behind a paywall.[16] Academic publication thus becomes a radicalizing rather than reproductive move.

Figure 7. A PECE essay has a shadow box-like structure, inspired by the art of Joseph Cornell. In each of any number of boxes within the essay, a creator can embed original text, found documents (as pdfs), audio and video recordings, and still images (displayed individually or in a photo essay). Creators can also embed another PECE essay within a PECE essay, rather like nesting dolls.__(http://theasthmafiles.org/content/hygiene-hypotheses-and-toll-receptors)

Conclusion: Designing for ethnographic differences

In *After Method,* John Law (2004) argued that conventional research methods can only ever partially account for the messy social realities that they seek to describe. Research methods, Law suggests, are also *performative*: they not only capture but also *produce* their realities. Methods, therefore, are never innocent, and necessarily generate

"truths and non-truths, realities and non-realities, presences and absences, but also arrangements with political implications" (Law, 2004: 143). For Law, such "ontological methodology" points to the insufficiency of extant social science research methods to account for the worlds we inhabit, and instead calls for "broader, looser, more generous [ways of thinking about methods]" in which multiplicities of truths, goods, and the worlds that they summon can be enabled (Law, 2004: 143).

As we have described here, we recognize the specificity of the intellectual lineage in which we work as STS ethnographers. In building infrastructure to support our collaborations and their inherent multiplicities, we had to express this specificity in technical terms. Tacit knowledge had to be rendered overt in both language and code. We have had to figure out collaborative workflows and infrastructure that would repeatedly unsettle ethnographic projects, keeping them open ended. And we had to invest considerable resources of time and money through long periods in which these resources were scarcer than we would have liked.

A key insight from our work is that there are many modes of both ethnography and collaboration, and the design of their supporting infrastructure matters. In some lineages of ethnography, often more sociological than anthropological, the challenge of collaboration is conceived in terms of stabilization and alignment: delimiting research domains, agreeing on problem characterization, developing shared vocabularies, building "shared data collection protocols" that "can and should yield data that are directly comparable" (Wutich and Brewis, 2019: 184), eventually arriving together "to produce an agreed interpretation" (Cornish et al., 2013: 79). These approaches often use computer assisted qualitative data analysis software (CAQDAS) like MaxQDA or Atlas.ti to meet these particular collaborative and infrastructural challenges.

Our approach and its challenges have been different, extending from a lineage of ethnography that encourages changes in ethnographic focus over time, responsive to continual re-readings of the discursive fields in which ethnography is carried out. Ethnography, in this vein, keeps beginning anew as it moves, its focus and questions continually shift in response to changing readings of context; by design, it generates a surplus of both data and project possibilities (Marcus, 2013). Challenging enough when done alone (because of pressures to advance through degree programs, obtain funding, publish in indexed journals, and so on); it is even more challenging when done collaboratively: the 'mess' of methods in social science research, as described by John Law (2004), becomes a technical problem. Collaborating researchers need ways to express, archive, share, and push many moments of analysis and interpretation, moving with their projects, chasing an expansive holism and semiotic density rather than settlement and focus.

A signature aspect of the experimental ethnographic lineage in which we work, we have learned, is that it *moves:* research questions, methods, and what is seen as relevant data changes as a project develops; what a collaboration learns continually redirects and recalibrates its projects. This is quite different in theory, practice, and comportment from many other fields and traditions of ethnography, where 'staying focused' and true to original research questions and protocols is a key criterion of the good researcher and research project. It takes a different kind of sensibility, different infrastructure, and different ways of writing about one's methodology to work ethnographically in an experimental vein.

The Asthma Files and associated collaborative projects have not been without social friction. But they have attracted people ready to be generous with their time and imagination, interested in both the critical promise of collaborative knowledge production and the making of a vital, inclusive, world-reordering ethnographic research commons. We both appreciate and worry about this. The Asthma Files has been largely self-organizing—growing informally with few formal MoUs or other overt collaboration agreements. We both cherish this, and know it veers toward the naïve and is not sustainable. We also know that the dominant order does not organically produce good collaborators. So, we are working harder to establish nomenclature around roles and workflows, writing short statements of 'collaboration ethics' on each instance of PECE,

and asking people to sign brief 'collaboration agreements' when joining a project. Such organizational design is a switchback of our own, adding more social structures and protocols to the infrastructure we have worked to keep open, requiring researchers to locate themselves in relation to others and other projects in our community.

But much more remains to be done. Some of the work is technical: making sure people understand the logic and rules of creative commons licenses, for example, and the ways the permissions structures in PECE allow users to create restricted spaces for a very delimited set of collaborators. Other aspects of PECE education are more overtly ethical, political, and cultural, calling people into concern about open access to scholarly publications, the promise of open data and collaborative knowledge production, and new kinds of research relations across generation and geography. Our workflows are thus rife with switchbacks and doubletakes. Switchbacks allow researchers to move between data, analysis, and expression iteratively. Doubletakes keep all in question. Experimental ethnographic workflows are indeed 'messy,' and even more so when collaborative—but they can be infrastructured. The work is both laborious and creative, conceptual and technical, affective and (we hope) effective, building capacity for addressing the many complex challenges that confront us today.

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References

Adams V (2016) Metrics of the Global Sovereign: Numbers and Stories in Global Health. In: Adams V (ed) *Metrics: What Counts in Global Health*. Durham, NC: Duke University Press, pp. 19–54. Available at: https://read.dukeupress.edu/books/book/78/chapter/100626/Metrics-of-the-Global-SovereignNumbers-and-Stories (accessed 15 March 2021).

Adorno TW, Hullot-Kentor B and Will F (1984) The Essay as Form. *New German Critique* (32): 151–171. DOI: 10.2307/488160.

Bateson G (1936) *Naven: A Survey of the Problems Suggested by a Composite Picture of the Culture of a New Guinea Tribe Drawn from Three Points of View*. Cambridge, UK: Cambridge University Press.

Bateson G (1972) *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*. Chicago, IL: University of Chicago Press.

Benjamin W (1968) *Illuminations: Essays and Reflections*. New York: Schocken Books.

Bhabha HK (1994) *The Location of Culture*. New York, NY: Routledge.

Boyer D and Marcus GE (2021) *Collaborative Anthropology Today: A Collection of Exceptions*. Ithaca, NY: Cornell University Press.

Clifford J and Marcus GE (1986) *Writing Culture: The Poetics and Politics of Ethnography*. Berkeley, CA: University of California Press.

Cornish F, Gillespie A and Zittoun T (2013) Collaborative Analysis of Qualitative Data. In: Flick U (ed) *The SAGE Handbook of Qualitative Data Analysis*. Los Angeles: SAGE, pp. 79–93.

Costelloe-Kuehn B (2012) *Environmental Media Systems: Innovations at the U.S. Environmental Protection Agency's National Exposure Research Laboratory*. Ph.D. Rensselaer Polytechnic Institute, Troy, NY, USA. Available at: http://search.proquest.com/docview/1222928604/abstract/AE2366C697BA4034PQ/1 (accessed 15 March 2021).

Daniel EV (1987) *Fluid Signs: Being a Person the Tamil Way*. Berkeley and Los Angeles: University of California Press.

Deleuze G (1990) *Logic of Sense*. New York, NY: Columbia University Press.

Derrida J (1978) *Writing and Difference*. Chicago, IL: University of Chicago Press.

Derrida J (1998) *Archive Fever: A Freudian Impression*. Chicago, IL: University of Chicago Press.

Dockery DW, Pope CA, Xu X, et al. (1993) An Association between Air Pollution and Mortality in Six U.S. Cities. *New England Journal of Medicine* 329(24): 1753–1759. DOI: 10.1056/NEJM199312093292401.

Ebron P (2001) Contingent Stories: Anthropology, Race, and Feminism. In: McClaurin I (ed) *Black Feminist Anthropology: Theory, Politics, Praxis, and Poetics*. New Brunswick, NJ: Rutgers University Press, pp. 211–232.

Estalella A and Criado TS (2018) *Experimental Collaborations: Ethnography Through Fieldwork Devices*. New York, NY: Berghahn Books.

Fischer MMJ (2007) Four Genealogies for a Recombinant Anthropology of Science and Technology. *Cultural Anthropology* 22(4): 539–615.

Fleck L (1979) *Genesis and Development of a Scientific Fact* (eds TJ Trenn and RK Merton). Chicago, IL: University of Chicago Press.

Fortun K (2003) Ethnography In/Of/As Open Systems. *Reviews in Anthropology* 32(2): 171–190. DOI: 10.1080/00988150390197695.

Fortun K (2009) Figuring Out Ethnography. In: Faubian JD and Marcus GE (eds) *Fieldwork Is Not What It Used to Be: Learning Anthropology's Method in a Time of Transition*. Ithaca, NY: Cornell University Press, pp. 167–183.

Fortun K (2015) Figuring Out Theory: Ethnographic Sketches. In: Boyer D, Faubian JD and Marcuse GE (eds) *Theory Can Be More Than It Used to Be: Learning Anthropology's Method in a Time of Transition*. Ithaca, NY: Cornell University Press, pp. 147–168.

Fortun K and Fortun M (2005) Scientific Imaginaries and Ethical Plateaus in Contemporary U.S. Toxicology. *American Anthropologist* 107(1): 43–54.

Fortun M, Fortun K and Marcus GE (2017) Computers in/and Anthropology. In: Hjorth L, Horst H, Galloway A, et al. (eds) *The Routledge Companion to Digital Ethnography*. New York and London: Taylor & Francis, pp. 11–20.

Fortun M, Poirier L, Morgan A, et al. (2021) What's so Funny 'bout PECE, TAF, and Data Sharing? In: Boyer D and Marcus G (eds) *Collaborative Anthropology Today: A Collection of Exceptions*. Ithaca, NY: Cornell University Press, pp. 115-139.

Gaudillière J-P (2004) Genesis and Development of a Biomedical Object: Styles of Thought, Styles of Work and the History of the Sex Steroids. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 35(3): 525–543. DOI: 10.1016/j.shpsc.2004.06.003.

Geertz C (1973) *The Interpretation of Cultures*. New York, NY: Basic Books.

Haraway D (1988) Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14(3): 575–599. DOI: 10.2307/3178066.

Harding SG (1986) *The Science Question in Feminism*. Ithaca, NY: Cornell University Press.

Harpring P (2017) Introduction to Metadata: Crosswalk (Getty Research Institute). Available at: https://www.getty.edu/research/publications/electronic_publications/intrometadata/crosswalks.html (accessed 15 March 2021).

Hodžić S (2013) Ascertaining Deadly Harms: Aesthetics and Politics of Global Evidence. *Cultural Anthropology* 28(1): 86–109. DOI: https://doi.org/10.1111/j.1548-1360.2012.01174.x.

Hunter DJ (2005) Gene–Environment Interactions in Human Diseases. *Nature Reviews Genetics* 6: 287–298.

Hurston ZN (1935) *Mules and Men*. Philadelphia, PA: Lippincott.

Keller EF (1992) *Secrets of Life, Secrets of Death: Essays on Science and Culture*. New York, NY: Routledge.

Keller EF (2002) *Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines*. Cambridge, MA: Harvard University Press.

Kenner A (2012) *Breathtaking: Contemporary Figures of U.S. Asthma Care*. Ph.D. Rensselaer Polytechnic Institute, Troy, NY, USA. Available at: http://search.proquest.com/docview/921504852/abstract/EAA20A974E2C4C66PQ/1 (accessed 15 March 2021).

Kenner A (2018) *Breathtaking: Asthma Care in a Time of Climate Change*. Minneapolis, MN: University of Minnesota Press.

Kondo DK (1990) *Crafting Selves: Power, Gender, and Discourses of Identity in a Japanese Workplace*. Chicago. IL: University of Chicago Press.

Lamphere L (2004) Unofficial Histories: A Vision of Anthropology from the Margins. *American Anthropologist* 106(1): 126–139.

Law J (2004) *After Method: Mess in Social Science Research*. New York, NY: Routledge.

Lippert I and Douglas-Jones R (2019) "Doing Data": Methodography in and of STS. *EASST Review* 38(1). Available at: https://easst.net/article/doing-data-methodography-in-and-of-sts/ (accessed 15 March 2021).

Marcus GE (2013) Experimental Forms for the Expression of Norms in the Ethnography of the Contemporary. *HAU: Journal of Ethnographic Theory* 3(2): 197–217. DOI: 10.14318/hau3.2.011.

Marcus GE and Fischer MMJ (1986) *Anthropology as Cultural Critique: An Experimental Moment in the Human Sciences*. Chicago, IL: University of Chicago Press.

Martin E (1998) Anthropology and the Cultural Study of Science. *Science, Technology, & Human Values* 23(1): 24–44. DOI: 10.1177/016224399802300102.

Mead M (1928) *Coming of Age in Samoa: A Psychological Study of Primitive Youth for Western Civilisation*. William Morrow and Company.

Meadows D (1999) Leverage Points: Places to Intervene in a System. *The Sustainability Institute*. Available at: http://donellameadows.org/wp-content/userfiles/Leverage_Points.pdf (accessed 15 March 2021).

Miller E and Gibson-Graham JK (2019) Thinking with Interdependence: From Economy/Environment to Ecological Livelihoods. In: Bennett J and Zournazi M (eds) *Thinking in the World: A Reader*. London and New York: Bloomsbury Publishing, pp. 313–340.

Mol A (2002) *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.

Nader L (1990) *Harmony Ideology: Justice and Control in a Zapotec Mountain Village*. Stanford, CA: Stanford University Press.

Nixon R (2011) *Slow Violence and the Environmentalism of the Poor*. Cambridge, MA: Harvard University Press.

Poirier L and Costelloe-Kuehn B (2019) Data Sharing at Scale: A Heuristic for Affirming Data Cultures. *Data Science Journal* 18(1): 48. DOI: 10.5334/dsj-2019-048.

Poirier L, DiFranzo D and Gloria M (2014) Light Structures in the Platform for Experimental Collaborative Ethnography. In: *Websci '14*, Bloomington, IN, 2014. Available at: http://tw.rpi.edu/media/latest/Light-Structure_WebSci2014_Poirier.pdf (accessed 15 March 2021).

Research Data Alliance (2016) About RDA. Available at: https://www.rd-alliance.org/about-rda (accessed 15 March 2021).

Rheinberger H-J (1997) *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Palo Alto, CA: Stanford University Press.

Rodriguez Medina L (2018) *On the Internationalization of the Social Sciences: A View from the South*. School of Education, University of California Los Angeles, USA.

Saheb T (2015) *Air Pollution Governance in Iran: Inhibiting Factors*. Ph.D. Rensselaer Polytechnic Institute, Troy, NY, USA. Available at: http://search.proquest.com/docview/1728799376/abstract/CAB1311AAA8F448BPQ/1 (accessed 15 March 2021).

Spivak GC (1987) *In Other Worlds: Essays in Cultural Politics*. New York, NY: Routledge.

Spivak GC (2012) *An Aesthetic Education in the Era of Globalization*. Cambridge, MA: Harvard University Press.

Strathern M (2004) *Commons and Borderlands: Working Papers on Interdisciplinarity, Accountability and the Flow of Knowledge*. Wantage, Oxfordshire: Sean Kingston Publishing.

Traweek S (1988) *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, MA: Harvard University Press.

Wutich A and Brewis A (2019) Data Collection in Cross-Cultural Ethnographic Research. *Field Methods* 31(2): 181–189. DOI: 10.1177/1525822X19837397.

Notes

1 Fortun et al. (2017) describe how PECE extends a long history of computers in anthropology.

2 Scholars' 'articulations' typically evokes the expressions at the end of the research process (i.e. books, articles, conference talks, etc.). We attend to articulations throughout the full spectrum of research phases that loop, iterate, and feedback on themselves.

3 Some of the socio-political effects of our own choices about how we produce knowledge include: expanding how researchers are credited for myriad (often gendered and racialized) forms of academic labor, reevaluating the basis of ethnographic authority, contributing to broader calls for celebrating (and not just 'tolerating') difference, diversity, and otherness, and opening more spaces for a 'politics of friendship' with more-than-STS researchers and colleagues.

4 The chart of gene-environment interactions from this article became an early reference in The Asthma Files, pointing to the discursive risks in accounting for 'the environment' in gene-environment interaction research, and their connections to technologies of measurement: ultraviolet light, HIV, beryllium, and asthma drugs were the other 'environmental' factors listed, entities which in 2005 could be fairly straightforwardly detected and quantified.

5 In her 'leverage points' article, a classic in the literature on 'systems thinking,' Donella Meadows' initial on-the-fly ranked list of the most effective "places to intervene in a system" is topped by "the mindset or paradigm out of which the system arises." In a later iteration, she concludes that even more powerful than changing a paradigm is developing the capacity to "keep oneself unattached in the arena of paradigms, to stay flexible… to 'get' at a gut level the paradigm that there are paradigms, and to see that itself is a paradigm, and to regard that whole realization as devastatingly funny" (Meadows, 1999:19). This is easier said than done, but we would argue that creatively designed infrastructure populated by diverse researchers (with good senses of humor) certainly can make it easier.

6 We often hear colleagues voice concerns that new student researchers are not yet ready or expert enough to contribute to collaborative knowledge production. We have turned their difference of perspective into an advantage, seeing it as yet another way to multiply perspective on what concerns us.

7 For a recent account of issues in Kingston, see https://www.theguardian.com/us-news/2020/aug/17/coal-spill-workers-sick-dying-tva. For details on the transfer of the toxic ash to Alabama, see https://earthjustice.org/features/campaigns/photos-a-toxic-inheritance.

8 https://pece-project.github.io/drupal-pece/.

9 See https://rd-alliance.org/groups/digital-practices-history-and-ethnography-ig.html.

10 Lindsay Poirier and Brandon Costelloe-Kuehn describe how this tangle of scales and systems can inform analytical approaches, specifically in the context of understanding data cultures and the socio-technical challenges to data sharing (2019).

11 PECE Design Logics articulate the epistemic, theoretical and ethical commitments that have shaped the design of PECE. These Design Logics are packaged within the Drupal distribution that a user downloads from GitHub to install their own instance of PECE—encouraging recognition of PECE as far from value neutral.

12 "CNG Dilemma in Delhi," data artifact contributed by Prerna Srigyan, 15 September 2020, Six+ Cities Research Project, The Asthma Files. https://theasthmafiles.org/content/cng-dilemma-delhi.

13 These analytic structures provide something akin to the 'cross-walks' librarians and archivists use to link different collections and projects (Harpring, 2017). In PECE, these linkages are more discursive than a strict translation.

14 https://theasthmafiles.org/content/breathless-snapshots.

15 As the QDR portal puts it, "increased openness facilitates the replication, reproduction, and assessment of empirically based qualitative analysis." https://qdr.syr.edu/about.

16 It might seem that this call for creating and maintaining a 'research commons' is in opposition to the 'enclosure' of data and knowledge. Instead, playing at the limit of the commons/enclosure binary, we would ask: what kinds of boundaries and enclosures can support a thriving commons? As Ethan Miller and J.K. Gibson Graham put it:

> while some enclosures disrupt and destroy commons… others actually constitute them. A community says: 'the water is ours, we share it. It cannot be privatized!' This is a boundary-drawing. The ethico-political question must, then, shift from its commonly-articulated form as 'commons vs. enclosure' to: what enclosure, for whom, for what purpose, and to what effect?... If commoning is a making-explicit of the negotiations of the common, then uncommoning is an anesthetization of the common, and ethical closure, or a rendering-non-negotiable of habitat relations (Miller and Graham, 2019: 327).