Entangled Inversions: Actor/Analyst Symmetry in the Ethnography of Infrastructure

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Abstract. In this paper we argue that the day-to-day work of designing and using information systems necessarily involves reflecting on these systems in ways that parallel how we, as social scientists, approach those same systems in the course of our analyses. This reflexive symmetry has important consequences for our research methods because it entails a shift in our form of research from a 'study of' a given community or project and towards an entangled process of collective reflection on these systems and practices. To articulate this reframing, we explore the notion of 'infrastructural inversion' to show how information infrastructure studies has always tacitly understood actors and analysts as both doing socio-technical analyses, and we extend this insight to how we think about our own methods. Next, we relate two of our recent fieldwork experiences amongst designers of information systems in the sciences to show practically how, through the course of research, we became entangled with our subjects through the sharing of notes and analytical insights, engaging in jointly authored papers, and other collectively sensemaking of the partially connected worlds in which we work. Finally, we move to a discussion of what we see are the entailments of this reframing of fieldwork, focusing on how all of this challenges our understandings of collaboration and reflexivity in ethnography. Overall, we suggest that our frame promotes an attunement to the field as a place of heterogenous collaboration rather than simple observation, and asks the fieldworker to be both conceptually and ethically open to the possibilities and consequences of collaboration with those that they study or work with.

Keywords: ethnographic methods, reflexivity, Information Infrastructure Studies, information and communication technologies

1   Introduction

Part of our work as ethnographers of scientific information systems [1] involves observing a field of actors engaged in the design, use or administration of that system. While we see ourselves as inheriting this approach from a long tradition of ethnographic field studies, we find our fieldsites differently constituted than 'traditional' anthropological or sociological studies of one culture in one place. Our observations of information infrastructures and the various communities of designers and users that engage with them take us to meeting rooms, laboratories, phone calls, team chat apps, and virtual documents and drives. All of these spaces, in-person and virtual, for us constitute 'the field' – the

empirical basis for our sociotechnical descriptions and analyses. We use these sites of practice as opportunities to reflect on the nature and history of contemporary scientific information work and its contexts.

As a short-hand, we often describe the work we do in these sites as a 'study of' a particular information infrastructure project. Over the past few years, however, our research group has become increasingly aware of the various ways that we have each found ourselves caught up in collaborations and other engagements with our subjects in a way that troubles this framing of the field as a place simply for observation. Many of our group have had least one 'side project' working with the subjects of our research, and these have paved the way for co-authoring academic papers in both 'their' and 'our' publication venues. We have also come to share anecdotes between each other of moments in the field during which our analytical insights have come to affect the design of the projects under study, or the ways in which we learn from or, perhaps more tellingly, argue with our informants less as subjects of research and more as coequals and interlocutors.

But what interests us is less simply the fact of collaboration, and more how the collaborations with our informants have left us with a sometimes attractive and sometimes uneasy loss of familiar distinctions: between our research projects and the projects we are 'studying'; between own observations and our own analyses; and between received categories of 'analyst' and 'actor.' Our collaborations in the field have not been a giving up the project of observation and reflection to temporarily engage in unreflexive design, but rather emerged because we have found the practices of our informants to continually involve their own self-observation and socio-technical reflection. These collaborations do not map easily onto the typical ethnographic tropes of participant-observation such as insider/outsider or actor/analyst, but rather blur the distinction of the terms of the field engagement altogether. Making sense of this pervasive entangling of our observation *of the field* with the reflective projects *in the field* is the subject of this paper.

These fieldwork entanglements have provoked us to reflect upon the ways we think about the nature of fieldwork methods and the relationship between social scientists and the system designers we study. Even in cases where these engagements were initiated as means to ethnographic ends – for the sake of improving access to the field, or for allowing a more anthropological immersion in the field of study – they have nevertheless tended to take on a life of their own. It is for this reason that we consistently say that we have 'found ourselves' working over data or materials with the actors we study, contributing expertise, or otherwise collaborating in ways that occur to us as surprising and emergent.

We prefer the notion of *entanglement* over the term collaboration because entanglement connotes the messiness of our engagements with our subjects. We loosely borrow the term from the work of Karen Barad who has used it chiefly in reference to the entangling of meaning and matter via the 'apparatuses' of physics and other natural sciences: 'Apparatuses produce differences that matter – they are boundary-making practices that are formative of matter and meaning, productive of, and part of, the phenomena produced' [2]. Like Barad's entangling of research instrument with the

phenomena they measure/enact, our methods of observation meet and thereby co-constitute the sites of our research.

Rather than the tidiness of *a priori* shared interests and a common vision or goal that the term collaboration implies, entanglement suggests the impossibility of maintaining distinct difference and of holding *our* threads of research work apart from those of the actors we study – that our objects of research and their reflections are both generated through being in the field. In these terms, analyst and actor do not bear the same valence of meaning in practice. Indeed, some strands of our work contain preoccupations and concerns that are frequently not of interest to the designers we encounter in the field; others run parallel to theirs but do not touch them directly. And so it is that we use entanglement to suggest that both our modes and objects of ethnographic inquiry have varying and shifting, but consistently co-constitutive, relationships to the practices and technologies of the actors under investigation in a way that is distinct from modes of social science collaboration that presume distinct roles for actors and analysts. Above all, we use entanglement to stress that the knots of common concern that emerge at the nexus of analysts' and actors' projects are neither simply objects of planning nor subjects of prediction, but rather constitute performative outcomes of the research process itself. These knots *become* our projects. Collaboration thus moves from a norm to be achieved, as it is considered in more 'participatory' style research methodologies, to a constitutive feature of fieldwork that must be navigated.

The issues at stake here tie into long-standing conversations in anthropology and other ethnographic disciplines around the nature of ethnography and social reflection. While space limitations preclude a comprehensive review of these conversations, we note here some affinities [3] between our thoughts on entanglement in fieldwork and other recent reflections on ethnographic methods amongst designers, scientists, and other knowledge workers.

In the introduction to an edited volume on 'experimental collaborations,' Estalella and Criado [4] describe finding themselves enmeshed in their informants' projects in generative, if sometimes uncomfortable, ways. They characterize these entanglements as 'tentative situations in which [ethnographers] appear to be promoted to repurpose their traditional techniques or are drawn into intense interventions in the field, at times working smoothly with counterparts, at other times clashing with them' [4]. Where previous ethnographic theory sought, first, to show how all ethnographic products involves the knowledge products of the others being studied and thus demand authorial recognition, and then, second, framed collaboration in the field as an ideal to be worked towards, Estalella and Criado describe their fieldwork collaboration as 'a form of engaging in joint epistemic explorations with those formerly described as informants, now reconfigured as epistemic partners' [4]. As we follow Estalella and Criado's account, fieldwork now becomes a convergence of similar-but-different actor-analysts whose hybridity is partially the outcome of a structural tendency of contemporary ethnographic engagements, and partially a result of the ethnographer's specific intentions.

Also working in anthropology, Marisol de la Cadena's has developed the concept of *co-laboring* [5], which she uses to describe her working alongside-with her informants and

their projects; along similar lines is Paul Rabinow's notion of *adjacency* [6], which emphasizes moving beyond traditional participant-observation towards a mode of fieldwork that strives more for collaboration and less for anthropological immersion.

Recent work in Science and Technology Studies (STS) has also offered its own notions of ethnographic entwinements through 'action-oriented' research [7]. Zuiderent-Jerak's approach to *situated intervention* argues for a need to go beyond the 'objectivity versus engagement' dichotomy and proposes a method for 'acting with' studied projects in which 'intervention aims at producing sociological knowledge by situating such interventions in sociologically unpacked normative complexities' [8]. Connected to this is his related notion of *artful contamination*, which depends on the input of actors in the field to prevent the (sociological) analyst from getting 'locked into pre-given problem spaces.' Our discussion here is, furthermore, inspired by and shares affinities with certain feminist approaches to collaborative fieldwork that urges an emergent approach to collaboration rather than taking a strictly critical [9] or, conversely, an idealized 'giving-back' approach [10].

In this paper we hope to offer a practical reflection on the emergence of these entanglements through descriptions of our own fieldwork trajectories. We argue that in fieldwork collaborations in this mode, the precise nature of the interventions and collaborations come about through an emergent process of working through epistemic, ethical, and political differences. The point is not that these engagements always happen the same way, or that they are intrinsically good. Rather, we wish to stress that they are akin to *experimental situations*: 'a distinctive articulation of the empirical work of anthropologists shaping their relationships in the field collaboratively' and 'a deviation from participant observation, where experiment sets the stage for the expansion of limits and possibilities' [4]. This entangled mode of ethnography is best unpacked by looking at multiple instances of its unfolding in our work. The empirical core of this paper is thus a recounting of how, in two different ethnographic settings of infrastructure design, the analyst became increasingly entangled in the actors' worlds, leading to a shift in position for both parties and a progressive blurring of boundaries between respective projects and commitments.

Before moving on to describe these cases, in the following section we outline the conceptual framing for our analysis by drawing on the notion of *infrastructural inversion* [11] to make sense of these entanglements. In this overview, we emphasize a relatively underexplored quality of infrastructural inversion: its *symmetry*. That is, we argue that infrastructural inversion is both a method of sociotechnical inquiry as well as an 'everyday' activity of scientific actors. Exploring the nature of this symmetry contributes to an understanding of how and why our entanglements emerge, and their consequences. Finally, it is worth noting that while we focus on infrastructural inversion, a concept close to our empirical and conceptual home in infrastructure studies [12] and legible to readers of this special issue, we hope that the implications of the discussion here are relevant to conversations around the nature of ethnographic study more broadly.

2   Infrastructural inversion as a 'symmetrical' concept

As ethnographers of information infrastructures, we study the infrastructural dimensions of scientific work [1]. Following Bowker and Star [13], our starting point is that infrastructure fades readily into the background of other, more visible work practices. Infrastructure enables specific (in our case, scientific) work practices to go on without requiring the constant attention of those actors whose work it supports. In general, our social scientific examinations of infrastructure aim to open up the many processes, systems, and social features wrapped up with infrastructure – which, by design and through much hard work, are rendered transparent – to empirical analysis, description, and sometimes critique.

In Bowker's original theoretical formulation, infrastructural inversion was not an etic practice, but rather referred to the emic processes of actors engaged in sociotechnical systems [11]. His example of increased life expectancy in 19th century Europe is instructive here: many believed this was a direct result of scientific and biomedical advances like vaccinations and novel treatments that had been developed in the preceding period, but a rethinking of the instruments and methods used to examine life expectancy revealed that it was in fact a function of changing living conditions such as the development of sewage treatment systems and improvements in food production and consumption [11]. Specifically who is doing the inverting in this archetypal example of infrastructural inversion remains underdetermined in the original text, but it is clear in Bowker's rendering that it is not a post-hoc inversion by historians or social scientists; rather, it is part of the history of the science itself. Paul Edwards [14], in his recent historical investigation of climate science, follows this formulation of infrastructural inversion, using it to describe a regular practice of the actors. Writing against the idea that actors do not think about their data infrastructures, he argues that 'infrastructural inversion is, in fact, fundamental to how scientists handle data [...] data aren't data until you have turned the infrastructure upside down to find out how it works' [14]. And yet, what Edwards does in his own redescription of the 'vast machine' of global climate science is certainly an infrastructural inversion in its own right.

As we gestured to in our opening paragraph, infrastructural inversion has thus also come to refer to the methodological approach of those conducting social studies of infrastructure. Slota and Bowker write that 'one of the most important developments in science and technology studies (STS) has been to refocus attention away from the spectacle of the pageant of history towards the formation and operation of infrastructures – an approach called infrastructural inversion' [15]. This may mean that the analyst is themselves inverting the infrastructure, i.e., focusing on the technological assemblage that supports (or not) the activities of actors: digging into histories, inspecting code, reading protocols, and so on. But it may also mean paying particularly close attention to the infrastructural inversions of the actors: how they are decomposing or questioning their own activities and technological architectures. Analysts may invert an infrastructure by unearthing its histories and technicities, or they may pay close attention as actors do the

very same. Both of these approaches can prove insightful for inspecting infrastructure. In short, actors' infrastructural inversions can serve as *resources* for social scientific analysis.

Our point in this paper, however, is not to rehearse the many different forms that infrastructural inversion can take, but rather to make infrastructural inversion a *topic* of conceptual and methodological elaboration (but see [16] for a brief and useful typology of approaches to infrastructural inversion). Emphasizing its aforementioned symmetrical qualities requires us to grant that 'researcher and 'ordinary' actors basically make use of the same competences when they do things with and upon the world' [17]. As Edwards makes clear, actors who typically draw on infrastructure as backgrounded also regularly invert these systems, becoming reflexive, if pragmatic, analysts in their own right. Infrastructural inversion, as with other socio-technical and ethnographic methodologies, is not alone the province of the analyst.

While this symmetry has been a theme both implicit and explicit throughout the various major texts of infrastructure studies, the field has not fully considered the ways in which actor and analysts' respective infrastructural inversions might come to meet each other in the aforementioned fields of research. What we want to highlight here is that the symmetry of infrastructural inversion that we use as social scientists to render visible the backgrounded work of system design and use are of interest to the actors as they go about understanding and intervening in their own infrastructural designs. While our analytic inversions of infrastructures might at first look different than those carried out by actors who more directly depend on them, or be done for different purposes, they may nevertheless come to be relevant for the actors themselves. Furthermore, the inversions of the actors themselves are likewise of interest to us, and not simply as data, but as infrastructure analysis itself. In sum, the analyst's topics may well become the actor's resources, and vice versa, in the practice of field study. Ultimately, as we show below, this leads to a progressive blurring of tidy distinctions between *actor* and *analyst*, *subject* and *object*, *them* and *us* through the entanglements that each of us feel in the field.

3 Becoming wrapped up in infrastructure – two cases

In this section we explore two such cases of symmetry in infrastructural inversion, and the resulting entanglement of projects, methods, objectives, and participants' identities. In the first case, an ethnographer begins as a relative outsider, but soon takes on a new role by championing participatory and user-centered design methodologies in a community-building and infrastructure design project in the biosciences. In the second case, another ethnographer finds it increasingly difficult to differentiate his own study from the instrument and database design project he set out to research, revealing increasingly thin distinctions between analyst and actor, and leading to productive engagements between them. In both cases, as actors carry out their infrastructuring work – surfacing various normative decisions and implicated actors – the analyst finds continual overlap with the studied actors, foreclosing the possibility (and the desirability) of attaining distance from

the object(s) of inquiry. This, in both cases, leads the analyst to play an active role in designing the particular infrastructures, although in different ways, and to different degrees, than the actors being studied. Likewise, the inversions and other reflections of the actors themselves become not just data but in fact theoretical resource for the ethnographer.

Our objective here is to demonstrate a mode of ethnography characterized by progressive entanglements between the studier and the studied, between *our* projects and *theirs*. Despite the expectations with which the analyst entered the field seeking a simple 'study of' these projects, over time this became an increasingly less tenable proposition. In both narratives, we highlight the breaking down of the distinction between analyst and actor that functions as an opportunity to pause and consider new conditions and ways of doing ethnography: as methodological ingredients for infrastructure studies that productively reconfigure relations between actor and analyst in novel and compelling ways.

We cull these stories from two larger concurrent projects being run out of the Data Ecologies Lab in Seattle, USA (based in the department of Human Centered Design & Engineering at the University of Washington).

3.1 Championing user-centered infrastructure design

First we present a story wherein Andrew, an ethnographer of the data sciences, found himself drawn into an infrastructure design project alongside a group of data scientists working in the biosciences. It was Andrew's *social* expertise that his actors found, in a commonsense way, useful and relevant to their endeavor, thus entangling him into their project. There is a certain irony here, however, since Andrew's longtime embrace of actor-network theory had conditioned him to have deep reservations about certain readymade explanations of 'the social' [18]. But nevertheless he found himself acting as the spokesperson for the virtues of participatory and user-centered design approaches [19, 20], both while attending weekly meetings as a participant-observer, as well as in the pages of the proposals and publications produced over the course of his time conducting fieldwork with these scientists.

Motivating their work of building a 'sustainable research community' was an understanding that datasets, data processing tools, and data visualization techniques are generally siloed within researchers' discrete communities of practice. Improving the quality and relevance of their research in the field of proteogenomics, then, would require mechanisms to facilitate and streamline the integration of disparate data resources spread across the domains of proteomics, genomics, and structural biology. Following an initial workshop in early 2017 that gathered an international group of proteomics, genomics, and structural biology researchers to discuss and examine opportunities for this kind of work, the core project organizers set out to design a technical framework that would enable the interoperability of these various data resources and tools for processing and visualizing data. Over the course of the next several months, Andrew attended the team's weekly

meetings and observed as the researchers worked through conceptualizing a design for what such an infrastructure could look like. Ultimately, the team planned to submit a follow-on grant that would provide the requisite funding for actually building it.

This early concepting phase first resulted in the drafting of a manuscript that one of the project's Principal Investigators proposed to submit to (and eventually published in) a genomics research journal [20]. The article gave a brief summary of the workshop, detailed the current state of the field in proteogenomics, and outlined the technical challenges that could be overcome by the construction of an interoperability infrastructure. The team invited all attendees from the aforementioned workshop, including Andrew, to be co-authors on the manuscript.

It was in this process that Andrew began noticing a distinct shift in his positioning in the field: much to his surprise, he found that his name had been placed near the top of the author list, alongside the core project organizers who were lead authors on the paper. Empowered as a lead author, and additionally motivated by a sense of responsibility that came along with the elevated authorial status, Andrew volunteered to help edit the document and to make a first pass at drafting its concluding section. In doing so, he aimed to sensitize the other team members and prospective readers of the manuscript to some of the design implications of their work. This was a first instance of Andrew working to invert the infrastructure of the interoperability framework by making visible some of the concerns and design issues that team members had themselves raised in their weekly discussions but had gone unmentioned in the initial draft of the text itself.

During one of the weekly team meetings, a project lead presented some early informal reviewer comments that he received back from the target journal following its initial submission. The feedback included an editorial suggestion that the manuscript include a discussion about possible challenges to setting up and maintaining the proposed interoperability framework. From Andrew's perspective, this was a prompt for the authors to reflect on issues of sustainability and so he offered that they might 'talk about challenges of identifying all of the tools [the framework sought to consolidate]; challenges of standardizing [different data formats]; and challenges of maintaining APIs [Application programming Interfaces].' The lead author replied to Andrew's comment, saying '[I don't] know what they mean by *challenges*,' while a second co-PI jumped in to try and clarify: 'If we develop APIs, how do we encourage people to use them? Maybe they don't have resources or want to change how they do things.' The lead author quickly answered back: 'The way to convince people is to say, "The proof is in the pudding!"'

This reply gave Andrew pause. As an ethnographer of data science and information infrastructures, he had become sensitized to the view that the sustainability of infrastructures does not ultimately lay in their mere existence, but rather relies on their embeddedness in a community of active users and on maintaining the functionality of their many constituent elements [21, 22]. He thus suggested that the team incorporate a discussion of user-centered design in the manuscript, which could help the authors rhetorically link their 'social' objectives of creating a sustainable research community with the 'technical' challenges of access and maintenance that the editor asked them to address.

The idea to include a discussion of user requirements in the manuscript did not in fact originate with Andrew's own thinking, though; rather, it had been introduced earlier on in the project by another team member who was eventually unable to continue attending the team meetings. Nevertheless, her nod to incorporating user requirements into the design of the framework dovetailed with Andrew's own perspectives on what is needed to sustain sociotechnical infrastructures. The move also occurred to him as a strategic way to provoke the other team members who were working to develop the interoperability framework to (re)consider the 'social' and 'technical' components of their framework and how these might combine to recursively sustain both the framework and its community of users - that is, a prompt for them to carry out their own infrastructural inversion [23].

This strategy ran counter to alternative approaches to engagement that Andrew could have pursued, such as imposing his own external sociological critique of their work, which could threaten to alienate the designers, if not just be ignored outright. It thus also perhaps accounts, at least in part, for his further entrenchment as a participating member of the project team, a fact evidenced by his being included as a collaborator on the proposal which the team ultimately submitted to the National Science Foundation for constructing their interoperability framework. As stated in that document, Andrew's role would see him 'deliver feedback on socio-technical facets of collaboration, policy ecosystems, and user-centered design, to inform a more responsive design and implementation process in constructing the [interoperability] framework.' His persistent participation in the project as the 'social expert' is revealing insofar as it clearly demonstrates the symmetrical interest in infrastructural inversion shared by actor and analyst alike.

3.2 Studying and building a database for Alaska

In our second case, Charlie, an anthropologist interested in the relationship between scientific information technologies and society, began studying a group of experts who had set themselves the task of developing a database to analyze indicators of community health across the U.S. state of Alaska's fishing communities. However, as he proceeded following the development of their data system, the aims of analyst and actor – namely, instrumentation and datasets as infrastructure for the former, and community health for the latter – began to seem increasingly entangled.

The working group team was composed of a group of social scientists on the one hand, and a group of representatives from Alaska's diverse fishing communities who were invited to participate as community experts. Charlie initially approached this working group as an opportunity to explore longstanding concerns addressed within the literatures of infrastructure and science and technology studies. In particular, he was interested in how standardized metrics are defined by contingent, but later rendered invisible invisibilized, decisions about the types of things being measured and the scales at which they are measured (i.e., infrastructural inversion). What, he wondered, was so novel about the way in which these groups put to use new strategies and technologies emerging from

the information sciences? Equipped with an analytical toolkit drawing Bowker's infrastructural inversions together with a number of other critical problematizations on state-scientific measuring practices, [11, 24, 25, 26], Charlie set out following this group and their work of designing their instruments and systems.

This feeling of excitement was soon tempered, however, once he began his actual observation of the project meetings. The group of designers were interested in their database project as a way to explore and make visible, in terms legible to state fishing managers and policy makers, the changing social structures of these Alaskan fishing communities that they themselves had come to know as residents or ethnographers in those places over the course of years, decades and even entire lifetimes. However, their interest in these data-intensive methods and schemas did not imply a naive acceptance of them as powerful or true way to represent these communities as compared to their experiential or ethnographic knowledge. In fact, it turned out that most members of the group, social scientists and community experts alike, were quite critical of the way in which these numbers reduced the complexity of the connections between social and natural drivers of community health. While at times there was excitement around these technologies and techniques and enthusiasm for what they could show, at other times participants lamented feeling that these information techniques were a language they were forced to learn in order to effect change in governance structures that favored quantitative evidence over qualitative ways of knowing. Both implicitly and explicitly, their critiques echoed social scientific analyses of high-modernist [24] or neoliberal [25] governance regimes that Charlie himself was drawing upon to make sense of their work.

Their reflections were aimed not only abstractly at the systems that they were attempting to affect, but rather also played out in the very design of the system itself. Meeting after meeting, Charlie watched as the group struggled over their various attempts at building a standardized list of indicators that would be viable across the state's communities. Health, of course, may be measured in any number of ways and means many different things to different communities, especially across a sociocultural region as large as Alaska; local situations meant that a variety of disparate factors would need to be taken into account to measure it. Much of the tension and work in the group meetings went into reconciling the 'hard' quantitative data and models that they compiled with their local expertise and ethnographic knowledge of these particular communities. They therefore continually 'inverted' both the official data that they drew from in building their metrics as well as their own knowledge bases that they built their hypothesis from. They also, from the very start, held in depth discussion of how a given standard, if it were to be taken up as a way of governing, might play out relative to various communities. In doing so they recognized the performative dimensions of their own systems, and worked hard to incorporate these reflections into the project itself to the best of their abilities.

In all of these detailed discussions, Charlie found himself left with an anxious sense of redundancy. He had come to the project worried about being overly critical of the group and its stated aims. He thought that we would have to temper his etic criticism in order to better take seriously the methods and perspectives of his interlocutors. What he found to

be the case was a group *already* engaged in reflection and critique that was fundamentally built into the realization of the objective itself.

One small example of this redundancy pertains to Charlie's interest in how project participants dealt with geographic scale in their systems. At a meeting early on in the project, all of the groups participating in the initiative were given a map of Alaska, which had been sectioned off into predetermined regions. The idea was to make their project's data interoperable with the other projects working on other aspects of the fishing systems, for example combining this social data with ecological data, or making the data more usable by state managers who would likely be using this regional breakdown. Charlie identified this as an information infrastructure problem and asked himself: What was the history of this way of partitioning the state, and what would the effects of this schema have on these instruments going forward? What comparisons would it allow for, and what would it hide? He had written some memos on the subject prior to commencing fieldwork and had planned to follow the life of this regionalization work as it was deployed in the project. A good first infrastructural inversion, he thought. However, it turned out that this map would have a lively existence among project participants themselves – not simply as a determining legacy force, but as an object of contestation and reflection among them.

Confirming what Charlie had discovered in his preliminary research, the regionalization of Alaska that project organizers used for dividing up the working groups' various analyses was based on management regions that had been initially developed by one of Alaska's fishing management agencies. This schema parsed Alaska into extremely broad regions based primarily on river watersheds, something Charlie had noted on the first day of the meeting. By day two, however – and without any of his own input – the actors were vigorously discussing the provenance of the map, its utility as a comparative device, and the problems that might arise from the fact that regions would be based on watershed rather than determined by socio-cultural criteria. Charlie remembers at the time returning to his memos regarding the maps, uneasily moving them from the 'analysis' category to the 'data' category in his fieldwork files, thinking now that the map partitioning had been inverted by the actors themselves, it could no longer itself be the object of his investigation, only the discussion around it.

Further unsettling were the many conversations he had with individuals from the work group that he was similarly unsure whether to categorize as analysis – in the same way he considered conversations he would have with someone 'back home' in his research group or while engaging a piece of anthropological literature – or as an empirical fieldwork finding akin to transcript from an interview. He knew, for example, that he was interested in the practice of 'translating' traditional Native Alaskan knowledge and expertise into this database and metric system and the issues of reduction that it suggested. It turned out many of the actors were deeply concerned with this as well, and Charlie ended up having many long conversations reflecting on this problem. Part of the point was that their reflections were not simply for analysis' sake, but rather to aid in their metric development itself. It was not as if there was a reflexive 'hat', worn by Charlie always but only in specific instances by the others. Reflection, rather, was built into the doing of the project

While the lack of distinctness resulted in certain ethnographic anxieties, it also meant that, once he felt empowered to speak as a coequal, his reflections on their work turned out to be useful, or at least legible, to his informants. Over time, Charlie's giving-in to these supposedly redundant engagements started to feel more meaningful – like he had something to add, while at the same time recognizing a shift in his own scientific questions over the course of these engagements. His somewhat abstract concerns of the social dimensions of scientific information technologies became more concretized by the fieldwork with his background in current anthropological concerns around global information connectivity, which mingled with and were transformed by the concerns and framings of his interlocutors.

Charlie's engagement as a contributor to the project would continue and formalize. He and a number of the working group members are currently drafting a reflection paper on their process of metric development, specifically with an eye towards bringing together Euro-American and Native Alaskan actors and epistemologies. Charlie had been taking notes and reflecting on many of the very same dynamics throughout the working group sessions, landing him in a felicitous position to contribute to the writing and publication process. In sum, once a mere ethnographic observer in the project, Charlie's role has increasingly taken on a more entangled inflection.

4 Discussion

With these two cases, we have illustrated some dynamics of what we call actor/analyst symmetry in the ethnographic study of infrastructure design. In both cases, rather than simply attending to these projects as observers, both Andrew and Charlie were drawn into participating via an overlapping of interests and capacities with their research subjects. While neither ethnographer started from idealized notion of ethnographic objectivity or uniqueness in theory, they were both, in their own ways, somewhat surprised to find that in practice their actors were actively engaged in their own socio-technical inversions as well as actively, and without hesitation, interested in the ethnographers' observations and analyses for their own purposes. What we have tried to show with these cases is that the symmetrical practices of actor (infrastructure designer) and analyst (ethnographer of infrastructure) have a very practical effect on the doing of fieldwork, an effect that changes both the field itself and the ethnographer.

We believe this is an underexamined facet of infrastructural inversion and ethnographic practice more generally when compared to, for example, the representational challenge of narrating actor reflexivity or analyst positionality in our ethnographic writings. It is worth noting that the idea of symmetry that we draw on comes from scholarship in STS and anthropology, and was used differently to describe an active, reflexive strategy of rendering textually equal, first, the worlds of 'true' and 'false' scientific facts [27], second, humans and non-humans [28], and, third, different cultural or experiential systems [29, 30]. Here we show how symmetry is not only a textual strategy

but is in fact a constitutive element of the very doing of fieldwork, one with analytical and stategic entailments. Symmetry as a condition, however, is not itself ethically normative, but we do think it points to another mode of ethnographic ethics focused on navigating the entanglements of fieldwork rather than how to construct more truthful or ethical representations. That our engagements with the design(er)s of information systems transform both the system and ourselves requires active awareness of how we engage with our fields for both epistemic and ethical ends.

The fieldwork configuration resulting from this symmetry is what we have described as an entanglement, not a field of 'studiers and studied', but one of iterative inversions carried out by actors and analysts (or rather, between actor-analysts) whom are respectively and collectively motivated by oftentimes overlapping matters of concern and analytical and methodological repertoires. In Charlie's case, despite differing objects of research (the communities themselves versus the community instrument), the relative similarity of his frameworks and those of his actors played a significant role in shaping their mutual engagement. On the other hand, Andrew's case is marked by significant disciplinary differences between analyst and actor, and yet a symmetrical set of inversions emerged nevertheless. We thus owe this mode of fieldwork less to the singularity of disciplines or their differences than to the fundamental symmetry of actor/analyst interest in and capacity for infrastructural inversion.

This mode of ethnography involves part structural tendency and part intention on behalf of the ethnographer and those under study. While the symmetry of reflection tends to enable and strengthen engagement, the capacity to terminate the engagement is equally symmetrical – that is, both actor and analyst may decide to no longer continue collaborating. In both cases presented here, the mutually agreed-upon strategy was to continue on, and in particular prestructured ways. But we could imagine other alternatives involving non-engagement, and so our intention is not to foreground a normative imperative to collaborate.

 We find much affinity between what we describe here and the research programs of participatory research [31] and participatory design [32]. But whereas these two approaches are programs for explicitly leveling the epistemic playing field between researcher and researched and designers and users, our mode of ethnography leads to a more open and emergent normative framework for the navigation of multiple possible collaborations and interventions with diverse actor/analysts in the field. Explicitly participatory research might very well be demanded in some cases, especially in situations of much more homogenous actor groups or extreme power differentials between researcher and researched, but for us it not necessarily the approach for all research situations.

In our sites of research, however, we see collaboration as a tactical question rather than an imperative. It is just as much something that to be faced as it is something to be promoted as an ideal. This leads more to a view of fieldwork research as a series of 'situated interventions,' following Zuiderent-Jerak, rather than explicitly participatory from the start. We thus find that rather than effectuating predetermined arrangements for collaboration, a more preferable route is to consider an 'ethics of specificity' where, by

intervening, the ethnographer commits to an emergent normativity based on a 'sensitivity to the ways in which research strategies and practices interact and mutate in the field […] enabling researchers to take seriously the theoretical, practical, and political consequences of such ongoing transformations.' [7]. We have not directly set out to test our commitments and normativities in the process of sociological knowledge production; rather, our hands have been (ever so delicately) forced. This, we believe, has been a productive impetus for drawing out the always-already symmetrical elements of infrastructural inversion.

We propose this model here, much like the models and instruments that engage in our fieldwork, as a performative frame to help sensitize ethnographers to meeting their fieldwork with an open and experimental approach to collaboration and exchange with their interlocutors. Thinking about fieldwork as a symmetrical, entangling process rather than a place simply for observation will have the pragmatic effect of better attuning ethnographic practice to some of the essential dynamics of fieldwork amongst such groups of actors and their projects. We hope that this will lead to developing stronger relationships and ultimately produce better reflections on the overlapping sociotechnical projects that we share with our subjects.

5   Conclusion

As ethnographers of information infrastructures studying scientists and others involved in the design of information systems, we have found our analyses to be in dialogue with the reflections of our research subjects. Their infrastructure questions posed reflexively are in many ways mirror the 'bread and butter' of our own analysis. We seek to understand how knowledge is produced by engaging with those in the production of knowledge; we seek to understand technology through engagement with those making use of, or producing it; we seek to learn about social dynamics by engaging with those for whom those dynamics are fundamental parts of their work life. This symmetry can cast the social researcher, in addition to their role as a scientist contributing to the ongoing conversation in their field (whether it be Science and Technology Studies, Anthropology, Human-Computer Interaction, or another field-based social science), as an external point of reflection on work practice, technology use, epistemology, and organizational/political negotiation of resources and capacity for the studied site.

By engaging as researchers in a work site, we become ourselves actors situated within the greater ecology of information work being done. The appropriate approach to such symmetrical conditions of research and design is a firmly pragmatic one that dispenses with any objectivist notions of absolute actor/analyst difference or similarity. Instead we must learn to treat the research field and the notion of infrastructure as a collectively defined object for working together with, along-side, and intervening in the on-going design of our collective sociotechnical worlds.

6 References

1. Star, S.L., The Ethnography of Infrastructure. American Behavioral Scientist, 43. (1999)
2. Barad, Karen Michelle. Meeting the Universe Halfway : Quantum Physics and the Entanglement of Matter and Meaning. Duke University Press, (2007)
3. Ribes, David. "STS, Meet Data Science, Once Again." Science, Technology, & Human Values, (2018)
4. Estalella, A., & Criado, T. S. Experimental collaborations : Ethnography through fieldwork devices (EASA series ; v. 34). New York: Berghahn Books. (2018)
5. De la Cadena, Marisol. Earth Beings : Ecologies of Practice across Andean Worlds. Duke University Press, (2015)
6. Rabinow, Paul. Marking Time : on the Anthropology of the Contemporary. Princeton University Press, (2008)
7. Zuiderent-Jerak, T., & Bruun Jensen, C. Editorial introduction: Unpacking 'intervention' in science and technology studies. Science as Culture, 16(3):227–235, (2007)
8. Zuiderent-Jerak, T. Situated Intervention: Sociological Experiments in Health Care. Cambridge: MIT Press, (2015).
9. Schuurman, N., & Pratt, G. Care of the subject: Feminism and critiques of GIS. Gender, Place and Culture, 9(3), 291-299. (2009)
10. Tallbear, K. Standing With and Speaking as Faith: A Feminist-Indigenous Approach to Inquiry. Journal of Research Practice, 10(2), (2014).
11. Bowker, G. C. Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920-1940. MIT Press. (1994)
12. Bowker, Geoffrey C, et al. "Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment." International Handbook of Internet Research, Springer Netherlands, Dordrecht, (2010)
13. Bowker, G. C., & Star, S. L. Sorting Things Out: Classification and Its Consequences. MIT Press, (2000).
14. Edwards, P. N. A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming. MIT Press, (2013).
15. Slota, S. C., & Bowker, G. C. Chapter 18: How Infrastructures Matter. In 2018 STS Handbook. MIT Press, (2017).
16. Karasti, H., Pipek, V. and Bowker, G.C. (2018). An Afterword to 'Infrastructuring and Collaborative Design.' Computer Supported Cooperative Work (CSCW), 27(2): 267–289, (2018).
17. Hansen, M.P. Non-normative critique Foucault and pragmatic sociology as tactical re-politicization. European Journal of Social Theory, 19(1), 127-145 (2016).
18. Latour, B. Reassembling the social: An introduction to actor-network-theory. Oxford: Oxford University Press. (2005)

19. Callon, M. The Role of Hybrid Communities and Socio-Technical Arrangements in the Participatory Design. Journal of the Center for Information Studies, 5: 3-10, (2004).
20. Glusman, G., Rose, P. W., Prlić, A., Dougherty, J., Duarte, J. M., Hoffman, A. S., … Deutsch, E. W. Mapping genetic variations to three-dimensional protein structures to enhance variant interpretation: a proposed framework. Genome Medicine, (9)113: 1-10, (2017).
21. Callon, M., Méadel, C., & Rabeharisoa, V. The economy of qualities. Economy and Society, 31(2), 194–217. (2002)
22. Randall, D. P., Diamant, E. I., & Lee, C. P. Creating Sustainable Cyberinfrastructures. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (pp. 1759–1768). New York, NY, USA: ACM. (2015)
23. Parmiggiani, E. Integration by Infrastructuring: The Case of Subsea Environmental Monitoring in Oil and Gas Offshore Operations. Doctoral dissertation. Norwegian University of Science and Technology, Department of Computer and Information Science. Trondheim, Norway: NTNU-trykk. (2015)
24. Scott, James C. Seeing like a State : How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press, (1998)
25. Hacking, Ian. Historical Ontology. "Making up people". Harvard University Press, (2002)
26. Ferguson, James. The Anti-Politics Machine : "Development," Depoliticization, and Bureaucratic Power in Lesotho. Harvard University, (1990)
27. Bloor, David. Knowledge and Social Imagery. Routledge & K. Paul, (1976)
28. Latour, Bruno, and Porter, Catherine. We Have Never Been Modern. Harvard University Press, (1993)
29. Descola, Philippe. "Transformation Transformed." HAU: Journal of Ethnographic Theory, vol. 6, no. 3, (2016)
30. Law, John, and Lin Wen-yuan. "Provincializing STS: Postcoloniality, Symmetry, and Method." East Asian Science, Technology and Society: an International Journal, vol. 11, no. 2, (2017)
31. Mcintyre, A. Participatory Action Research. Sage Publications, (2008)
32. Schuler, D. & Namioka, A. Participatory Design: Principles and Practices. Lawrence Elbaum Associated, Publishers. (1993)