Data-in-Place: Thinking through the Relations Between Data and Community

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ABSTRACT

We present findings from a year-long engagement with a street and its community. The work explores how the production and use of data is bound up with place, both in terms of physical and social geography. We detail three strands of the project. First, we consider how residents have sought to curate existing data about the street in the form of an archive with physical and digital components. Second, we report endeavours to capture data about the street's environment, especially of vehicle traffic. Third, we draw on the possibilities afforded by technologies for polling opinion. We reflect on how these engagements have: materialised distinctive relations between the community and their data; surfaced flows and contours of data, and spatial, temporal and social boundaries; and enacted a multiplicity of 'small worlds'. We consider how such a conceptualisation of *data-in-place* is relevant to the design of technology.

Author Keywords

Data; data-in-place; digital civics; community; place.

INTRODUCTION

Data—as it is being articulated in the rubrics of big data, data science, business intelligence, etc.—has been attributed a very special status. It has come to be seen as a proxy for the facts [7, 13, 28]. Yes, it needs to be collected and analysed, and in some cases highly technical and specialised tools and knowhow are required to do so. Yet wrapped up in the hubris, it is seen as a raw, exhaustive resource to be mined and, once in hand, used with authority. With data's collection and specialised analysis, controversies can be settled [2, 21].

Of course, this surprisingly popular idea grossly oversimplifies the kind of outcomes that can be gleaned using data and how data is used in practice. Data scientists are well aware of the pitfalls of reading too much into their data and drawing out factitious results. Their work is replete with inferences and informed judgements, refuting data's immediate equivalency with the facts and suggesting a good deal of interpretive skill is required to get data to do work. Numerous commentators in HCI [e.g., 24, 29] and from the social sciences [*cf.* 15 for comprehensive review] have demonstrated as much and made convincing arguments that spell out the limitations of (big) data and data analytics. Broadly, the critiques target the imagined objectivity of data and data processing, and point out the intrinsic biases that become visible when data is, in practice, amassed and subject to analysis. A reoccurring theme is that the objective stance is seen to deny the politics and ethical questions bound up in using data. The assumption is that the presumed rawness of the data and its sheer scale (alongside the automation of the analysis), obviate any kind of perspectivism.

Also raised in these arguments are questions about the situated nature of data and its analysis. Seen as anything but raw, data is understood to be produced or enacted through on-going circulations and relations. Data, from this viewpoint, doesn't by itself assert things in the world; rather, it helps to surface, assemble, cement and (at times) unravel forms of knowing, ideas, controversies, and so on. Also, it combines with and is entangled in wider forms of life, not always simplifying and narrowing in on the facts, but often further complicating what is at stake and introducing new and different forms of trouble.

What these developing ideas are beginning to point to then is the need for a reconceptualisation of data, one that accounts for the ways in which it is contingent on very particular circumstances. The call is for a data that doesn't presume an intrinsic generality, but that acknowledges precisely its place in and amongst other worldly things. It is this invitation to think differently about data that we respond to in this paper. As a preliminary exercise, we explore the possibilities of addressing the recognised challenges by using the concept of *data-in-place*. We introduce this term not to merely situate data in particular physical spaces or within

particular activities, but rather to think of it in terms of a *social geography* in which data, people, and things intermingle to continuously enact place.

The impetus here is a theorising in urban sociology and geography in which the reductionist tendencies of seeing "the social" as ultimately quantifiable are being countered "by rethinking sociality as a spatial complex of uneven and constantly evolving human and nonhuman forces..." [26, p.3]. This opens up a way of seeing data as threading into "spatially variable surfaces" [26, p.11] that materialise specific configurations of people, things and places, and give form to the very particular kinds of worlds we live in. As we'll go on to show, this conceptualisation doesn't lessen the importance of data, but orients the possibilities in different ways—shifting the emphasis away from data reconciling facts and oversimplifying what people want and how they behave, to ways of enabling rich and heterogeneous human and nonhuman assemblages to coexist and emerge.

Data in Place
Below, we describe how we've begun to think about data-in-place through a project being conducted on Tenison Road, a single, mostly residential road in Cambridge (UK). The details of this now year-long project will follow. First though, it is worth giving some explanation to why we've come to conjoin data and communal life and, through that, started to think about data-in-place as a productive concept.

Community has drawn increasing attention in HCI over recent years. Communities have been seen as a convenient resource for 'in the wild' trials [8, 25], while a range of projects have sought to introduce technologies and services into neighbourhoods [25, 19, 3, 4, 14]. For ourselves, most salient amongst these have been projects that consider how technology (infra)structures underlay and enmesh with communities and their geography. This presents a compelling position from which to understand technology's ubiquitous presence in the everyday. Dourish and Bell [12] write of the shaping forces such infrastructures exert in communities (and elsewhere), demonstrating just how instrumental they are to human and collective experiences.

Data has a relevance here, as it too weaves into these infrastructures, with its dependence on the networks of ubiquitous computing to be sensed and routed. What studies in HCI are beginning to demonstrate is, again, how closely intertwined communities, place and data come to be in this web of the sociotechnical. Projects such as the Tidy Street project [5] and Visualising Mill Road [17] show the speed with which data finds its way into a community's social geography (even with relatively simple data infrastructures), highlighting the particular socio-spatial configurations and also the possibilities for intervening in and disrupting them [also see 11, 12].

Alongside this research, there has been a growing concern for data as it pertains to civic and communal life. Whether we like it or not, it is becoming increasingly clear that this

is an arena in which data will have a significant and meaningful impact on our lives [30, 9]. With issues of engagement, participation and public welfare paramount in public discourses and policy making, civic and communal life is increasingly being subject to what is being referred to as "datafication" [18]. Metrics are being collected to gauge everything from the state of citizens' eating habits to their happiness, and in turn these 'assets' are being used to determine public initiatives and policies. Ostensibly, data is operating as a stand in for collectives, citizens and publics, and decisions are being made on the basis of data about how society should be organised and run.

This loose grouping of work and thinking around data, community and place highlight, as the geographer Wilson phrases it, a particular "imbrication of the urban and the digital, the techno and the cultural" [31, p. 859]. In different but connected ways, they indicate a growing intensity of action at the nexus of data (infra)structures and the ways we live together. Furthermore, they foreground the very material ways in which data—commonly perceived as remote, neutral and general—makes its presence felt when situated in real-world places and, simultaneously, the tensions that can arise when we inhabit those places together.

This, then, is what has led our sights to converge on data and communal life, and directed our attention towards data-in-place. Our extended engagement with Tenison Road is born out of the sense that there is a need to understand not only how to generate, analyse and use data, but how, over time, it comes to entangle and settle in a place. The work we present thus aims to thicken the understandings we have of data in the places we live, on roads, in communities, and in neighbourhoods. By working through data-in-place, our hope is to develop a way to express how such places intermingle with data. In short, we want to provide a conceptualisation of data directed at how data comes to matter.

In what follows, we'll first describe how we've engaged with Tenison Road through a diverse set of activities and interventions. We aim, here, to explain why we chose Tenison Road, and to illustrate our commitment to engaging deeply and over an extended period with a community in order to study data-in-place. Next, we'll review three ways that we've been working with residents, each presenting insights into how they are making sense of data and putting it to use. This will lead into a breakdown of how the research has helped to conceptualise data-in-place. We'll introduce four approaches to thinking about the concept that are helping us to make sense of the project's results. We'll conclude by reflecting on how this thinking might shape the design of interactive data systems and infrastructures.

ENGAGEMENTS
Why Tenison Road then? From the outset we were motivated to understand experiences with data from the inside, not abstracting away from the difficulties and quandaries thrown up by examining real people and their understandings and uses of data. Thus, we started the project by sur-

veying the data we could find about our own local communities, the places where each of the project team live. The results varied enormously, showing the differing concerns of city and rural communities, and the uneven nature of data such as national statistics and geo-located social media. This led us to thinking about how a single community might understand the heterogeneous forms of data that it could amass about itself. Through a meandering decision-making process, we pondered on the road our research lab had recently moved onto, Tenison Road. We appreciated the varied demographic on the road, but we were also drawn to how our own presence was likely to further complicate the question of how data comes to matter in a place. Our hearts, then, settled on studying Tenison Road.

Tenison Road is a street in Cambridge that runs for roughly half a mile from Station Road (leading to the railway station) to Mill Road (one of the more cosmopolitan and diverse Cambridge areas; Fig. 1). The variety of residents include students and tenants who live near Mill Road, family housing around the Green at the centre, and tourists who stay in bed and breakfast lodgings nearer the railway station. The smattering of 'commercial' enterprises include a lighting shop, pub, language school, YMCA, charity, solicitors' office, and our lab. Notably, the road is also part of the site of a major redevelopment program around the station. Our lab represents an early stage of the development, which is otherwise manifest in considerable building works surrounding the southern end of Tenison Road. Needless to say, both the works and final development are having and will have serious implications for Tenison Road itself.
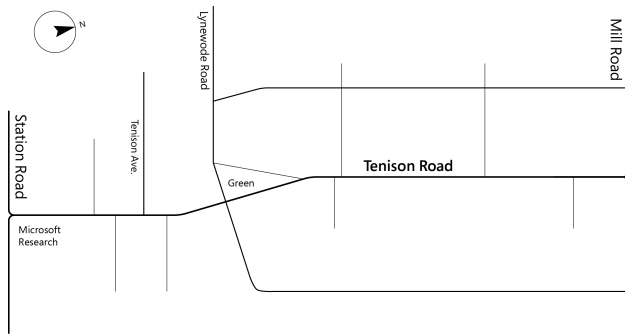

Figure 1. Tenison Road neighbourhood schematic.

In October 2013, we delivered about one hundred invitations to the properties on Tenison Road for a project launch hosted at our lab. Since then, the backbone of our engagement has been a series of topically-driven, evening community meetings, which occur approximately every month. These are organised via email (about 60 residents have signed up to our email list) and are usually attended by 20-30 residents plus members of the project team. Over 12 months, we've also sought to encourage other data-related engagements with the residents, including asking them to complete data notebooks, occasional data surveys (on local plant and wild life), installing and managing different 'data technologies' (see below), and on-going impromptu interactions in person and electronically. More formally, we've

also conducted, with residents and proprietors, ten in-depth interviews concerning the geography of the road. The first five of these focused on the social geography of the street, while the latter five focused on the ways in which data and information flows through it. In both cases, participants used printed maps to illustrate their thoughts. In all, the project has consisted of a diverse set of engagements aimed at building a trusted relationship with the community and insights into their evolving views of data.

As well as empirical insights, a range of ideas for what we've called 'data technologies' have emerged through these different engagements. To date, our activities have given rise to: the deployment of five off-the-shelf Air Quality Eggs [1] in residents' homes; the building and deployment of a system for monitoring vehicle traffic and noise levels; the production of a paper-based archive of the street's history and a complementary online databank; and the deployment of an existing system, PosterVote (Fig. 2a) [30], which supports push-button voting using augmented posters installed on the street. The research team are also in the midst of deploying over thirty bespoke voting devices, named Bullfrogs (Fig. 2c), that allow residents to participate in hyper-local polling and voting from their homes.

Data from these technologies are being collated on the project website, and were also showcased at a street party held in August 2014 (an event run with the local community to celebrate the street's 125th anniversary). The street party was an opportunity to engage residents who were not already involved in our project, and enabled the material archive and traffic data to be displayed—the latter was visualised on bespoke physical charts (Fig. 2b). We also ran a number of data exercises at this event; for example, households were invited to design bunting flags to show the number of years they'd lived on the street (Fig. 2d).

Figure 2. PosterVote installed on Tenison Road (a), and the physical charts (b) BullFrogs (c) and custom bunting (d) at street party.

THINKING THROUGH THE DATA

It's not possible, within the scope of this paper, to cover all of the data exercises and related discussions undertaken in the past year. We limit ourselves here to three major strands of the project that have played a significant part in our engagements. These address social heritage through the curation of existing data; traffic through the capture of vehicle and environmental data; and the complexities associated with polling residents for their opinions on local issues. We consider approaches to dealing with existing data first.

Archiving: Dealing with Existing Data

A theme identified early on as being of significance to the residents was that of community: how can a sense of community be collectively fostered, and can data have a role in this? These questions led to, amongst other things, the creation of two archives of Tenison Road's history, one physical and one digital. In this section, we consider the ways that the archives bring data together to produce a historical narrative. In particular, we attend to the role that certain individuals on the road have played in developing this narrative, and how their activities appear to have been bound up with particular temporal, spatial and social factors.

The two archives, although both about the road, are produced in quite different ways. The physical archive is being curated by one of the residents, a trained archivist and former librarian, who has volunteered as part of the project to collate content from sources including census data, newspaper clippings, information from fellow residents and the occasional found object. Building this archive is a serious endeavour; at the time of writing it takes the form of three large ring-bound folders, two of which form the main archive and one that is a loan copy available to others. In contrast, the digital archive, or 'databank', was built by the research team, and residents can upload their own content to it via a website. The different formats obviously have implications for access: the physical archive is stored at the archivist's home, and can only be viewed with her consent, whereas the databank can be seen and contributed to by anyone with access to the web. This leads to its own issues; for example, some residents are uncertain of the ethics of publishing details online about the people who used to live in their houses, a factor that is not queried when it comes to the physical archive. Yet a broader problem is the rather diffuse responsibility for updating the databank, in contrast to the clear role the archivist has taken on with its physical counterpart. While the databank is somewhat sparse, the physical archive is substantial, and continues to grow.

The archivist has fully embraced the task of producing the ring-bound archive, and is able to articulate a clear motivation for doing so: "I want to see certain improvements are made in planning and safeguarding our heritage". Documenting local places with "heritage assets" that are of "local interest" could, in her view, be brought to bear on any future discussions about proposals to renovate the street, and may be of special value where buildings have no formal

protections against redevelopment. This endeavour entails creating a holistic but unique document, one which extends existing records that can be obtained from the library and online sources. Accordingly, she seeks to engage other residents in its production, drawing in content that they have about their own houses (such as house deeds and photos), to enrich the archive further. She has organised it to make it easy to find content about each house, to support the personal interests of different individuals. However, engaging others in a way that might encourage them to dig out any relevant content that they have is not straightforward:

"I try but it's quite hard because if you think about it people are at work… What I'm trying to do by presenting the archive at these public occasions [e.g. the street party and community meetings] and answering questions... I am then hoping if you cast your bread upon the waters it might come back fruitcake."

The archivist points out the value of the street party and community meetings, as in the ordinary course of events little happens that might give her the opportunity to publicly share the archive and even less occurs that might engage others in the process of its production.

Indeed, interviews with other residents resonate with the view that there are few places on the street that serve as hubs for the exchange of information or data [cf. 20]; instead, people are more likely to encounter others while *moving* through the street. Yet, while the street is described by residents as a thoroughfare, they rarely move along its full length, often walking or cycling along the streets that run off it to reach the town centre or the north of Cambridge. Thus, the people they encounter tend to be those who use the same routes, at the same times. These spatial and temporal qualities to the road give rise to fluid networks of information exchange, motivated by common interests and needs. For instance, one resident described how he knows "a lot of people from dog walking", and that this gives rise to "a lot of exchange around general dog chat" but also to "social manoeuvring". He gives an example of how a proposal from the council to require dogs be kept on their leads in the local cemetery was retracted, due to "people saying they would write to their MP [Member of Parliament], and they did, so it escalated very quickly and was a word of mouth thing". Networks can thus be responsive to triggers, but they are dependent on common concerns.

The archivist too is connected to other residents of Tenison Road through the location of her home, her daily routines, and her own concerns with local issues. Indeed, her presence on the street is felt; she keeps her neighbours' keys, accepts deliveries on their behalf, and was described as an "expert" by others through her role in producing the physical archive. But this does not, it seems, make it easy for her to gather archival data. Consequently, and despite her efforts to engage others, the archive is largely made up of her own research, found objects (including a letter from a former UK Prime Minister, which was found amongst a neighbour's recycling in a shared alleyway), and content

from a few people who attend the meetings and attended the street party. Also worth noting, in a minority of cases her role is a barrier to the inclusion of content. On one occasion a resident preferred to give a set of photos, found during home renovations, to the research team. She viewed these as depicting content that the archivist might be too close to, having been resident on the street when the people who these items had belonged to had lived there. Thus, the production of the archive is directly influenced by spatial factors (e.g. the location of the archivist's home), temporal factors (e.g. her ability to connect with people who work to different temporalities) and social factors (e.g. the privacy implications bound up with her role as archivist).

Traffic and Local Redevelopment: Capturing Data

The second strand of the project we wish to highlight is one that involves residents more broadly, and has implications for not only those who live on the street but also for those who pass through it. Below, we reflect on our efforts to capture data about the street's environment, an effort that was, unsurprisingly, precipitated by residents' concerns over the local redevelopment plans and their impact on traffic on the street. The findings show again that data collection is most impassioned when it is driven by matters that are clearly meaningful to a place. At the same time they extend this, showing more clearly the competing interests of different parties.

Residents were keen from the outset of the project to capture data about Tenison Road's traffic. The deployment of a thermal camera (mounted on our building) and Air Quality Eggs is being done in part out of curiosity (some residents wondered whether their back gardens would have better air quality than their front gardens, for example) but principally to amass data as "evidence" and even as "ammunition" in dialogues with the council. Traffic calming plans put forward by the council, through a public consultation, have raised concerns and residents have seen the data as a way to prioritise the issues and put forward their case. The collection of data about air quality in particular was seen to be a means of effecting change, having been cited by one of the residents (also secretary of the local residents' association, and considered to be someone who "knows everything") as being used by another nearby street to demand the implementation of traffic calming measures. In one meeting, this resident heralded: "The purpose of data is action."

Notably, the council does already collect local air quality data. There is an air quality station visible from the street, but residents have no straightforward means of accessing the data that it produces. Speaking at a meeting, one said, "The information is there, but it's buried." However, there is a further reason as to why residents wish to collect their own data. The council and especially the developers are seen as having an agenda that is at odds with that of the residents, and this is believed to be reflected in the data that they collect. At interview, one resident commented:

"The council writes to us a lot about planning applications, we get quite a lot of junk mail from the council. They've sent us recently a survey about our views of the street and sent it online which I think is pretty terrible, I think if you looked at it, it has one of those questions where it says 'Do you really agree, do you strongly agree, do you agree a bit or don't you care' and it always tips to the answer and they make it so long that you get half way down and give up."

This view that data is non-representative or biased extends to measures of speed taken by the police force (who have reportedly done so wearing high-visibility jackets, which cause the traffic to slow down) and estimates of volume presented by the developers (which simply haven't been accepted as having face validity). Thus, one resident highlighted at a meeting the distinction between data "coming from us" and "being done to us". Importantly, this view extends to the researchers' role in the project as well; her desire is to be directly involved in the production of data.

The above demonstrates a certain unity amongst the residents in terms of their aspiration to use data to negotiate with the council. However, discussions at community meetings also reveal divergent voices in terms of how traffic calming might be accomplished in practice. Concerns in relation to this include parking, noise pollution, air pollution, speed, volume of traffic, implication for safety, and implication for community and the sense that one can connect with neighbours living across the road. Traffic calming measures that might, for example, reduce speed (e.g. 'speed bumps') could also increase noise (due to the need to brake and change gear on approach) and reduce the number of parking spaces on the street. One resident has described how he wouldn't mind speed, so long as it was "silent speed", but this opinion has been contested by others. The multiplicity of viewpoints that surfaces is difficult to reconcile with the process of collecting data for 'the street', which implies a collective goal. Next, we consider what data could potentially bring to a situation like this, where there is a recognition of multiple viewpoints and different stakeholders.

Voting and Polling: Making Data

In this last of three sections, then, we begin to consider how technologies for voting on local issues and polling residents from the street might have a role to play in acknowledging and addressing multiplicities. We will see how data is seen as having a capacity to draw people together, but also how the perceived ability to deal with multiple viewpoints is bound up with stakeholders that are thought of as neutral.

At the time of writing, one voting technology (PosterVote) has been deployed on the street—mainly in relation to recently proposed traffic calming measures—and another (Bullfrog) has been demonstrated at the street party and is midway through a field trial. The use of these technologies on Tenison Road are still, therefore, in their nascent stages, but they have nevertheless been utilized in grounding discussions at community meetings about what questions might be asked of the street, and the challenges bound up

with framing these. At the heart of these discussions is a recognition that Tenison Road is fairly heterogeneous, encompassing areas that are "wholly privately owned, quite big houses, people that are more established in life versus… student, buy to let areas". The people who attend the community meetings tend to be owner-occupiers, who are part of the community around and near to the green. They themselves recognise, "Our group is interesting, committed, but it's a particular demographic of Tenison Road."

Residents also understand that polling technologies such as PosterVote, that can be installed on the street itself, may offer a means to gather data from people who do not attend the meetings, including those who pass through rather than live on Tenison Road (e.g., pedestrian commuters who use it to access the railway station). However, they note issues around "who frames the questions" and people's "agendas". Indeed, in discussions about the possibility of using PosterVote to canvas opinion about whether a new local history board should be installed on the Green, one resident suggests a positive community sentiment: "yes, because I think you'll find support". Yet, at the same time, there is dissent. At least one resident (through correspondence with both the resident association's secretary and the council) has vigorously protested yet more "clutter" on the road.

The community meetings held in our offices have been identified as one avenue where such dissent can be acknowledged: "you guys are obviously aliens, you're above and beyond Tenison Road […] trying not to be dictatorial […] makes you not of Tenison Road". As people with no stated agenda, who do not live on the street, we have been described as bringing an impartiality to the project that is expressed through the provision of "a neutral space" to meet in and a stability in initiating meetings that are separate to those run by the residents' association (who are seen as having a particular set of concerns). The resident quoted above expands: "I see you guys as people who don't have an axe to grind about the data, you just want it to flow".

This neutrality has been deemed important also in the ways data is produced. In the context of the project, data is seen as a potential "catalyst to try and build some kind of cohesive community". But the issue of collecting data is not straightforward, either because it necessitates directly asking for information from neighbours, or because it means dealing with conflicting voices that may be expressed through anonymous polls. In relation to the former, some residents have expressed the need for someone outside of the street to take the "patriarchal" role of collecting data. We have noted the archivist's tactic of sparking people's interest in the archive rather than explicitly asking them to contribute content to it, and reticence to ask for information was also quite visible when a resident initially volunteered for the role of producing the bunting for the party, but then withdrew with the explanation that it would be inappropriate for her to ask questions of people living on the street (eventually we engaged a local artist to undertake this role).

In relation to the latter, the problem of managing differences of opinion has been raised explicitly in discussions about what should happen when the project ends.

Thus, while data is seen as potentially drawing community together, the problem of framing questions and dealing with differences of opinion mean that generating data is a potentially divisive endeavour for communities to engage in.

THINKING THROUGH DATA-IN-PLACE
Broadly, then, over the last twelve months, what's come to be apparent in working with the residents of Tenison Road is how they've been able to grasp the value of data and its relevance to local concerns. Much of the above is an indication, it seems fair to say, of the well-rounded ideas residents have developed about data and what it can do for them. Despite protestations from many—voicing their ineptitude with technology—it's clear the data we've been collecting is coming to be a viable way for residents to think about and act on local matters. In this light, the data seems not a portentous technology set to dramatically transform daily life or decisively determine facts and outcomes, but more a substance being drawn into (and sometimes rubbing up against) the everyday business of living on a road.

As a concept, data-in-place thus helps to draw out ideas of data coming into being through growing and shifting relations with a street, its residents and the environment. For HCI, what though can we learn by seeing things in terms of this gradual and on occasion capricious emergence of situated and contingent data, what conclusions might we draw that have relevance to the design of interactive technology?

Accessible and Sustainable Data Systems
A straightforward implication points to the design of data systems that should be either more accessible for non-technical users or that incorporate some sustained technical support. Strikingly, it has not been a lack of understanding of the relevance or importance of data that has hindered people's imaginations on Tenison Road. Rather, residents have, quite reasonably, voiced worries about their lack of know-how and confidence to install and run data based technologies. On numerous occasions and in various contexts, we've been told the data-related activities we've been collectively involved in would have been impossible without us. To put it bluntly, putting data into a place is, we've found, an active venture and, unsurprisingly, demands a specialist knowledge and commitment to keep it going.

This raises a number of issues echoed in a relevant paper by Taylor et al. [25] that discusses withdrawing from community engagements. The paper's authors highlight the heavy reliance on researchers to keep deployed systems working and the challenges involved in building solutions that can be sustained once projects have been completed and researchers leave. This will no doubt be a persistent problem in, as Taylor et al. refer to it, "experimental technology" research. However, it's also the case, we imagine, that a range of services now openly available and appearing to

garner a user base will provide viable solutions for communities wanting to collect and exploit data (e.g. *Netatamo* and *Withings Home*, and services like *Neighborland*).

Beyond these practical concerns, what we want to develop here are implications that account for the more nuanced relations between place, community and data that have surfaced in our research. Broadly, we see our emerging results giving rise to a conceptualisation of data that remains, as it were, on the ground. This isn't to repudiate the value of (big) data, but to recognise that the situated qualities of data—of data in place—open up a new set of possibilities for designing data orientated tools and systems. We see this data-in-place having implications for a design approach that accommodates the always emerging assemblies of place, community and data, and at the same time one that enables specific and unique configurations to flourish. Below we elaborate on four strands of thinking that we hope help to orient design in this way. Through ideas of *mattering*, *contours*, *structures and boundaries*, and *multiples*, our aim is to suggest that data technologies might be conceived of as an ecosystem of devices and services. Here, the provenance of data across networks of people, places and technologies would be treated as something continually enacted in-place, and the data would purposefully be enriched and thickened based on the always emergent relations.

Mattering
Key to making sense of data in this way then is understanding how it materialises in place. Counter to the common view of data as abstract and general—figuratively in the clouds—we've come to understand it as something that is always, in some form, bound up with what matters. This is meant in both senses of the word, in that we see data coming into being in material ways, and also in ways that are meaningful—that matter—to people. This point is well-developed by Wilson [31], so we'll not dwell on it here. Let us briefly though illustrate it through the voting and polling systems we've been working on with the community.

In line with similar concerns for the hyper-local [3, 14, 30], our exercises in engaging the community in local forms of participation have purposefully sought to link locally formed opinions to place. For example, in using PosterVote to let people express their degree of support for the council's proposed traffic calming measures, posters were located where those changes would be made, materialising votes on specific devices and in very specific locations. With Bullfrog, our aim is to do the same, but provide the community with a mechanism that produces a denser map of the things people want to ask, their responses, and how these are located and perhaps distributed along the road.

What residents' reflections on these aims show, so far, is how the data—in this case the results of local votes and polls—is meaningful precisely for how it comes into being, materially. As we've seen, the material configurations of posters along Tenison Road matter to residents because they do more than simply record counts of votes—they seek

to address the uneven demographic distribution along the road and different degrees of involvement both in our research project and the council's attempt at a democratic process. The very existence of posters with particular questions and in certain places is recognised to embody impartial agendas, reflecting intensities of feeling and the differing notions of a collective good on the road.

We find much is lost, then, if data is abstracted away from place, not understood as coming to matter in place. Furthermore, this understanding of data shows how it privileges some readings, and discounts or deters others. In short, the mattering of data, how it materialises and comes to be meaningful in place, presents a way of enriching its value. What we begin to tackle here is how we might come to conceptualise this in a productive way.

Contours
Residents' mapping exercises have etched out fluid movements and transient encounters with data across and along Tenison Road; news on the street is most remarkable for how it travels, not how it stays fixed in particular sites. Passing people on a dog walk, the chat over the garden fence or the chance encounter on the way to the shops are the forms of transmission. These are temporally sensitive and opportunistic, threaded into small geo-temporal moments in which residents interact and share news with those they already know through common interests.

Seeing data in place (and mapped), these read as contours that data both follows and etches out. On maps, they read like a networked tapestry, one knitted into and inexorably interwoven with the road's physical and social geography. Our data-in-place helps to tease out the ways these contours are performed, how they are embroidered (to continue the analogy) into the places people inhabit.

Take our role in collecting and managing data on Tenison Road. As we've recounted, we hold a peculiar position in the eyes of the residents. Our perceived role as an "outsider", somehow "alien" to the community, positions us as "neutral". We've been described as simply interested in the "flow" of data. This neutral status as overseer of data flows—of installing and maintaining devices for voting and polling for instance—is understood not just to be technical, but also a facilitator of 'community'.

Flows materialise data in particular ways, forming contours between and around how it is generated and maintained. By sensing and managing the data to ease these flows, we build surfaces and structures that shape the capacities for data's movement into and along the road. boyd and Crawford [6] begin their article '*Critical questions for big data*' by citing Kranzberg's famous quote: "Technology is neither good nor bad, nor is it neutral". So it is here. We intensify the collection of data at points on Tension Road with our traffic and air quality monitoring, and build data structures on our servers that place these readings along an incrementally growing timeline (in human readable increments). This fig-

ures Tenison Road in particular spatiotemporal terms, fore-grounding discrete regions of space-time to be preserved and, in some cases, used (i.e., in conversations with local government). Interjecting data into Tenison Road is then grafting and knitting data into a geography of the neigh-bourhood; despite our perceived neutrality, our work with the data gives shape to a new and emerging kind of place.

Structures and Boundaries
Positioning data in place like this, rather than in the ab-stract, also requires a different consideration of how it is produced and shared. In place, this is circumscribed by lo-cal temporalities, spatiality and sociality—by residents hav-ing their distinctive rhythms; traveling by different routes and using different modes: walking, cycling and driving; and having friendships and acquaintanceships built around common interests. So for example, the archive includes found objects, which were discovered in the alleyway next to the archivist's street, while the Air Quality Eggs are lo-cated on the houses of residents who come to the communi-ty meetings, and who live towards the centre of the road. The community meetings are organised around the nine-to-five working day, a temporality that cannot suit everyone [23], and the proposition of attending them may in any case be of greater interest to people who consider themselves to have a vested interest in the street (e.g., owner-occupiers) than those passing through (e.g., students and tenants, not to mention commuters and tourists).

The temporalities, spatiality and sociality thus give shape to contours through which data 'flows' on Tenison Road. They also structure the data itself. For example, a new for-mal network may be precipitated by nearby development plans to build new homes behind a row of existing homes, while dog walkers might form a more fluid network that may nevertheless quickly react against a proposed require-ment for dogs to be put on leads. In either case, the data coalesces and spreads across the road at/between different regions and in distinct rhythms, building uneven networks of data nodes and classifications purposefully assembled for a common use. Far from generic or arbitrary, these 'data structures' are consequently deeply entwined with place, caught up in the geospatial and temporal rhythms of what matters on the road and to its residents.

Boundaries are a feature of these structures too. Not neces-sarily connected in time or space, the structures keep data separate. Residents can, of course, intersect with different structures and thus move and share data. However, general-ly, a lack of common concerns inhibits the flow. Even though the data might be useful to both parties, we're un-likely to see those protesting the development share data with the dog walkers, simply by dint of the different mo-tives. Boundaries to data are, then, a product of the road's social geography. Indeed, some boundaries are upheld de-liberately, with a view to protecting privacy. It is difficult to abstract away, anonymise, and decontextualize data in small communities; prior work by Cross has highlighted the

ways that members of a small, rural community might ob-ject to the sharing of data even within that community [10]. On Tenison Road, too, we see residents reticent to engage in data collection when this means directly soliciting it.

Data-in-place, then, is not simply an aggregation across individuals living on a street, but a reflection of a communi-ty with its own spatial, temporal and social structures and boundaries. In some cases, efforts are made to overcome these boundaries, while in others, work is done to ensure they are upheld. But ultimately, structures and boundaries shape production and carve out certain paths for sharing.

Multiples
The shifting positions people can inhabit, and the different places they can be in the flows of data suggest what might be thought of as a multiplicity of 'small worlds' [27, 22]. The contours and boundaries performed as data suffuses Tenison Road mark out realms with distinctive relations between people, things, places, etc., each with an internal logic accounting for the flows and connections.

Such worlds are in the making on Tenison Road, forming perhaps most visibly around the major development plans and local government initiatives, which aim to appease lo-cal residents through 'traffic calming'. The County Council, through a traffic survey, circumscribes and marks out a ter-ritory by counting vehicle turns at each junction along the road. The map of numbers produced from this operates in a comparative logic; data counts for how it can establish par-ticular categories of road and expected traffic flows. On Tenison Road, the council wants to determine whether there is in fact a traffic problem to be answered by comparing this data to surveys on similarly categorised roads, and, if they can afford it, further surveys at the same junctions.

On the road, the rationale is different. The same data is an impetus for residents to ask questions that they tell us are more relevant to life on Tenison Road. It's the speed be-tween the junctions they say that matters, and the noise and pollution. The neighbourhood is described as literally and figuratively divided by the fast moving and high volumes of traffic. Yes, the residents have different motives here (some wanting slower and less cars, and some wanting quiet), but the data counts for what we are told emphatically is a "qual-ity of life" for the neighbourhood, a push for a common good through collective action. It's this that has driven, above all else, the installation of the sensors that monitor sound levels, traffic speed and air quality.

Seeing data find its place in these ways shows multiple worlds of relations and logics if not yet formed, then in the making. Critically, though, these worlds aren't easily dif-ferentiated. The traffic monitoring matters are of course much more complicated, with actors and relations flowing across both these worlds and the numerous others that have a stake in who will and won't travel along Tenison Road. Let us make a last point to illustrate how the multiples work into and through one another.

As part of the project's collective deliberations over traffic, one discussion has developed into the possibility of tracking residents' changing movements and travel routines over the course of the year, aiming to reflect the changes afoot to the built environment. To this end, two residents have volunteered to wear location-tracking devices and feed their geo-temporal data into the larger corpus of traffic data. An email received from a father and his two children (who all regularly attend community meetings), responding to this location-tracking, asks how the data might be understood in terms of another of the project's data exercises, the archive:

"... I appreciate traffic is a major theme but we all think we don't want to end up being the city council traffic department. Traffic is about people moving and people moving in the wider aspect is hugely interesting- moving for work, moving for school, moving for fun. we'd all be very up for tracking ourselves and seeing how our movement phenotypes differ.

I think the ideas of archive and record are more interesting and potentially engaging in wider sphere and would be very interested how we could use the tools of today to record life and movement. combining the movement record within the sociological record might be able to make traffic just that little more permanent than the more short term but ever present gripes of urban traffic."

This message situates location data in terms of quite a different sense of movement along Tenison Road. The data is seen as constitutive of a "movement record" that locates the to-ings and fro-ings on the road in wider trajectories of time and social life. The data is not so clearly judged in terms of collective action and communal good, but rather in how a community hopes to learn about itself and represent itself, historically. Movement data, but also "the tools of today", become entangled in particular moments and these are located in extended lines of changing human, machine and social relations. Through data-in-place, we see then a multiplicity of worlds being brought into being. These worlds are small, and spatially and temporarily bounded, but the point is data weaves its way into them, as a shaping force.

CONCLUSIONS

This paper represents an effort to think through data and how it comes to be actively entangled in social and communal life. Through *data-in-place*, we've presented a conceptualisation that aims to thicken and deepen what we've observed to be the tight-knit and always emerging relations between people, places and data. Our data-related activities and engagements with a road's community have been interpreted in terms of *mattering*, *contours*, *structures and boundaries*, and *multiples*, each of which seek to capture the experiences of using and being exposed to data.

In this, our broad aim has been to show how data-in-place might open up ways of thinking about our interactions with data. We've foregrounded the unevenly distributed and heterogeneous nature of data when it is encountered in place. We've seen too how data materialises in distinct ways and ways that matter, differently, to people and places. Our own interventions on Tenison Road draw on these ideas, experimenting with a diverse range of ways to generate and experience data. PosterVote, the Bullfrogs, the physical charts, and a variety of on and offline surveys and data representations have been designed to be sensitive to the distinctive qualities of data each engenders when put in place.

In these terms, we suggest it may be helpful to approach design in terms of an ecosystem of data forms for generating, viewing and possibly analysing data. Of course, ideas of device ecosystems have been around for some time, and it's fair to say that the growing and evolving range of services and apps available online and on mobile devices will meet this need. We thus see the value here being in how we consider extending the ecosystem analogy to include our situated interactions with data, and how we build a rich variety of data-driven systems and services to accommodate the materially and spatially bound ways we live with data.

The notions of contours, and the changing structures and boundaries seen through data-in-place direct attention to the ways we structure data and, in turn, enable access to it. At a high level, this implies that we need to think of structures that support some kind of representation of data's active presence in place. These might express how data travels geographically and between people, and when, where and with whom it gathers significance (traversing through the contours and across the boundaries of a social geography). They may represent the different ways these parties invest in and (re-)inscribe data with particular understandings, across time and space. Productive here, would be a structure representing the rich geo-temporal tapestry data is entangled in. It would show it not to be a singular set of static facts, but part of the continuous and processual circulation of things, people, places, motives, ideas, and so on.

Further, this suggests the need to treat data as something that multiple parties have a stake in, perhaps even jointly own. Current data services do not deal with the distinction between personal and collective ownership well, failing to capture how a group in the workplace differs from a family, interest group, resident association, or neighbourhood. Proposals for rethinking what community ownership of data might look like include the notion of data co-ops, storage services set up to be of benefit to a community rather than of value to shareholders [16]. As we have seen, communities raise a particular set of issues when it comes to stewardship and privacy, issues that could be explicitly acknowledged through design. This might take the form of encrypting parts of a dataset, making data available for limited, or even future periods of time, and linking it to a specific agenda that the data is associated with. Perhaps, as motives shift or the role of stewarding changes hands, access to data would need to be renegotiated.

These modest ideas are offered as illustrations in our thinking through of the relations between data and communal life. As we extend our work with Tenison Road and develop similar programs elsewhere, our aim is to further examine data's presence in place and see whether as a conceptualisation of data, data-in-place can come to help people and

communities live productive and meaningful lives. In doing so, we seek to build on what we have expressed here: that the ways in which data is produced are shaped by the social and material qualities of place, qualities that, if recognised in the design of data technologies, might underpin a very different understanding of the uses data might be put to.

REFERENCES

1. Air Quality Eggs. http://airqualityegg.com. Accessed September 9 2014.

2. Anderson, C. The end of theory. *Wired magazine.* (2008), 16-07.

3. Aoki, P.M., Honicky, R.J., Mainwaring, A., Myers, C., Paulos, E., Subramanian, S. and Woodruff, A. A vehicle for research: using street sweepers to explore the landscape of environmental community action. In *Proc. CHI 2009*, ACM Press (2009), 375-384.

4. Bellotti, V., Cambridge, S., Hoy, K., Shih, P. C., Renery Handalian, L., Han, K. and Carroll, J. M. Towards community-centred support for peer-to-peer service exchange: rethinking the timebanking metaphor. In *Proc. CHI 2014*, ACM Press (2014), 2975-2984.

5. Bird, J. and Rogers, Y. The pulse of Tidy Street: measuring and publicly displaying domestic electricity consumption. *Pervasive 2010 Workshop on Energy Awareness and Conservation through Pervasive Applications.*

6. boyd, d. and Crawford, K. Critical questions for big data: provocations for a cultural, technological, and scholarly phenomenon. *Info Com Soc 15*, 5 (2012), 662-679.

7. Bowker, G.C. The Theory/Data Thing. *IJOC 8*, (2014), 1795–1799.

8. Carroll, J. and Rosson. M.B. Wild at home: the neighborhood as a living laboratory for hci. *ACM Trans. Comput.-Hum. Interact. 20*, 3 (July 2013), Article 16.

9. Crawford, K., Faleiros, G., Luers, A., Meier, P., Perlich, C. and Thorp, J. Big data, communities and ethical resilience, a framework for action." *Bellagio/PopTech Fellows White paper* (2013). http://www. rockefeller-foundation.org/blog/big-data-communities-ethical.

10. Cross, J. Life off the grid. Presented at the *Symposium on Producing Data: Practices, Materialities, Values*. September 3 2014, Edinburgh, UK.

11. Dourish, P. Re-space-ing place: "place" and "space" ten years on. In *Proc.* CSCW '06, ACM Press (2006), 299-308.

12. Dourish, P. and Bell, G. The infrastructure of experience and the experience of infrastructure: meaning and structure in everyday encounters with space. *Environ Plann B 34*, 3 (2007), 414–430.

13. Gitelman, L, ed. *Raw Data is an Oxymoron*. MIT Press, 2013.

14. Hu, Y., Farnham, S.D. and Monroy-Hernández, A. Whoo.ly: facilitating information seeking for hyperlocal communities using social media. In *Proc. CHI 2013*, ACM Press (2013), 3481-3490

15. Kitchin, R. (2014). Big Data, new epistemologies and paradigm shifts. *Big Data & Society 1*, (1).

16. Klein, E. Who owns our data? *Presented at the Symposium on Producing Data: Practices, Materialities, Values*. September 4 2014, Edinburgh, UK.

17. Koeman, L., Kalnikaitė, V., Rogers, Y. and Bird, J. What chalk and tape can tell us: lessons learnt for next generation urban displays. In *Proc. PerDis 2014*, ACM Press (2014), 130-135.

18. Mayer-Schonberger, V. and Cukier, K. *Big Data: A Revolution that will Change How We Live, Work and Think*. London: John Murray, 2013.

19. McGookin, D., Brewster, S.A. and Christov, G. Studying digital graffiti as a location-based social network. In *Proc. CHI 2014*, ACM Press (2014), 3269-3278.

20. Pettigrew, K. Waiting for chiropody: Contextual results from an ethnographic study of the information behaviour among attendees at community clinics. *Info Process Manag 35*, 6 (1999), 801-817.

21. Prensky, M. H. sapiens digital: from digital immigrants and digital natives to digital wisdom. *Innovate 5* (3, 2009).

22. Savolainen, R. Small world and information grounds as contexts of information seeking and sharing. *Libr Inform Sci Res 31*, 1 (2009), 38-45.

23. Sharma, S. *In the Meantime: Temporality and Cultural Politics*. Duke University Press, 2014.

24. Strengers, Y. Smart energy in everyday life: are you designing for resource man? *Interactions 21*, 4 (July 2014), 24-31.

25. Taylor, N., Cheverst, K., Wright, P. and Olivier, P. Leaving the wild: lessons from community technology handovers. In *Proc. CHI 2013*, ACM Press (2013), 1549-1558.

26. Thrift, N. (2014). The "sentient" city and what it may portend. *Big Data & Society 1* (1).

27. Urry, J. Small worlds and the new 'social physics'. *Global networks* 4, 2 (2004), 109-130.

28. van Dijck, J. Datafication, dataism and dataveillance:. *Surveillance and Society 12*, (2014), 197–208.

29. Vertesi, J. and Dourish, P. The value of data: considering the context of production in data economies. In *Proc. CSCW 2011*, ACM Press (2011), 533-542.

30. Vlachokyriakos, V., Comber, R., Ladha, K., Taylor, N., Dunphy, P., McCorry, P. and Olivier, P. PosterVote: expanding the action repertoire for local political activism. In *Proc. DIS 2014*, ACM Press (2014), 795-804.

31. Wilson, M.W. Data matter(s): legitimacy, coding, and qualifications-of-life. *Environ Plan D 29*, 5 (2011), 857–872.