Political Geography 78 (2020) 102147

Contents lists available at ScienceDirect

Political Geography

journal homepage: http://www.elsevier.com/locate/polgeo

Between capture and addition: The ontogenesis of cartographic calculation

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ARTICLE INFO

Keywords:
Calculation
Cartography
Ontogenesis
Capture
Addition

ABSTRACT

This paper argues that cartographic calculation can be considered as a form of 'capture'. It suggests that surveillance narratives, typically used to illustrate sovereign forms of power, can be augmented by other socio-technical approaches. Accordingly, the paper develops the idea of capture from media studies to reframe cartographic calculation in computational terms. In doing so, it engages with work in political and digital geography, arguing that the rise of digital devices, apps, platforms and services have led to the generation of huge volumes of event-based knowledges; with significant implications for the study of the calculation. It subsequently argues that cartographic calculation is not, however, solely composed of calculative practices that simply capture cartographic data, but also necessarily composed of calculative practices that add knowledge into, and proliferate renders of, the world. Two dynamics of this oscillating process – anticipation and correspondence – expose the ontogenetic tendencies of cartographic calculation. The paper draws on the use of a digital protest mapping app to exemplify these forces.

1. Introduction

This paper argues that cartographic calculation can be considered as a form of 'capture'. The calculation of territory has often only been considered a state practice, ordinarily associated with modern techniques of governance designed to measure, order and control. Classic examples include population censuses (Hannah, 2009) and cartographic surveys (Edney, 1997, pp. 1765–1843), with work on the cartographic calculation of space and territory (Crampton, 2006; 2011) considering the extent to which territorial risks are constructed, managed, and mitigated, by the state through such practices.

Yet many non-state actors engage in cartographic calculation. Likewise, navigational approaches to calculation (November, Camacho--Hübner, & Latour, 2010) have re-imagined cartographic calculation, by rendering risks as internal to the practice of calculation, rather than externalized in territory 'out there'. These have allowed us to re-evaluate historical cartographic calculations, but also to foreground the media(ted), distributed, and digital dynamics of cartographic practice in world today. The paper is split into three parts.

Firstly, with the proliferation of digital devices, platforms and services, it considers how the generation of 'event-based' knowledges (Hannah, 2009, p. 68) derived from such technologies are changing cartographic calculation. Data produced through these calculative efforts come in multiple forms; capturing locative data, environmental data, bodily data, and other kinds of use data. The consequence of such developments is that sovereign nation-states are no longer dominant actors in the cartographic calculation of territory. This has significant implications for how we consider the technical realities of cartographic calculation.

Secondly, I argue that Agre's (1994a) 'capture model' can augment surveillant narratives, to articulate the novel dynamics of cartographic calculation by, and through, digital devices, platforms and services. Borrowing from computer science, Agre considers how so-called 'grammars of actions' (1994a, p. 102) are imposed upon human activities, allowing them to be captured and rendered formally, or computationally. Recent work on the technologies of capture, have argued that digital devices and platforms variously 'hook' or 'trap' users (Seaver, 2018); capturing attention (Dieter & Gauthier, 2019) through clever interface design. Similarly, that cartography has long engaged in the instrumental, and sometime violent, 'capturing' of geographic knowledge (Wilson & Elwood, 2014), whilst others have considered how value is captured or extracted from labour (Marx, 1976). Together, these recent works prioritize technological protocols and socio-technical interaction to articulate calculative practices.

However, thirdly, following Gerlach (2014), I temper this argument by suggesting that cartographic calculation not only involves the capture of event-based knowledges, but also necessarily entails the proliferation of data into the world. Rather than posit cartographic practice as *either* a process of capturing data *or* of adding data into the world, I suggest that cartographic calculation is built on a double tendency to

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https://doi.org/10.1016/j.polgeo.2020.102147
Received 15 February 2019; Received in revised form 6 December 2019; Accepted 4 January 2020
Available online 11 January 2020

minimize *and* maximize risk, between securitizing and resisting (Crampton, 2010; Perkins, 2013). In other words, I argue that cartographic calculation is premised on an 'ontogenetic' (Kitchin & Dodge, 2007) oscillation between these two poles; always capturing, always proliferating. I provide empirical justification for the above, by looking at two cartographic processes that reveal this ontogenetic effort, as evidenced in recent protest events in the UK. I refer to these features as *anticipation* and *correspondence*.

2. Event-based knowledge

While sovereign actors have committed to undertake ambitious, sometime disastrous projects to extinguish existential threats (Edney, 1997, pp. 1765–1843; Hannah, 2009), cartographic calculation is performed by many other actors who not fit into a sovereign mould.[1] Moreover, territorial calculations are not executed in frontier spaces at the limits (geographical, political, technological, social) of their operation. As Galloway and Thacker suggest, even the sovereign state has shifted to articulating a new 'regulatory model … fostering, impelling, and optimizing life' (2007, p. 76). This is evident, for example, in the change in status of the UK Ordnance Survey, from executive agency to government-owned company (Ordnance Survey, 2015). Arguably, the nation-state is no longer the most dominant actor in cartographic calculations of territory; usurped by the power of Google (Dalton, 2015; Zook & Graham, 2007a). While Kinsley (2014, p. 369) has noted 'there have been fewer studies of calculative practices by non-state actors', cartographic interventions by Zook and Graham (2007b), Crandall (2010) and Barreneche (2012), as well as work on the limits of state calculation by Stark (2009) on the economy, de Goede (2005) on finance, Gerlitz (2016) on social media, and O'Grady (2016) on emergency responders, suggests ample scope for a greater interrogation of cartographic calculation by non-state actors.

Non-state actors are typically involved in the generation of 'event-based' knowledges (Hannah, 2009, p. 68), and many contemporary cartographic calculations are not performed by sovereign powers. I contend, therefore, that surveillance narratives commonly used to explicate ostensibly 'digital' practices as diverse as border control (Topak, 2014), community policing 'watch groups' (Spiller & L'Hoiry, 2019), and anti-poaching initiatives (Massé, 2018) can be augmented by computational approaches to provide a competing account of this fragmentation.

Primarily, we have witnessed a shift in data collection techniques, now routinely performed both computationally and digitally (Galič, Timan, & Koops, 2016). As some have suggested, a surveillance model, indebted to Bentham and Foucault

> … fails to highlight certain aspects of the *technical elements of new media* – glossing over ways in which the institutional practices of computer system design may be antithetical to privacy, as well as ways that the tools of computer science may be able to provide effective privacy-enhancing technologies. (Wardrip-Fruin, 2003, p. 737, emphasis added)

Accordingly, references to the Panopticon or the 'surveillance gaze' (Lyon, 2006; 2018) do not necessarily account for the form of contemporary digital data, nor how it may be collected or analyzed. Digital devices, platforms, and services are integral to the generation of event-based knowledges. They increasingly take multiple forms; with geo-locative data (Duggan, 2018; Thatcher, 2014; Thatcher, O'Sullivan, & Mahmoudi, 2016), environmentally-sensed data (Calvillo, 2018; Coletta & Kitchin, 2017; Gabrys, 2016; Gabrys, Pritchard, & Barratt, 2016), life-logged data (Ash, 2018; Crawford, Lingel, & Karppi, 2015; Lupton, 2016; Pink, Sumartojo, & Lupton et al., 2017; Wilmott, Fraser, & Lammes, 2018), and web-tracking data (Gerlitz & Helmond, 2013; Peacock, 2014) actively extracted, purchased, solicited or otherwise procured using digital devices, platforms, and services each with specific

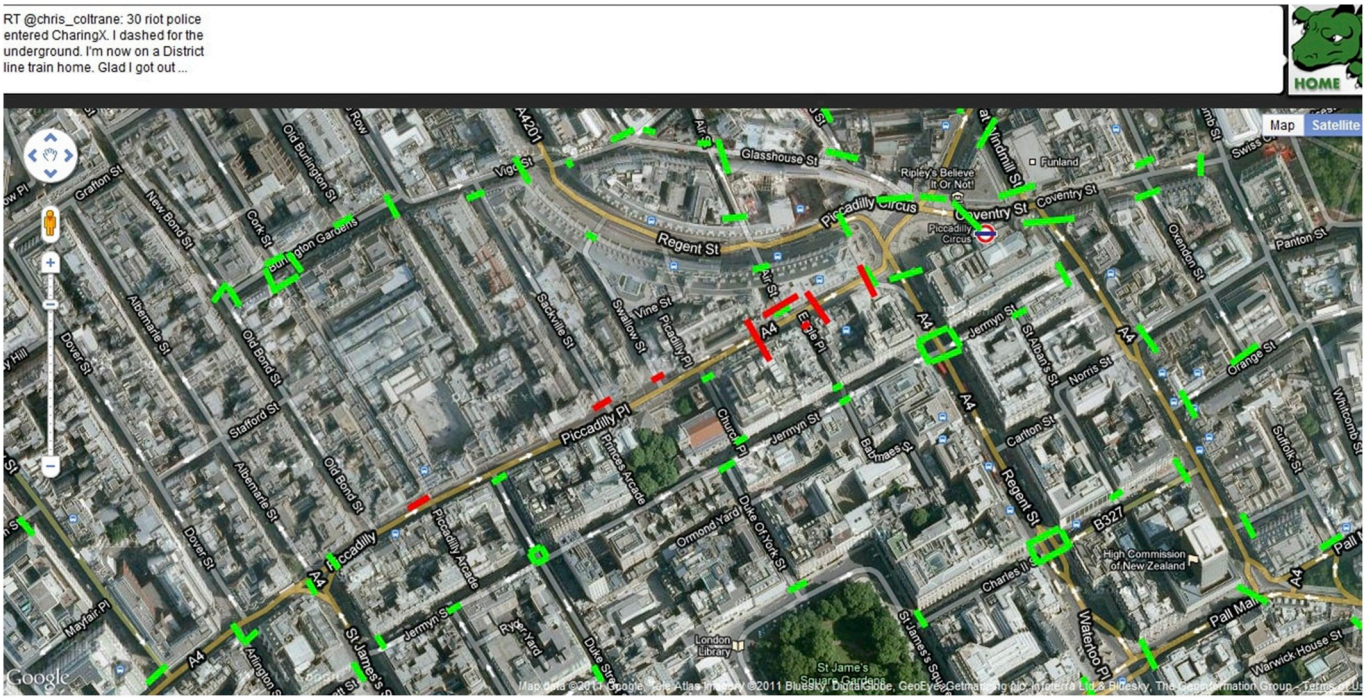

Fig. 1. A typical Sukey map. Note the impassable roads in red (middle), and the retweeted message (top left). Author. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

[1] Indeed, as is noted by Edney (1997, pp. 1765–1843), early colonial surveys were undertaken on behalf of private companies such as the British East India Company.

technical elements that affect calculation and knowledge production.

The inadequacy of panoptic terminology has long been noted (Baumann & Lyon, 2013; Manokha, 2018), in part because of changing technological realities. However, variations continue to endure. Elwood and Leszczynski (2011, p. 8), for whom surveillance 'implies a unidirectional power relation between viewers and viewed', suppose that the geoweb better represents a 'omnopticon' (2011, p. 8); with Google Street View and Twitter's GeoAPI evidently 'more than just surveillant technologies' (2011, p. 8). Likewise, Wilson (2012, p. 1273) has hinted that location-based services offer a 'different iteration of urban surveillance'. In each case, there is a desire to modify traditional surveillance narratives, but also a reluctance to completely dispose of them. I argue here that computational models offer an analytical framework to account for these transformations.

As Hannah explains, event-based knowledges are '[m]ore fleeting, 'transactional' … records of individuals being at particular places doing specific things at specific times (e.g. buying something with a credit card or running a red light)' (2009, p. 68). The identification of event-based knowledges as a specific kind of spatial inscription, generated during so-called 'mapping moments' (Dodge, Perkins, & Kitchin, 2009), provides the opportunity for a wider interpretation of calculation beyond the state, as well as a more obvious exposition of contemporary cartographic calculation. These 'more fleeting' activities, compared to the creation of coordinate systems, say, ordinarily enroll 'everyday' actors beyond nation-states and global technology companies. Moreover, the records Hannah speaks of are computationally-constituted; captured by specific digital systems.

Visual metaphors provide a partial account of what is happening at a technical level in Hannah's examples (a credit card purchase, a failure to stop at traffic lights), and attempts to multiply or iterate the viewpoints do not necessarily illuminate what is happening at a socio-technical level. Although visual metaphors may be useful in describing the effect CCTV cameras have on inattentive drivers, they distract from the computational agency mobilized in a credit card purchase.

Further, November et al. (2010) render cartographic calculation in *navigational* terms. In this, territory is not 'out there' to be mapped through a cartographic exercise (like in British India), but is generated within; exposed through cartographic calculations made in the navigation of space. In this, the existential risks that stand in the way of successful calculation are posited neither as subjects (e.g. citizens) to be known nor objects (e.g. landforms) to be mapped but as 'quasi-objects' (Latour, 1993, pp. 51–52). Cast in these terms, the West German census forms, enumerators, and legal challenges discussed in Hannah (2009; 2010) all constituted 'quasi-objects' (neither objects nor subjects) critical to the execution of both census and boycott. Similarly, the East India Company, military science, triangulation, and local bureaus in Edney (1997, pp. 1765–1843) all were – to varying degrees – inherent, hybrid hurdles to successful calculation. It is through navigational calculation, rather than the map, the territory or modern institutions such as the nation-state, that the world is composed.

Thus, I posit the following: cartographic calculation is now primarily comprised of the generation of event-based knowledges, in so-called mapping moments. In summary, cartographic calculation is not an exclusive sovereign act, but one eminently performed by other actors. In only using visual metaphors, we risk ignoring the calculative practices undertaken in the pursuit of cartographic knowledge production, as well as their situated nature. If these event-based knowledge processes have the capacity to engage with, affect and otherwise re-constitute other operative elements – from basic coordinate systems to demographic data – then it is necessary to scrutinize their ontogenetic force. I now turn to explicating a model that can augment these aforementioned approaches.

3. Capture

In contrast to a surveillance lens, a 'capture model', argues Agre (1994a, p. 109), 'describes the situation that results when grammars of action are imposed upon human activities'. Here, Agre borrows from computer science to suggest that computational rules (what he calls 'grammars') can affect, or govern, the performance of human actions; for instance, in how call centre operators speak to customers according to a pre-defined conversational script. It is this model, I argue, that can elucidate novel, non-sovereign cartographic calculations, in which computational stages of data capture, institutionalization, analysis and visualization are integral to the rendering of territories. In other words, how a capture model may explain 'how the gathering of … information has benefits as well as privacy implications and work-restructuring implications, even if the individual in question is not continually under observation' (Wardrip-Fruin, 2003, p. 738).

Wilson and Elwood (2014, p. 231) argue that '[c]apture is fundamental to human thought, action, and culture', rather than a product of computational or digital relations. As they continue, '[t]raditions of storytelling aggregate captured human experiences, just as these captured moments enable institutions of human knowledge' (2014, p. 231). Similarly, as Seaver (2018) has noted, 'cultures of capture' are as relevant to the trapping of animals for food, as to the 'hooking' of users of digital platforms. Dieter & Gauthier, 2019 expand on the latter, exploring how websites capture attention through 'chrono-design' and the control of browser elements. Capture, therefore, can be variously depicted as an embedded cultural practice through which spaces, places, people, things and – importantly – events, are known, used or experienced.

Capture has also been conceptualized as a kind of extraction. In Marx's (1976) work, surplus-value is 'captured' or extracted from the worker. It is through this capture of surplus-value, that the capitalist accumulates capital. Here, like in Agre and others, a capture process is imposed on human activities, but more precisely on labour itself in a capitalist system. Thus, a conversational script given to call centre operators is intended to maximize this capture of surplus-value from the worker. Through this process, Marx argues, the worker is exploited; forced to work 'to produce not only a use-value, but a commodity' (Marx, 1976, p. 293). In Marx, whilst surveillance may well take place, as Woodcock (2016) contends in relation to call centres, this is in order to enable the ongoing capture of surplus-value from labour; now redolent of an 'age of big data capitalism' (Fuchs, 2019, p. 53).

Agre's use of the term also 'bring[s] to the surface the connotations of violence in the metaphor' (1994a, p. 106), that is echoed in Seaver's (2018) account of how digital 'recommender systems' act as traps to ensure users remain attracted to services such as Netflix and Spotify. In this, the practice of capturing data is made material, embodying a kind of 'imprisonment' (Agre, 1994a, p. 106), 'representational colonization' (Agre, 1994b, p. 181), or exploitation of knowledges, experiences, or attention. This is otherwise missing in strictly computational definitions. Euphemistic references to the 'acquisition' of data, such as in November et al. (2010), not only belie the interventionism of cartographic calculation, but also obstruct an understanding of the material effect calculative practices have on the accumulation of spatial or geographic knowledge. Although Agre's use of the term capture cannot be reduced to either cultural (Wilson and Elwood/Seaver) or economic (Marx) extraction, these traditions help to contextualize it.

The capture model also focuses attention on the *capture-ability* of knowledge, phenomena or activities. The suggestion by Agre (1994a) is that the capture process is always necessarily incomplete, driven by an iterative, computational logic that seeks minor tweaks and corrections as knowledges, phenomena or activities themselves transform. This might involve a range of social and technical methods, including; simplifying the knowledge or activity to be captured, expanding the technical infrastructure to deepen the capture process, or re-orienting the knowledge or activity towards the system or tool. A capture process, therefore, is likely to have a significant effect on the knowledge, phenomena or activities attempting to be captured. Thus, designers of capture tools – Seaver's recommender system developers, Dieter and Gauthier's website software engineers – are always bound by the need to

constantly update and improve the tool's ability to effectively capture things. Active resistance is possible; once again highlighting the extractive nature of the capture process as it affects and governs the actions, movements, thoughts or form of those subjected to it. I will explore this in the final section.

A second meaning of capture concerns the *capacity for representation*. As Agre suggests, 'one might refer to the object classes of an object-oriented computer program as "capturing" the distinction between standing orders and particular occasions on which goods are delivered' (1994a, p. 106). In this second sense, capture is posited as an abstraction able to diagrammatize and operationalize relationships between different entities or dynamic forces. Thus, it becomes important for operators to 'understand their work within the terms of the machine's representations' (Agre, 1994b, p. 183). It behooves researchers to do likewise; articulating mechanic processes on their own technical terms. As Agre argues, this creates a common 'ambiguity between an epistemological idea (acquiring the data) and an ontological idea (modeling the reality it reflects) that pervades 'the vocabulary of computing' (1994a, p. 106). This second, arguably *ontogenetic*, definition is reflected in the work of many cartographers, necessarily constrained by operational protocols and data structures that limit how knowledge is captured, ordered and classified.

4. Addition

Yet as Gerlach (2014) has argued, cartographic calculation entails more than the extraction of knowledge. His definition of vernacular mapping posits that

> … such [cartographic] performance[s] are not taken to be technologies of capture, but techniques of *addition*; of adding more to the riskiness of cartographic politics by proliferating yet more renders of the world. (2014, p. 23, original emphasis)

Here, Gerlach demands that we think in more abstract terms about what mapping is, and what ethico-political positions it manifests. These commitments are both ontological and epistemological in scope; concerning both the material aspects of cartographic calculation (such as the capture of data), but also the knowledges that affect its deployment (the decisions that drive technological development). For Gerlach, vernacular mapping practices – 'mundane cartographies … non-statist, extra-institutional, [and] participatory' (2014, p. 23) – do not merely concern the 'capturing' of phenomena. Instead, they involve 'techniques of addition' that add more into the world. Vernacular mapping practices, Gerlach argues, do not exist to extract or a wrestle geographical data *from* the world and into the map. Instead, they involve a proliferation of knowledges *into* the world, through mapping practices.

Following Thrift (2011) and echoing Mackenzie (2006), Gerlach sees cartography as an abstract device or 'engine' generating ever more moments, states, and situations. As Kitchin and Dodge (2007, p. 335, original emphasis) have suggested, maps 'are always *mappings* … constantly in the state of becoming', rather than informational outputs generated through data capture, as Agre (1994a) might have it. In this, Gerlach posits a radical epistemological framing of cartographic practice as able to add to the messiness and openness of political action, rather than limit it to a kind of extractive, informational science. Gerlach is thus keen to avoid framing cartography as a rote collector of spatial data that is sensed, stored or analyzed. In this, it possesses a limited geopolitical energy.

Productively engaging with Gerlach's (2010; 2014; 2015) vibrant and hopeful work, I argue that generating 'riskier' cartographies is an equal *ontogenetic* tendency vying with the capture, calculation and ordering of geographical knowledge. Further, that cartographic practice (in vernacular or other forms) cannot escape imposing grammars of action upon the knowledges, phenomena, or activities it wishes to use. I argue that while this does not occlude a vitalist account of cartographic practice offering a hopeful epistemology full of élan and vigor, it does provide an ontological counterweight; rendering cartographic calculation a situated, pragmatic pursuit. In so doing, it contends that abstractive energies are constituted in and through all examples of cartographic calculation; whether explicitly radical or hopeful. In other words, that it involves *both* capture *and* addition.

Both Agre's capture model, and what we might call Gerlach's 'additive model' are more-than-representational (Duggan, 2018). Implicitly (like Agre) or explicitly (like Gerlach), both consider maps as ontogenetic in nature, with cartographic practice understood as 'a process of constant reterritorialization' (Kitchin & Dodge, 2007, p. 335). Applying Agre's model to cartographic calculation, we can say that attention is directed towards the production of a cartographic object (paper map, digital interface) itself, with the aim of ensuring a *relative* ontological security (the map-as-object) (Lammes, 2017). While it is acknowledged that maps are ontogenetic in nature, the cartographic process (capture, calculation, visualization) ensures the object (paper, digital) is assured relative security; however fleeting. As Agre's (1994a) model suggests, a capture process imposes itself on phenomena that might, in turn, solidify and strengthen the infrastructure itself. But as further suggested by Agre, that process is never inevitable. As mentioned previously, there may be great resistance to a capture process; resulting in an obstructive activity (knowledge is protected), a less effective infrastructure (data becomes difficult to process), or a reformatted cultural practice (phenomena mutate or transform). These struggles and negotiations invoke the contingency of the capture model, and consequently, of cartographic calculation.

In the additive model, attention is directed towards multiplying versions and visions of the world itself. In this, Gerlach (2014) suggests, the aim is to ensure a relative ontological insecurity of the world, rather than a relative security of the map. Yet the 'world' in this case is simply an array of possible events, activities and practices generated through, but also affected by, cartographic calculation. These renders may indeed lie outside the net of cartographic calculation (Crampton, 2002), exhibiting a vitality that is uncaptur-able or incalculable (Wilmott, 2016). Yet, as I argue, the generation of these versions and visions of the world should simply be seen as an ontogenetic reality, rather than (only) an epistemological desire. Hannah's (2009) census exercises, and Edney's (1997) cartographic survey, can be considered as *both* capture projects *and* additive projects; simultaneously minimizing and escalating operational risks and contingencies. The difference between the capture model and the additive model is not a political rift between extraction, capitalization, and territorialization on one hand, and addition, dissipation, and deterritorialization on the other. They do not stand as competing models. Instead, they constitute the 'evental' (Shaw, 2012) nature of cartographic calculation. In other words: all cartographic practice entails capture and addition.

It is acknowledged that Foucault articulated in the 1970s how 'disciplinary normalization' (2009, p. 57) imposes 'optimal' models on 'people, movements, and actions' (2009, p. 57) with uncertain, varied effects. It is also acknowledged that more recent work has articulated this double movement between the capture of data, and the generation of new selves, sensibilities and practices (Lupton, 2014; 2018). However, it is to argue here that these occur *in combination* as part of the same generative force, rather than separately with one (capture) imposed on, and affecting, another (addition).

The crucial task, therefore, is to explore how these moments of capture and addition manifest in cartographic calculation. In the final section I will provide an attempt; drawing on the use of a digital mapping app during protest events in the UK. I animate these moments through the articulation of two ontogenetic dynamics: *anticipation* and *correspondence*. These dynamics, whilst hinted at in Kitchin and Dodge (2007), especially in two cartographic vignettes, are not fully articulated as constituent of an 'ontogentic understanding of maps' (Kitchin & Dodge, 2007, p. 340). The intention is to do greater justice to their entanglement here, grounding them in the navigation of a protest event.

5. Between capture and addition

5.1. Anticipation

Between 2010 and 2013, a digital mapping app called Sukey was used by student protesters to keep 'safe, mobile and informed' (Sukey, 2012, n.p.) during protest events. The app comprised of a digital map displaying the accessibility of streets in the immediate area. Those blocked by police, and therefore impassable, would show up in red. Those safe to use would show up in green. An integrated twitter account gave protesters live textual updates. Both contributed to the safety and knowledge of protesters by aiding their navigation of the immediate area.

It was celebrated both in the media and in activist circles as an 'anti-kettling' app (Fales, Keca, & Thompson, 2012; Kingsley, 2011), enabling protesters to anticipate and avoid police containments. While this was largely true, the app was reliant on the capture of critical information from protesters themselves, through cartographic crowdsourcing. It operated as a kind of live, protest version of an OpenStreetMap party in which participants could collectively, and intensively, collect data to add onto the map (Gerlach, 2018; Perkins, 2013; Perkins & Dodge, 2008). Generally, the data consisted of messages and photos identifying the location and possible intentions of police officers policing the protest event. Users could submit information via a basic text service, or publicly using twitter and the relevant event hashtags.

Sometimes this information was provided by protesters known to the developers of the app, embedded as they were within student activist networks at the time; analogous to OSM gatekeepers (Stephens, 2013). This information was easier to verify, with contributors trusted to provide accurate information. However, as a unique demonstration in protest crowdsourcing, many messages and photographs were provided by other protesters keen to help, but with no immediate connection to the developers or the immediate activist network. This meant that a greater amount of care was needed to verify the information, before translating it into a cartographic feature (green or red) or simultaneously communicating the details via social media.

During this period, numerous student and anti-austerity demonstrations were held, including the March for the Alternative (2011), which saw 400,000 people protest in London alone (The Guardian, 2011). As a result, protesters rapidly accumulated a comprehensive knowledge of central London; not just its main thoroughfares, but also the many arcades, side-streets, cut-throughs and footpaths that constitute it. This enabled the active contributors to the platform to become primed for the capture of information necessary for protester safety and mobility. Nick Seaver (2018, p. 432) discusses how 'ancient hunters in northern Argentina left tools and traps across the desert for future hunters', constituting what Alejandro Haber (2009, p. 427) has called a 'landscape of anticipation'. Similarly, protesters during such events developed an operational sensibility, in which police ranks, units, vehicle types, officer communications, gestures, and actions became increasingly known to contributors, thereby enabling anticipation of events before their happening (Amoore, 2013; O'Grady, 2016). These crowdsourcing efforts demonstrate the effect of cartographic capture, through a form of 'anticipatory calculation' (O'Grady, 2016, p. 72) in which a protest event in London could be ordered and known. (see Fig. 1)

Ordinarily, protesters would be requested to submit information using a specific message format. This included three features: the what, where, and when of the submitted event. A typical message might have read: 'riot police amassing at corner of Duncannon Street and the Strand, just now' or 'police containment on Piccadilly outside Fortnum & Mason, in place for 10 min'. These concise missives were easily parsed by developers working to verify, communicate, and translate them into cartographic updates. In adhering to this desired format, the messages generated a capacity for representation as Agre (1994a) suggests, allowing the events captured through a process of anticipatory calculation to be smoothly rendered in representational form. Consequently, this made verification easier as the developers did not have to spend time corroborating sources or searching for more precise information. In other words, they imposed a grammar on communicative action.

The material effect that these calculative practices had on the accumulation of spatial knowledge was also evident. On one hand, police officers were often uncomfortable with having their actions scrutinized, warning observers to avoid obstructing manoeuvres or arrests knowing that witnesses could decontextualize gestures, actions and movements once uploaded to social media or sent to the platform. On the other hand, many protesters were hesitant to participate in the crowdsourcing of information due to the public nature of the platform, and other technical shortcomings such as nonexistent documentation on the use of encryption algorithms in the app, or on how to delete photo metadata sent to it (Spy Blog, 2011). Similarly, many would avoid using smartphones during protest events altogether, fearful of the use of police technologies such as IMSI catchers (Cheshire, 2015; Gallagher & Syal, 2011; O'Neill, 2014).

The surveillance model of privacy seems appropriate for these moments; protesters feared being observed by police (or, anyone for that matter) both on the public platform and in the protest itself. Likewise, police seemed wary of being subject to forms of sousveillance (Brucato, 2015; Mann & Ferenbok, 2013; Ullrich & Knopp, 2018) both through the map and via other reporting practices. Here, both police and protesters were equally, and evidently, aware of the power of such practices to alter decisions and actions made during protest events. Yet, the capture model highlights the relationship drawn between moments, messages, and maps; drawn together through representational demands. A surveillance model attempts to establish a (visual) metaphorical connection between actors that a capture model is able to materially delineate; the latter better placed to establish moments of 'situated action' (Suchman, 1985) in which the anticipation of events was cartographically sought.

But, in taking up Gerlach's (2014) concern, much of this work also *added* data and knowledge into the world, as well as necessarily capturing and categorizing it. In the first instance this entailed the capture of commands, actions and movements of, more often than not, police officers. But with every moment captured, every message sent, every verification made, every cartographic translation executed, and every update communicated, ever greater number of data points and subsequently generated knowledges became actionable. This additive framing also counters the strict instrumental violence of capture, by enabling a comprehension of how a proliferation of such knowledges may render an 'ontology of association' (Amoore, 2011, p. 27) more difficult. While the platform may have fueled correlative techniques that exposed active contributors, obfuscation through proliferation may well have rendered active identification impossible, or at least onerous (Brunton & Nissenbaum, 2015). As Gerlach (2014, p. 23) identifies, each of these data points added 'more to the riskiness of cartographic politics' by enrolling myriad events, moments and incidents into the cartographic engine, generating more cartographic calculations, necessitating more moments of cartographic labour, and constituting more territorial appraisals.

If we are to return to Marx, we could say that the anticipatory potential of the app stimulated engagement beyond mere use-value (rote navigation). Here, users were drawn into performing cartographic tasks – most notably, the submission of mappable incidents – that generated collective surplus-value for the assembled crowd. In this, active contributors became conditioned into using the app in this expansive manner, beyond simply profiting off the cartographic labour of others. Here, the computational grammars optimized this process, ensuring that contributors could engage in other actions and activities.

The point here is that so-called 'mapping moments' (Dodge et al., 2009), in which event-based knowledges are generated, are constituted through an ontogenetic oscillation between capture and addition. Communicative reports requested by map-makers from protesters were

formatted to ensure events (police lines, protester movements etc.) could be mapped, whilst generative of actions necessarily exceeding this logic; inviting active resistance to capture processes noted by (Agre, 1994a). These subsequent actions (speech acts, gestures, bodily movements), brought to life by these previously captured reports, again providing the raw material for further communicative reports, captured knowledges. Whilst it is arguable whether grammars imposed of the communication of events also became imposed on movements themselves; say, onto particular protest manoeuvres, they nonetheless affected cartographic practice. I now turn to a second dynamic to evidence the ontogenetic tendency of cartographic calculation; *correspondence*.

5.2. Correspondence

Successful cartographic calculation also relies on achieving correspondence between signposts (November et al., 2010). This correspondence, however, does not rely on the '*resemblance* between *two* elements' (2010, p. 586, original emphasis) such as the map and the territory, but a '*relevance* that allows a *navigator to align several successive signposts along a trajectory*' (2010, p. 586, original emphasis). In other words, if there are 'obstacles' (2010, p. 587) that prevent the alignment of signposts – anything from physical landforms, to technical glitches – then cartographic calculation is in danger.

We can explore this issue of correspondence with further reference to Sukey. As mentioned in the previous section, colour coded lines on the map represented differing degrees of accessibility. Much of the information that lead to the drawing of these lines was crowdsourced by protesters. Yet many who used the app were neither active contributors, nor engaged in the submission of information. These people simply used the map as a navigational tool (i.e. for 'subsistence') to keep safe and mobile; avoiding blocked streets, moving to safer locations, or using the map to find landmarks. Accordingly, each of the coloured lines adorning the map assumed great importance to protesters; quite possibility the difference between containment and ongoing freedom.

As many of these protest events were largely unpredictable, and even volatile, the correspondence between cartographic feature, observable actuality, and navigational desire became vital (Hind & Lammes, 2015). While the coloured lines representing the impassability of particular roads and junctions was comparably understandable, the 'swarming reality' less so (Olsson, 2002, p. 255 quoted in; Crampton, 2002, p. 16); especially without the greater operational knowledge acquired by active contributors to the platform. Here, then, protesters had to develop an array of interpretive navigational skills (event-based knowledges) that enabled them to match the swarming reality of not-quite police containments, and nearly-blocked roads with the clean, clear and categorized features depicting this maelstrom in the map itself.

However, in 2013, the app shut down. In subsequent protests, protesters had to navigate by other means; either by using generic map apps like Google Maps or Apple Maps, or by using their own extant spatial knowledge. This had a deleterious effect on the capacity for protesters to perform acts of navigational correspondence, necessary for maintaining safety and mobility. During major demonstrations the platform was able to map associated levels of risk in relation to emergent containments. This formed the central function of the app and enabled people to act on the accessibility of any roads or junctions within the vicinity of a protest to ensure they did not walk into a containment. This attenuated processual correspondence risks, generated in the heat of navigating a protest. In its absence, protesters were unable to access event-based knowledges generated through mapping moments. In other words, that previously generated collective forms of surplus-value either evaporated or were captured elsewhere.

This meant that many students, invariably new to activism and to London, could only follow precautionary advice issued by student unions. Whilst buddy systems and demonstration 'blocs' recommended by these bodies were useful for solidarity, they were less able to deal with the fast-moving, unpredictable nature of many contemporary protests; acting akin to reactive, 'high modern' (Legg et al., 2012, p. 191) institutional practices of data collection. Moreover, such precautionary techniques, could not provide active navigational assistance.

As one student activist put it, following the additional withdraw of support from the National Union of Students (NUS) for a demonstration in late 2014 (Young-Powell, 2014):

> You know, they [NUS] were like "ah, you guys don't have the right risk assessments in place." I was like "NUS you have so much experience of organizing this kind of thing can you please help?" instead of just criticizing. It meant it was easier for them to … pull out. There was a question [at a student meeting], where someone was like "how can we be sure that there's no risk associated with this?" [And] someone said … "there's always risk associated with this … there's going to be a police presence. There is risk associated with it if you attend …. so it's your decision whether to go or not."

Yet in the platform's absence, protesters were arguably in greater danger; less able to align necessary 'signposts' in the navigation of the protest, only able to follow and adopt general risk management strategies. In this sense, Sukey operated as a form of 'care-tography' (Hind, 2017) offering event-based knowledges generated through collective surplus-value. In a protest, the city looks remarkably different. Sukey aided in the interpretation of this radical difference, in ways other tactics and tools could not.

The experience of using the app was not dissimilar to how November et al. (2010, p. 585) ocean skipper and her crew felt, navigating across the ocean, 'views … made fuzzy by the sea spray … voices covered by the roar of the waves … hearts excited by the heat of the race'. While Sukey was active, this oscillating, swarming, disorientating reality was not necessarily avoided by activists. Instead, according to a possibilistic logic (Amoore, 2013) many protesters were not only happy to proliferate more renders of the world, but eager also to enroll these renders, these excess calculations, into their decisions. Many map users would not seek to escape areas displayed on the map in red (i.e. blocked) if they saw something quite different. Nor would they avoid confrontation and seek security. Instead, protesters trusted the correspondence capacities of the platform; often probing and testing their accumulated knowledge. Thus, features 'on' the map were granted the same importance as other worldly phenomena 'off' it, while territorial encounters were assessed for their significance. Both were equally able to enter the game of navigational correspondence (Hind & Gekker, 2019); fearless in spite of 'views … made fuzzy by the sea spray [and] voices covered by the roar of the waves'.

The platform did not provide explicit navigational instructions, but with collectively captured event-based knowledge, users were able to make navigational decisions. Protesters became capable of anticipating events; not categorically avoiding spaces or situations that posed assumed or *a priori* risks, but actively engaging with them to modulate outcomes. It was through the platform that users were able to assess the legitimacy or credibility of the navigational information presented to them. Its use constituted a 'resituating of digital spatial knowledge politics' (Elwood & Leszczynski, 2013, p. 555), in which 'individualized interactive/exploratory ways of knowing' (2013; p. 555) were synthesized through shared use. In doing so, this synthetic approach was trusted over institutionally 'silo-ed', generic, assumed, or universal methods of capturing territorial knowledge. In the app's absence, as noted above, this modulation became impossible, with critical data points missing or otherwise unobtainable.

Here, a post-surveillance model approach might point to the multiple informational viewpoints made possible by the crowdsourcing efforts of Sukey, in which bi-directional (sur- and sousveillance), or multi-directional power is enacted. Whilst these viewpoints were evidently in action – proliferating as more protesters used the map – a surveillance framing concentrates attention on the sources of information, rather

than their translation and modulation. A capture model approach situates this knowledge-accumulation as a series of interconnected navigational decisions, or 'intermittent accomplishments' (Hui, 2012, p. 206) in which cartographic information is mobilized.

Yet, correspondence – as a feature of cartographic calculation – is not only or strictly dependent upon the capture and communication of navigational signposts. Instead, as Sukey shows, correspondence was attained *both* through the alignment of signposts (in both map and world) *and* the generation of further signposts to be assessed and evaluated as legitimate and credible by protesters and app users. As November et al. (2010) argue, navigation is anything but a smooth, pre-calculated endeavour – even with the appropriate technologies and the ability to plot a course in advance. Instead, correspondence is an active process, and like anticipation, is only realizable in the moment through an oscillation between capture and addition; in this case, of signposts. As theorists have sought to argue, shaping the capture-ability of phenomena is inherently tumultuous, often violent.

Thus, as these last two sections have determined, cartographic calculation is not only precarious, but dependent upon an 'oscillation' between securitization and resistance, the minimization and maximization or risk, the capture and addition of cartographic data (Crampton, 2010). These, I argue, are the ontogenetic tendencies of cartographic calculation. But as hopefully demonstrated, they are also calculative tensions that do not need to be resolved; affecting and modulating cartographic practice.

6. Conclusion

This paper has argued that cartographic calculation entails both the capture and addition of knowledge from, and into, the world. It argued that rendering cartographic calculation in navigational terms, allows for the internalization of attendant calculative risks (to the calculator) within the calculative process, rather than rendering them externally 'out there' in the territory (November et al., 2010). In this, the paper enables the re-framing of historical cartographic calculations, such as those undertaken by colonial powers or mid-century nation-states, beginning instead with the technological specificities of these particular political actors; rather than starting with and returning to sovereign states. While this is a methodological approach common in other disciplines such as media studies, it is less commonly found in political geography; and as such represents an alternative and possibly fruitful re-appraisal of cartography as a calculative force. It proceeded in three parts, which I summarize here with four subsequent reflections.

Firstly, it argued that with the proliferation of digital devices, platforms and services new forms of event-based knowledge are being generated. These calculative practices are, it is further argued, no longer the preserve of the state. Instead, cartographic calculations are now primarily being performed by other varied actors. This paper has argued that surveillance approaches can be augmented in order to account for these varied actors and attendant practices. In applying other models, it allows us to appraise the technical processes at hand (such as calculation, capture, addition and correspondence), preventing us from overstretching and generalizing the use of surveillance as an analytical tool, while also preventing its misunderstanding as a universal and dominant (rather than particular) mode of power.

Secondly, the paper used Agre's (1994a) 'capture model' to articulate cartographic calculation. Premised on the deployment of computational grammars in the workplace, Agre's articulation of capture as a method of shaping human activity shares some resemblance to Marx's (1976) work on the extraction of surplus-value from labour. This has hopefully opened up the possibility of bringing recent work on the digital cultures of capture (Dieter & Gauthier, 2019; Lury & Day, 2019; Seaver, 2018), into conversation with both the political geographies of calculation (Amoore, 2013; Amoore & Piotukh, 2016; Elden, 2007; Hannah, 2009, 2010) and the cartographies of calculation (Crampton, 2011; Pickles, 2003).

However, thirdly, following Gerlach (2014), the article argues that cartographic calculation does not only entail the capture of cartographic data, but also entails the proliferation of 'yet more renders of the world' (2014, p. 23). But instead of a choice – capture or addition – I argue that cartographic calculation entails both the capture of cartographic data and the release of more knowledge into the world. The consequence is that cartographic calculation must constantly seek to modulate security and risk; at once both seeking to capture cartographic data (stabilizing the map), as well as seeking to add cartographic knowledge (destabilizing the world). This opens up the possibility of testing, and refining, what is an ont*ogenetic* tendency of cartographic calculation (Kitchin & Dodge, 2007), thinking in new ways about how data is circulated, valued, valorized and realized through modulation rather than binary or even processual opposition between cartographic 'production' and 'consumption' (Del Casino & Hanna, 2006).

The paper provided empirical justification for the above, regarding cartographic calculation and the shift toward the capture/addition of event-based knowledge in so-called 'mapping moments' (Dodge et al., 2009), by looking to processes of anticipation and correspondence evident in the digital mapping of protest events. Here, the mapping of emergent moments required active contributors to the Sukey platform to 'capture' them cartographically, generating collective surplus-value, while also simultaneously through active use of the map, multiplying possible territorial possibilities. The dynamics of anticipation and correspondence, as actualized in situated moments of cartographic calculation, illustrate its ontogenetic tendencies. The automation of navigational practices (Brown & Laurier, 2017; Hind, 2019) as seen in the testing of autonomous vehicles (Bissell, 2018; Stilgoe, 2018), or the distributed of sensing capacities (Gabrys, 2019), as witnessed in marine environments (Howe, 2019; Pezzani & Heller, 2019) for instance, provide interesting empirical scope for investigating other such dynamics that evidence these tendencies in the capture and proliferation of cartographic knowledge.

Declaration of competing interest

None.

Acknowledgements

I would like to thank Sybille Lammes, Chris Perkins, Clancy Wilmott and Alex Gekker for generous and insightful feedback on early drafts of this paper. I would also like to thank Louise Amoore, as well as colleagues in Locating Media, for comments on later versions. Robust and rigorous feedback from three anonymous reviewers also greatly sharpened and refined the arguments in the paper. I thank them too. Any errors that remain are solely my own. This research was funded by the European Research Council under the Seventh Framework Programme (FP7/2007–2013) (grant no. 283464).

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