MAPPING URBAN ASSEMBLAGES: The Production of Spatial Knowledge

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ABSTRACT

This paper engages with the ontology and epistemology of urban mapping. While GIS and other digital technologies have long transformed the capacities for representation of urban data here we explore the capacity of mapping to produce new ways of seeing, understanding, planning and designing the city. With a primary focus on urban morphology, distinctions and overlaps between mapping, diagramming, planning and designing are articulated within a framework of assemblage thinking. Through cases drawn from urban design research we analyse the mapping of political conflict, transport flows, functional mix and informal settlement. It is argued that urban mapping is a form of spatial knowledge production that is often diagrammatic, embodying a spatial logic that cannot be reduced to words and numbers. Urban mapping constructs interconnections between the ways the city is perceived, conceived and lived; and it can reveal capacities for urban transformation - the city as a space of possibility.

INTRODUCTION

A map is a graphic representation of the spatial arrangement and distribution of a territory, a lens through which we see the city. Maps are forms of discourse that frame our experience of places and spatial practices; tools that we use to navigate, control, understand, imagine and transform the territory of the city. There are as many kinds of maps as the uses to which they are put. Navigational maps are wayfinding devices that we use to learn a city’s spatial layout, to become oriented, to move and interact in urban space. Tourist maps become incorporated into marketing particularly in orienting the tourist gaze and constructing place identities. Official maps generally reflect authorized ways of seeing the city and sustain conventional political ideologies and conceptions of place (Wood 2010; Harley 1989). Maps are forms of military intelligence, crucial for both establishing and stabilizing state power (Adey et al 2013; Weizman 2003). On the other hand, mapping can contest authorized cartographies, exposing inequities and contesting dominant power relations (Peluso 1995; Dalton and Mason-Deese 2012). The map as art challenges objective conceptions of territory to open a window on new ways of seeing and imagining (Harmon and Clemans 2009; Amoroso 2010). Professional mapping is a practice through which researchers and built environment professionals rethink, explore, and gain a deeper understanding of how the city works, and how it might be transformed through urban planning and design. In these ways mapping variously incorporates navigation, marketing, politics, resistance, art and professional knowledge. While our focus is primarily on the last of these it is not always possible to distinguish them in practice.

A major transformation in professional mapping has long been underway through the emergence and development of Geographic Information Systems (GIS) - digital technologies designed to harvest, manipulate and display complex spatial datasets (Tomlinson 2013). Here the cartographic interface is utilized as a research tool for analysing and rethinking the city - extracting and juxtaposing layers of spatial data and thus visualizing spatial patterns that are not obvious to a
naked eye (Bodenhamer et al. 2010). GIS enables an active engagement with a broader range of objective and reliable data for gaining a deeper understanding of the current performance of the city and its future transformation (Maguire et al. 2005). A key potential of computer-aided mapping technologies lies in the capacity to develop a better understanding of cities as complex adaptive systems (Batty 2013; Portugali 2000; Hillier 1996). However, as the name suggests GIS deals primarily with data at a geographic scale and less commonly with the morphological urban design data.

Our focus in this paper is on the epistemology of mapping and its role in the production of spatial knowledge. If maps inevitably embody the values of the cartographer then what is their relation to the facts? If maps can lie (Monmonier 1996) just like words and statistics, what is their status as spatial knowledge? What role can maps play in revealing the forces at play in shaping the city and our uses of its public space networks? How can maps open up the urban imagination - the spaces of possibility? Our goal is to explore such questions through some specific urban maps and using a framework of assemblage theory (Deleuze and Guattari 1987).

**ASSEMBLAGE**

A brief introduction to assemblage thinking will stress that an assemblage is a whole whose properties emerge from interconnections, interactions, flows and synergies between different parts (DeLanda 2006). The places, buildings, neighbourhoods and identities that are the most visible parts of cities are the emergent effects of these productive processes. The Deleuzian ontology is one that seeks to understand morphogenetic processes through which forms come into being. Unlike a 'system' that implies hierarchy, assemblage thinking assumes what is often called a 'flat ontology' (Marston et al. 2005) - an arrangement, alignment or patterning of interconnected entities without any natural hierarchy. A city is a socio-spatial assemblage of territories that have been produced through underlying morphogenetic processes. It follows that urban mapping involves a task of revealing the dynamics from which these actual territories have emerged. Assemblage thinking involves a key distinction between the 'virtual' and the 'actual'; the city that has been 'actualized' is but one version of what is possible. Deleuze and Guattari (1987, 12) distinguish between a map and a tracing where tracery is a simple reproduction of the real while a map engages with possibility and capacity. Yet mapping that loses contact with the empirical world also loses potency; maps are formed from a multiplicity of tracings. While urban mapping begins with the territories (buildings, streets, practices) of the actual city, it can expose what DeLanda (2011) calls a 'space of possibility'. Here we find a potential of urban mapping to become more rigorously geared to creative urban transformation.

There are early instances of such an approach to urban mapping, most notably the psychogeographic mapping produced by artists and intellectuals of the Situationist International in the 1960s. Constructed through a practice of critical 'drifting' through urban space known as the 'derive', these maps were fragments extracted from the official urban plan and juxtaposed to create possible interconnections, opening marginalized spaces and routes through the city with a certain ludic quality (McDonough 1994; Pinder 1996). In a similar vein Gandelsonas (1991) produced maps of Chicago that foreground the alleyways while erasing the streetgrid, enabling a new reading of the city. Both kinds of maps were largely deconstructive gestures aimed at subverting and critiquing official urban plans; forms of discourse more than spatial knowledge.

The seminal work in mapping from an assemblage perspective comes from Corner (1999, 214) who discusses mapping as a creative agency that produces understandings of "the various hidden forces that underlie the workings of a given place". He proposes forms of rhizomic mapping where even the most un-mappable aspects of a place may be revealed by means of establishing connections between layers of data. He suggests three key aspects: 'field', 'extract' and 'plotting'. The field is the surface or analogic ground on which mapping takes place; the conceptual framework within which projection, scale, and orientation are organized. Extracts are the layers of data that are observed, selected and represented. Plotting is the experimental practice of creating new relations between extracts. Corner's published maps are often collages
that incorporate photographs and become ambiguous images that slip between spatial knowledge and art/design, between the map as means and end (Corner and MacLean 1996).

For Deleuze and Guattari (1987) the map is a partial synonym for what they term the ‘diagram’ (also known as the ‘abstract machine’). This is a very difficult concept that refers to the idea that assemblages are produced by an immanent set of forces in a particular diagrammatic configuration (Deleuze and Guattari 1987, 164). An example here is the diagrammatic flow of pedestrians towards an urban magnet or attraction that is used to stimulate consumption in shopping malls (Dovey 2010: 27). Another example is the diagram of asymmetric visibility that Foucault (1977) identifies as the panoptic disciplinary gaze. In each case the diagram propagates through a multiplicity of spatial forms at different scales; while the detailed maps or plans will differ the diagram remains the same. One of the tasks of mapping is to reveal the diagrammatic forces that are immanent in the urban assemblage.

Our interest lies in understanding the map as a production of spatial knowledge - mapping as process rather than product, means rather than end. Through a series of case studies drawn from research we discuss the role of mapping in understanding transport flows as potential for transit-oriented development, functional mix as generator of synergies and alliances between uses, urban morphology as mediator of political conflict, and the politics of spatial knowledge in the social struggle over transformations of place. Through these cases we seek to articulate the role of mapping in urban analysis, production of spatial knowledge, mediations of power and the challenge of re-shaping the city.

FLOWS

Figure 1. Twenty Minute access by four transport modes in Melbourne (Source: Dovey & Woodcock 2014)
Figure 1 shows a map designed for understanding the potential for transit-oriented development to reduce car-dependency. Based on a series of case studies in Melbourne it maps the spatial range that is accessible within 20 minutes using four different transport modes: walking (green), cycling (yellow), public transport (blue) and car (red). The data for these space/time calculations was harvested from public transport timetables and Google Maps. Each colour zone is an isochrone that represents the spatial access within the given time limit. These superimposed zones of 20 minute access are also loose correlates of the cognitive map upon which decisions about mode choice and time are based in everyday life. For instance the map shows that at this 20 minute timescale cycling (orange) has a clear advantage over public transport and in some directions walking is faster. While one doesn’t need maps like this in order to make such choices, we suggest that they are useful for research in three primary ways.

First, they enable us to compare levels of access using different transport modes for any given location. This is a map of the spatio-temporal assemblage which provides an objective basis for the conditions on which people will make a mode-choice for any particular trip. This is a map of potential rather than actual trips; there is no presumption that people will automatically abandon their cars when the map indicates it is rational to do so. While the difference between the car zones (red) and all of the other zones can be read as a measure of car-dependency for that location, this will depend on the distribution of desired locations. The second use of such maps is that it enables us to compare such levels of 20-minute access across different locations in the city. The isochrones can be aggregated to map the entire city with measures of comparative connectivity, mobility and walkability – to map inequities of access. Finally this form of mapping can be integrated with design research to enable an understanding of the ways designed change can enhance urban mobility and aid the choice between alternate designs. New public transport connections and greater frequency of service will transform the isochrones, as will investment in roads, cycle paths and pedestrian networks. The effects of such designed change can also be simulated, mapped and compared with existing conditions as a basis for investment decisions and public debate.

Our point here is not to present the results of this research but rather to understand urban mapping as a production of spatial knowledge. Such mapping is very far from a simple presentation of a set of spatial facts; it is both complex and problematic. Trips by car or public transport are inherently multi-modal – they variously involve walking, parking and waiting times (which we have incorporated). Isochrone maps will also differ over time with daily, weekly and seasonal rhythms. Car traffic slows during peak periods while public transport is more frequent – differences represented on this map by darker red and blue during evenings. Buses and cars can be delayed in traffic. Walking and cycling zones are normally more predictable and stable but are mediated significantly by weather, safety and ability. Mode choice may also depend on road surface, noise, cost and aesthetics. In other words, mapping can easily become a form of propaganda – how much time to add for parking or waiting? There are an infinite number of factors that influence potential access zones – the dilemma is that to ignore them can produce inaccuracy but to include them can paralyze the mapping process or render the maps complex and illegible. Once the map loses legibility it also loses its potency as spatio-temporal knowledge. Accurate maps of urban assemblages are essentially impossible – the issue is how they enable us to see the city in new ways. Isochrone mapping enables us to see differences between modes and time-based zones; differences between different parts of the city; and differences between existing and future levels of mobility.

The map does not simply represent selected aspects of the city so much as it works to connect them in a conceptual manner. In doing this the map becomes more diagramatic and abstract; the relations between zones reveal a set of immanent forces, embodied in the urban morphology. The greatest potential of such mapping is that we can begin to model the transformations of access and equity that might be produced by infrastructure investment. Yet here again the complexities multiply because the city is a self-organizing system wherein adaptations are difficult to predict.
Figure 2 shows a map of a neighbourhood of Fitzroy in Melbourne that was mapped at the cadastral scale as part of a study of creative clustering (Wood & Dovey 2015). It shows the distribution and relations of primary functions: housing (red), employment (blue) and retail/public/recreation (yellow) plus relatively less mixed-use lots. Over fifty years ago Jacobs (1961) argued that a mix of functions and the various forms of co-functioning between them was a key to understanding how cities work. She noted that the modernist segregation of the city into mono-functional zones had the effect of disrupting synergistic flows of urban life – the close connections of home to work, school, shopping, entertainment and recreation. Principles of functional mix are now mainstream in urban design theory and practice; however the task of mapping it has been plagued by the fact that there are an infinite number of possible functions within the city. Standard categories include residential, industrial, commercial, retail, education, sports, entertainment, recreation, health, transport, government, public facilities, parking, vacant and hospitality. The challenge is that of mapping such multiplicity within a single stratum of data; this is a field of differences wherein functions are not found but constructed. The first challenge is in achieving a consistency of categorization since the boundaries of many of these categories overlap and one can easily become the subset of another (is a vacant shop a vacancy or a shop?). Second is the number of categories since there are already fifteen listed above and each of them could be usefully subdivided, yet no map with more than about seven categories will be easily legible (Miller 1956). Functional mix is vertical as well as horizontal so there is the challenge of representing the range of vertical mixes in two dimensions. The final challenge is that functional mix is highly scale dependent and will produce different mappings at different scales of building, lot, neighbourhood and district. These problems are relatively easily dealt with in strictly
modernist cities with strong state control where functions largely conform with planning zones. Traditional and informal cities, however, are a very different matter where ‘grandfathered’ functions (legacies of an earlier mix) and informal adaptations prevail. A paradox here is that the more mixed the city is then the more difficult it is to map.

A key goal of mapping functions is to better understand productive differences between attractions - the flows, synergies, alliances and co-functioning. The approach we want to discuss here is adapted from a Netherlands-based research team (Nes et al 2012; Hoek 2008) and begins by dividing urban functions into just three primary categories of housing, work and amenities, plus the various forms of mixing between them. Amenity is a catch-all that incorporates shops but includes any function that attracts people other than for work or housing. This is a typology that is useful for understanding the ways urban space mediates flows of people between functions. If we want a simple way to understand why anyone might be in any particular urban location at a given time then it makes sense to say that they live there, work there or are visiting some kind of facility or amenity. In our view these categories are better labelled 'live', 'work' and 'visit' because 'amenity' is a more generic term that could include housing and work. It is tempting to call this third category 'consumption' or 'exchange' but these do not quite cover community attractions with considerable effects on flows.

A key difference from most functional mix typologies is that here the concept of functional mix is incorporated directly into the category system. The mapping index is represented as a triangle (Figure 2) organized as three primary colours, three mixed colours and light grey for the mix of all three functions. Instead of spending the limited colour spectrum on the full range of possible functions, it identifies just three functions plus four kinds of mixing between them. If living is red (housing), work is blue (factory) and visit/amenity (shops, park) is yellow, then the live/work mix is purple, visit/live (shop/house) is orange and visit/work (shop/office) is green. Buildings such as hospitals and hotels are likely to show a significant mix of all three (light grey). An immediate problem with such a typology is that nearly all sites in the city can be construed as a mix of all three. How are we to map a tall residential tower with retail on the ground floor? Is it red because of the 90% residential floor area, orange because of the volume of visits generated by the retail space, or light grey to indicate that some people also work there? Shops and museums attract large numbers of visitors yet significant numbers of people work there and an office complex will also attract visitors. What is to stop a pedantic mapper from colouring the entire city light grey? We can resolve this with a range of mixed colours to show the degree of visitation and jobs but this takes us on a path towards infinitely variegated maps that will again become illegible. In order to achieve legibility we need to gloss over a large number of differences that would be significant from another perspective. There are an infinite number of landuse functions that might be identified; the city is a multiplicity - a field of differences within which identities emerge from our attempts to make sense of difference. The key to this functional mix triangle is its use in showing potential connections between the primary places we live, work and visit. The map in figure 2 was produced in order to make visible the pattern of relations between jobs, housing and visitation in the neighbourhood of Fitzroy. This is a highly mixed neighbourhood, as would be apparent in any contrast with a typical suburb (entirely red) or financial district (blue + green). The point here is not to analyse this particular map but to suggest that such mapping can enable us to better understand the relations between functional and spatial patterns, and the potential flows, alliances and synergies between different functions.
CONFLICT AND PLACE IDENTITY

Figure 3. Mapping Ethnic Targets in Sarajevo (source: Ristic 2011)

Figure 4. Mapping the geography of fear – Sniper Alley (source: Ristic 2011)
Our next case discusses the role of mapping in understanding conflict over place identity. Our examples are maps of urban destruction (figures 3 and 4) and spatial discourses of street naming in Sarajevo during and after the war of 1992-1995 (figure 5). Sarajevo is essentially a linear city that developed along the narrow valley of the Miljacka River surrounded by mountains. The city developed from the 14th century and has always been a crossroads housing a mix of ethnic groups. In 1992, Sarajevo’s population included 40% Bosniacs (Muslim), 30% Serbs (Orthodox), 20% Croats (Catholic) and 10% others. The ethnic history and diversity are evident in the cityscape which has developed from east to west along the narrow valley. To the east are the Ottoman town (14th-19th c) and the Austro-Hungarian town (late 19th c) which both include a mix of religious buildings and public buildings linked to a politics of integrated ethnic differences. Further west is the socialist-period town (1945-1992) in which modernist architecture and urbanism without ethnic identification was used to promote ethnic equality.

In 1992, after centuries of peaceful ethnic co-existence, a resurgence of ethnic nationalism led the country into a violent civil war. The Bosnian Serb Army (BSA), which fought for division of the country and purification of ethnic identity, besieged Sarajevo and sealed all entry and exit points, surrounding the city from the mountains and seizing one urban district on the river. The BSA positions enabled a commanding view of most of the city. The first major practice of violence was targeting key public buildings with artillery and mortar. Figure 3 maps the ways in which public buildings (religious, cultural and political) were ethnically identified before the war: mosques and Islamic cultural buildings associated with Bosniacs (green), Orthodox churches and cultural institutions related to Serbs (blue), Catholic cathedrals and cultural institutions linked to Croats (magenta). Those state political, administrative and cultural institutions identified with Bosnian multiculturalism are also marked (yellow). Red frames around footprint contours identify buildings that were targeted and destroyed in the shellfire. Analysis of this map reveals that the largest number of destroyed buildings were those linked to multiculturalism. It also reveals that the few Muslim buildings that were destroyed were neither the oldest, nor the most prominent; rather they were located to the west of an imaginary line of ethnic division. The architecture was targeted and demolished primarily on criteria of ethnic purification – symbols of multiculturalism and ethnic mixing were targeted across the entire city; Muslim identified buildings only where they were ‘out of place’. The city west of the imagined partition was to be purified of both mixing and difference.

A second major practice during the siege was the targeting of public spaces throughout Sarajevo by snipers located along the siege lines. Figure 4 maps these practices and shows how they were mediated by the urban morphology of buildings and street networks (Ristic 2014). The red-to-yellow gradient hatch represents the level of danger in exposed public spaces within the city. The hatch reveals a geography of fear that emerged particularly in the socialist era city. The Ottoman and Austro-Hungarian towns were safer because they were more distant from the snipers and their perimeter block morphology and narrower streets provided more cover. The larger expanses of the modernist western section were both more exposed and closer to the snipers. The strip of urban space marked in black became known in the global media as Sniper Alley, stretching along the river to the east and the boulevard to the west. This was the primary east/west flow and severing of traffic along this alley meant that the ethnically mixed city in the east became detached from residential suburbs on the west and south. The map enables an insight into how terror fragmented the city as a socio-spatial assemblage. Some of the safe zones into which the city was partitioned during the war continue to operate as ethnic ghettos.

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Although the attempt to divide Sarajevo along ethnic lines did not succeed during the siege, however, the conflict has since transformed into a cold war that is evident in spatial discourses of street naming. Post-war authorities have changed about four hundred street names. Figure 5 maps this transformation in relation to streets of central Sarajevo, coding their ethnic identifications before (upper) and after the war (lower). The maps reveal a particular renaming pattern. Most of the primary pedestrian and vehicular arteries, which framed the traffic network of the city, had Serbian-identified (blue) or multicultural names (yellow), which were replaced with Bosniac identified names (green). While many secondary streets with Croatian-identified names remain unchanged, Serbian-identified names remain only in a few tertiary streets. These maps
reveal a post-war politics of both the eradication of Serbian identity and a marking of the city as Bosniak-dominated territory, particularly along major paths that frame the image of the city.

![Map of Sarajevo showing post-war renaming of streets](source: Ristic 2011)

Figure 5. Post-war renaming of streets in Sarajevo (source: Ristic 2011)

The maps above enable a better understanding of the spatial consequences of ethnic conflict on urban transformation in Sarajevo. They do not merely document the scale of destruction or the distribution of terror in public space or the disposition of the renamed streets. They also enable an understanding of how such transformations of place mediate the politics of ethnic nationalism – the ways the assemblage of geography, urban morphology, spatial practices and discourses mediated practices of ethnic division/segregation, purification and exclusion. They also offer an insight into the ways in which the city mediates relations and practices of power – how it was adapted to enable practices of wartime violence and terror, and the ways in which ethnic domination was camouflaged in spatial discourse. These maps also enable seeing space through time – comprehending Sarajevo’s history and urban transformation from an ethnically mixed to an ethnically segregated city. Mapping can create potential for urban planning and design by enlarging the professional imaginary about forms of reconstruction, the representation of identity and construction of urban memory without producing trauma and prolonging conflict (Ristic 2011). The maps above enable a better understanding of the spatial consequences of ethnic conflict on urban transformation in Sarajevo. They do not merely document the scale of destruction or the distribution of terror in public space or the disposition of the renamed streets. They also enable an understanding of how such transformations of place mediate the politics of ethnic nationalism – the ways the assemblage of geography, urban morphology, spatial practices
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MAPPING INFORMALITY

Figure 6. Mapping Informalities – Dharavi, Mumbai
(source: Mumbai Housing and Area Development Authority)
Figure 6 shows a map of the morphology, functions and possible transformation of the informal settlement of Dharavi in Mumbai. 'Informal' settlements (partially synonymous with 'slums' and 'squatter' settlements) comprise up to half the population of many cities of the global south. While many such settlements remain threatened with eviction most are now permanent parts of these cities and the task is one of incremental upgrading in collaboration with resident communities based on existing informal morphologies (Hernandez and Kellett 2010; Dovey 2014; Pieterse 2011). Informal settlements are mostly quite literally 'off the map' of the formal city, represented, if at all, as zones of marginal urbanization without street/lane names or formal legitimation. The formal city is the one where the State takes control and responsibility, the informal city disappears from the map because it is relatively unrecognized by the state (Shatkin 2004). Counter maps of slums and informal settlements are emerging in part to render the invisible visible, highlighting precisely those parts of the city that have been rendered 'other' by the official maps. Such maps become a means of claiming the right to the city and establishing a sense of belonging to it.

Since informal settlements generally emerge without maps of any kind – the spatial knowledge needed to construct, navigate and extend them is held collectively and informally by the residents. This knowledge includes the morphology of building forms, densities and spatial structures; the demography of population densities, addresses and identities; and the spatial practices and functions. Such knowledge, which is crucial to any kind of effective incremental upgrading process, is also a form of power. The mapping of such forms of spatial knowledge plays a key role in the upgrading and formalization process.

The complexities of this issue are illustrated by the case of the giant informal settlement of Dharavi in Mumbai where the State wished to undertake a detailed mapping of morphology, functions and populations as a prelude to extensive redevelopment (Patel et al 2009). The resident communities were suspicious of the State's agenda and deeply resistant to such mapping. The result was that the State was forced to engage NGOs with strong connections to community-based organizations as mediators in the mapping process (SPARC/KRVIA 2010). Figure 6 is a map of one section of Dharavi that shows building footprints, public toilet facilities and commercial buildings. The heights of buildings are coded on each property with the label G+1 (ground plus one or two-storey). The building footprints have been mapped with an accurate GPS and show the labyrinthine pedestrian network with a high level of detail. There is one particular inaccuracy in that while all buildings are marked as two-storey, many of the buildings are actually three or four storeys in height. This is a result of an informal code suggesting that rooms should not be added above the second floor – any floors above that height have been simply omitted from the map which therefore cannot be used to determine such transgressions nor any kind of demolition plan. There is also another major omission: while the functional mix is accurate to a point, it omits widespread use of space for industrial production (mostly textiles). Fieldwork suggests that close to half of all floorspace is used for such a function and most of these double as living space for migrant workers (Dovey & Tomlinson 2012). The reasons for this omission are not simply that such functions are illegal since most of the settlement is technically illegal. For residents these industrial activities are a key source of income and many of the upper floors (also unmapped) have been built precisely for this purpose. The authorities have no plans to upgrade or replace the industry (much of which is sweatshop conditions), so the existence of such functions is a stumbling block in negotiations for upgrading. If mapped in terms of the triangle of mixed functions introduced earlier, most of the footprints on this map would be purple, orange or green representing a vertical mix (live, visit, work) in most buildings. This is an extreme level of functional mix that is never found in the formal city, but it must be understood as part of any upgrading process. This map also shows an overlay of a proposed new roadway that would see many of these buildings demolished - a highly contentious proposal that has thus far been resisted.

Accurate mapping is necessary for any effective upgrading process, yet both residents and authorities have differing interests in the ways the place is mapped. Mapping is a way of formalizing the informal, yet the omissions can also enable informality. Figure 6 is a map that exposes conditions of poverty: it shows laneways that are less than a metre wide, some tiny building footprints and a scarcity of open space. Mapping exposes the real scope of the challenge while also exposing the neighbourhood to the panoptic view of the state. The point here is not so much to argue for accuracy as to suggest that all maps make claims as accurate forms of spatial
knowledge. Maps are sites of contestation that inevitably reflect the interests of those undertaking the mapping. All maps are enmeshed in practices of power and the construction of knowledge. The decision on whether the neighbourhood is mapped, what forms of data are collected and whether they are collected accurately are all part of an ongoing negotiation about future transformation. The map represents a tacit agreement about what can and cannot be formally agreed as spatial knowledge at one point in time.

DISCUSSION

All of the maps introduced above operate as graphic tools for analysing and understanding the city. They each select and juxtapose chosen layers from the complex field of possible data, to become the information through which the map represents the territory. The assembly of layers of data on the map produces new ways of seeing the city. This involves making the invisible visible; the data that cannot be grasped by the senses becomes visible on the map. The overlay of sniper fire and urban morphology and that of street names and territories enables comprehending the politics of place identity. The overlay of cars and public transport and that of functional and spatial patterns enables insights into connective networks that sustain the city as a socio-spatial assemblage. In this sense, mapping involves a production of knowledge about how the city works and plays a key role as a knowledge base for its effective transformation.

We often think of knowledge as embodied in words and numbers, with images serving a largely illustrative role. Most academic discourses about space, including the ‘spatial turn’ in social theory have remained contained within a verbal logic (Warf and Arias 2009). It remains common to read entire books - even seminal works - ‘about’ space without any representation ‘of’ space. Indeed, there is the sense in much social theory that such a focus on the particularities of spatial form is a fetish, as if spatiality were merely the foam on the surface of deeper economic and social forces. Conversely there is also a substantial literature from the design fields where mapping flourishes as an aesthetic discourse with little social critique. Both fields reflect an ideology of separation between the sociality and spatiality of the city; mapping becomes crucial to the construction of knowledge about such interconnections. The mapping presented here ranges from the discourse analysis of street names to the science of transport flows, gearing methods of both humanities and sciences to urban morphology – mapping is inherently multi-disciplinary.

To understand the role of the map in the production of knowledge we return to the concept of the ‘diagram’ – the set of productive relations between forces that is immanent to an assemblage. This difficult concept can be traced to Foucault who established that practices of power cannot be separated from the production of knowledge and that this knowledge/power regime is often embodied within the spatiality of the city (Foucault 1977; Deleuze 1988). The diagram is not an ideal or model from which the city has been assembled; nor is it a formula that is applied like a design technique. The point of mapping is not to produce a facsimile of the city nor an image to be replicated but to spatially expose the abstract set of forces that produces and sustains the city for better or worse. These forces may be political, material, aesthetic, social, economic or environmental. It can be confusing, however, to identify the diagram with either a map or a set of superimposed maps. The diagram is an abstraction of the spatial relations between the map strata; the map depicts how these relations are embedded in the urban morphology and underpin the workings of the city.

Mapping can expose the ways the city is grasped by the senses, represented in professional discourses and lived in everyday life – the dialectics between ‘perceived’, ‘conceived’ and ‘lived’ as described by Lefebvre (1991). Lefebvre’s goal is to link the materiality of built form and spatial practices to the technologies of representation and the phenomenology of everyday life (Schmid 2008). It is tempting to suggest that mapping is located as part of the second category of conceived space; yet mapping also engages directly with the relations between them. In the case of Sarajevo the perceptions and practices of the sniper, the conception of a divided city and the geography of fear in everyday life are all engaged in a single image. The urban transport isochrones bring together spatial practices and conceptions in images that map the
phenomenology of space/time in everyday life. Mapping can show the ways that dialectics of space are embodied in the city and work to produce and reproduce it.

Spatial knowledge produced through mapping involves a certain level of abstraction. Mapping often requires a typology, a sifting of typical characteristics as a means of imposing order upon a field of differences. The task of mapping is not to expose or identify some supposed pre-existing truth - but rather to expose a logic through which the urban assemblage emerges. Thus, mapping is a practice of engaging with difference in the city. It is a fundamental precept of assemblage thinking that difference precedes identity; identities of people and places emerge from a multiplicity of interconnections, flows and juxtapositions. Bateson (2000, 459) famously argued that information is a "difference which makes a difference" and that "differences are the things that get onto a map" (p.457). The differences that are mapped here - between cars and public transport, between mixed and monofunctional, between different ethnic identities, between exposure and safety - all make a difference to how cities work and can be adapted or transformed. The Sarajevo maps reveal practices that worked to prevent ethnic mixing, divide the city into purified enclaves and produce exclusive ethnic identities. The Dharavi map shows how some differences (building heights and functions) are excluded or distorted in accordance with particular interests.

It is clear that desires to transform the city are key drivers of mapping practices – desires to reduce car-dependency or to upgrade informal settlements. One of the greatest potentials of urban mapping lies in its overlaps and intersections with planning and designing. Mapping is generally seen to articulate an existing city while planning and designing engage with the possible city; yet mapping also discloses and unfolds potentials and possibilities. The best of urban mapping exposes potential for adaptation and transformation, what DeLanda (2011) calls the 'space of possibilities'. The ultimate test of mapping as spatial knowledge and its greatest potency lies in the potential to expose capacities and possibilities that are at once real but not yet actualized. Mapping as a form of knowledge production links diagrammatic thinking and spatial representation to open up and transform the urban imagination.

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