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Bias in urban research
From tools to environments

Mark Shepard

Introduction
What we see is influenced by how we see, which in turn is conditioned by the tools we use to see with. One could say these tools bias what we see. Yet while human bias is defined in terms of a preference, predisposition, prejudice or predilection for or against something or someone, instrument bias can occur for very different reasons. On the one hand, measuring tools can be improperly calibrated, leading to a scale producing inaccurate measurements for weight, for example. Alternately, instruments can be designed to weigh various aspects or qualities of the object under investigation differently, such as when an ultraviolet (UV) filter reduces transmission of specific wavelengths of light through a camera lens. Regardless of whether the bias in question is the result of error or intent, we can say the relation between the tools and objects of research is anything but neutral.

As we more frequently view cities through the data they generate, we often deploy algorithms as tools for insight. Methods involving big data and machine learning introduce forms of bias that are both inherited from human bias residing in the dataset itself, as well as generated by the way in which the algorithms operate on that data. Algorithmic bias can include the filtering of content for particular individuals based on a history of their online activity, as often occurs with social media. Alternately, where algorithms operate within decision-making contexts, bias can arise from how an algorithm generates outputs that discriminate against a protected population. Consider predictive policing platforms that have been shown to produce a feedback loop which often results in the allocation of more patrol cars to neighbourhoods with higher populations of racial minorities, irrespective of their “true” crime rate (Ensign et al., 2018).

To the extent that our understanding of a city is shaped by the methods by which we apprehend it, so too is the city shaped by this understanding. The evolution of urban environments can be understood as an ontogenetic process, whereby the relation between the tools and objects of urban research and design is recursive and mutually reinforcing. Indeed, as neighbourhoods become instrumented with arrays of sensors, and their residents in turn generate ever-larger volumes of data as they go about their daily business, the tools themselves are beginning to merge with the environments on which they are reporting. This chapter traces this shift from observational tools to environments that observe in an attempt to examine the changing nature of bias.
in urban research and design and the subsequent implications for epistemologies of urban environments. Following the introduction of two pre-cinematic optical devices that embody radically different epistemological models, I proceed through a comparative analysis of two approaches to urban research that employ techniques of moving image analysis that contrast small data studies with big data analytics. I conclude by asking how recent developments in the quantification of urban life through smart city initiatives are altering not only how we conceive cities but also how we perceive their citizens.

**Observational devices and their epistemic implications**

Observational devices have long been used in the effort to represent urban space. Canaletto’s use of the camera obscura to chart the urban landscape of 18th century Venice is well known (Figure 3.1). While the optical principles of the device were known for centuries, by the early 19th century, the camera obscura was recognized as the dominant model for observation. As art historian Jonathan Crary has noted, the device represented more than just the performance of optical principles; it also articulated an epistemology of the relation between observer and world (1990). The camera obscura posited a disembodied observer occupying the interior of a darkened enclosure into which the exterior world is projected by means of a tiny aperture in one wall as an inverted two-dimensional image. This model of observation served as an analogy for human vision: the aperture of the room was a corollary for the human eye, and the dark interior a metaphor for the mind to which the world is represented as image. In this model, the observing subject is constructed as both monocular and devoid of other senses. Such veracity of observation, already a conviction of Enlightenment thought, was firmly grounded in an empirical demonstration of the mechanical optics of vision in which the other senses are not to be trusted.

![Figure 3.1 Camera obscura – Athanasius Kircher, 1646](source: Public domain via Wikimedia Commons)
By comparison, the stereoscope, itself a by-product of early 19th century advances in physiological optics, capitalized on the discovery that with binocular vision, each eye sees something slightly different due to the angular disparity existing between them (Figure 3.2). The production of depth in sight was subsequently understood to be related to the mind’s ability to unite and reconcile two dissimilar images. The stereoscope was developed to reproduce this optical experience mechanically. Significantly, the device marks an intent not just to *represent* a given space, but to *simulate* its presence. What is sought is not merely a likeness, but a lucid tangibility. With the stereoscope, one is confronted not with a view of the world through an aperture or frame, but with the technical reconstitution of an already reproduced world fragmented into two non-identical models (Crary, 1990). Through the incorporation of the observing subject into the mechanics of the device, the stereoscopic image is produced. The body is immobilized and integrated with the apparatus. The subject becomes a participant in the production of a verisimilitude through a process of unifying and reconciling the experience of difference. The disjunction between an experience and its cause is reified, the “real” conflated with the “optical.” Absent is the notion of a “point of view” in a Cartesian sense. There is, in the end, nothing out there.

These pre-cinematic optical devices present different modes of observation that condition how one engages with an environment and what can be known about that environment. Embedded within the historical and scientific contexts from which they emerged, they present contrasting models of the relation between an observer and world as mediated through an optical device. What’s striking is not only how each constructs radically different observing subjects, but also how both illustrate divergent epistemological assumptions.

*Figure 3.2 Stereoscope, 1861*

*Source: Public domain via Wikimedia Commons*
underpinning the truth claims they articulate. The shift from an accurate likeness forming the basis of a truthful representation to a tangible presence that enacts the visual experience of a given space marks changing notions of the role and status of the body and its sensing capabilities in the production of knowledge: from a disembodied, monocular subject occupying the interior of the device to the integration of the observing subject into the mechanics of device itself. The radical differences between these devices highlight the role of the apparatus in constituting not only the parameters of what we know about the world, but also how we conceive our relationship to it, and ultimately how we construe who we are and our agency to act within it.

With the introduction of film at the close of the 19th century came the ability to capture movement and change in urban space over the course of time. The early city symphony films, for example, use the lens of the cinematic apparatus to record the rhythms of the industrial city. Walter Rutmann’s *Berlin. Die Sinfonie der Großstadt* (1927) is a catalogue of urban movements that follows a linear progression from morning to night. Repetitive, cyclical operations of machines are juxtaposed with the actions of people over the course of the day. Urban life converges with the industrialized city into a tightly synchronized composition. The convergence of urban life with the mechanics of film is even more pronounced in the classic *The Man with the Movie Camera* (1929) by Dziga Vertov in which the mobilized camera itself becomes a protagonist in a series of scenes that depict life in the city (Figure 3.3). From dawn to dusk, citizens in Kiev, Kharkov, Moscow and Odessa are shown at work and play through their interactions with the machinery of modern life. The film culminates in a rapid montage that juxtaposes the aperture of the camera with a human eye: a dizzying fusion of observer and observational device. The superimposition of the observing subject into the observational device is complete.

*Figure 3.3* Film still from *The Man with the Movie Camera*, Dziga Vertov, 1929
*Source:* Public domain via Wikimedia Commons
The quantification of vision

By the latter half of the 20th century, the role of the moving image had shifted from that of representing urban environments to serving as an explicit tool of empirical urban research. William Whyte employed time-lapse photography in the 1970s to study the interaction of people with and within urban space in Manhattan. In the film *The Social Life of Small Urban Spaces* (1979) (Figure 3.4), he presented the outcomes of his Street Life Project, a decade-long study of open public space and street life in New York City that had been commissioned by the New York City Planning Commission (Whyte, 1980). Whyte’s research used direct observation as a method to focus on small-scale, street-level studies that examined human behaviour in public places. The time-lapse opening shot of the Seagram building’s plaza over the course of a day correlates a moving patch of sun with areas of activity within the plaza. Within the filmic frame we see a clock, a sign of the empiricism underlying the researchers’ aspirations toward the factual verification of a set of hypotheses.

Whyte mapped the micro-interactions between people and those between people and urban space in order to document patterns of use and activity over time. This street-level investigation incorporated both an observational device and a research methodology focused on urban amenities such as “sittable” space, street, sun, food, water, trees. The correlation between the path of the sun and the activity within a plaza, for example, is perhaps obvious, as Whyte remarks. Yet the rhetorical role of the mechanical apparatus is clear: the camera is understood as a transparent research tool, enabling the study of the role of movement and social interaction in urban space, as well as the use of moving images in spatial analysis. Designed to influence public policy on the design of urban plazas, Whyte’s filmic observations and detailed analysis claimed the status of factual representations of how small urban spaces are used in New York City.

At a time when the rhetoric of the quantifiable is re-emerging as the primary driver of urban development, Whyte’s project can be understood as a precedent to more recent initiatives in the commercial software industry that embrace empirical methods of observation in studying urban environments. Placemeter, for example, was a technology start-up founded in 2012 that used algorithms to extract data about urban life from video feeds and sensors that are distributed throughout...
the city (Figures 3.5 and 3.6). Their product was a software platform that employed crowd-sourced, window-mounted smart phone cameras and machine vision algorithms to develop datasets on urban activity. Yet unlike Whyte’s controlled research project, Placemeter leveraged video streams sourced from the public at large who had signed up with the service. Users streamed video data captured by a camera mounted on their window to Placemeter’s servers, where the data was analysed. The results were subsequently accessed through an online dashboard.

Placemeter used crowd-sourced data to quantify movement in urban spaces. Through proprietary machine vision algorithms, the software first classified different kinds of moving objects appearing within the video frame: pedestrians, bicycles, motorbikes, vehicles and large vehicles. Subsequent analysis extrapolated various attributes about this activity, including volume of foot traffic, speed and dwell time of moving bodies, and the use of specific urban amenities, for example. Various “solutions” were offered for smart cities, transportation, retail, advertising and what the company’s website terms “tactical urbanism.” Applications included:

- discovering crowded and under-used areas through looking at user flow data;
- analysing the use of specific design features (park benches, recycling bins, playground equipment);
- measuring the impact of special programming (concerts, farmers markets);
- determining the impact of temporary events (street closures, art installations).

*(Placemeter.com, 2016)*

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*Figure 3.5  Placemeter smartphone cameras capturing pedestrian traffic*

*Source: Courtesy Lee Kim*
The platform essentially applied the logic of website-analytics to the task of measuring urban activity, tailored to the needs and interests – the *biases* – of the transportation, retail and advertising industries.

While quantifying street-level activity such as foot traffic in front of a retail store has obvious implications for how real estate is valued and marketed, what is at stake when the system is deployed at an urban scale? In one such case, the city of Paris and Cisco have worked with Placemeter and other sensing platforms to test different urban planning models for the redevelopment of the Place de la Nation. As part of an initiative known as the €1 billion Paris Smart City 2020, the project was viewed as an experiment that would yield results that could be extrapolated across the entire city, from the Place de la Bastille to the Place des Fêtes, the Place Gambetta, the Place d’Italie, the Place de la Madeleine and the Place du Panthéon.

The Place de la Nation is a large, circular intersection in eastern Paris that is divided into a series of concentric traffic islands by broad streets. The guillotine that used to dominate its centre island has been replaced by a monument by Jules Dalou that commemorates the French Revolution. “Le triomphe de la République,” as the monument is entitled, portrays a figure that symbolizes the Republic being held aloft by a lion-drawn chariot that is being led by the figure of Liberty, attended to by those of Labor and Justice, and followed by that of Abundance. Today Place de la Nation is a busy traffic circle devoid of pedestrians. The project for Place de la Nation integrated a range of technologies for sensing and acquiring data. A device called the “Breezometer” analysed the air quality from sensors located in the plaza. Fullness levels of waste containers were monitored by sensors embedded inside their shells. Anti-noise panels measured real-time sound...
levels. All collected data were reportedly fed to ParisData, an open data portal developed and maintained by the City of Paris. Information panels situated on-site were to provide passers-by with data visualizations about the project. Cisco deployed Placemeter to study the number of pedestrians and bikers, automobile traffic patterns and other activities occurring in the plaza. These data were intended to be combined with other data to study the effects of closing streets at certain points for a period of time, for example, or how widening bike lanes and moving benches, chairs and other amenities to different locations affects patterns of use and activity in the plaza.

Both Placemeter’s platform and Whyte’s method are based on empirical visual evidence recorded through time-lapse photography. Whyte’s results, however, were presented in the form of charts and graphs that are now referred to as “small data.” As Rob Kitchin and Tracey Lauriault note, prior to the emergence of big data, all data studies were essentially small data studies (Kitchin and Lauriault, 2015). Small data is common to social science research, and is usually produced through surveys, interviews and other qualitative research methods. Small data studies generally involve a targeted inquiry designed to answer specific research questions. They tend to be context-rich, in-depth investigations of a specific issue or set of issues. They are based on limited volume and variety of data collected at specific points in time. Placemeter and the associated technologies employed at the Place de la Nation, by contrast, are based on a distributed sensing model where data streams from multiple sources are aggregated and interpreted by machine learning algorithms. These data streams share attributes with what are called big data. As described by Kitchin (2014), big data are huge in volume, high in velocity, created in or near real-time, diverse in variety, structured and unstructured in nature, temporally and spatially referenced, exhaustive in scope, fine-grained in resolution, uniquely indexical in identification, relational in nature, flexible, extendable and scalable. Significantly, machine learning based on big data eschews an initial hypothesis in favour of pattern-recognition, aiming to reveal previously unknown correlations and other insights.

Whyte’s research departed from a set of research questions focused on understanding the micro-interactions between people and an existing urban environment, around which a methodology for observation was developed. The Place de la Nation project, by contrast, deploys a suite of existing sensing devices as part of the design process to iteratively study how people behave in a specific urban space and test alternatives for its modification. That the project presupposes methods of quantification based on sensor data might lead one to paraphrase Maslow in saying that if the only instruments we have are sensors, we will treat everything as if it were data. In effect, the observational device in this case becomes the process of quantification and analysis of data, a process that generates and tests hypotheses about urban activity based on iterative analysis of a series of design proposals.

In contrast to Whyte’s method which used time-lapse photography to test a set of hypotheses about how people inhabit urban space, Placemeter employed machine learning algorithms trained on big data in an attempt to derive hypotheses from patterns of movement and activity, quantifying the life of the street in terms of pre-established classifiers. Former editor-in-chief of Wired magazine Chris Anderson has described this new era of big data and machine learning as one of knowledge production characterized by “the end of theory” (Anderson, 2008). In other words, big data and machine learning enable an entirely new epistemology for making sense of the world; rather than testing a theory by gathering and analysing relevant data as Whyte did, this new approach seeks to gain insights “born from the data.” Here, correlation supersedes causation.
Testbed neighbourhoods

While platforms such as Placemeter add big data and machine learning to the instruments available for the research and design of urban environments, other initiatives look toward the instrumentalization of the urban environment itself. New York City’s Hudson Yards project is the largest private real estate project ever to be built in the United States. Over the next decade, the $20 billion project—which spans the seven blocks of 30th to 34th Street cordoned by 10th and 12th Avenues—will add 17 million square feet of commercial, residential and civic space. Reports claim that it will contain the nation’s first “quantified community,” a testbed for applied urban data science (Leber, 2016). Led by Constantine E. Kontokosta, a professor of urban informatics at the Center for Urban Science and Progress (CUSP), the Quantified Community, as he refers to it, aims to be a fully instrumented urban neighborhood that uses an integrated, expandable sensor network to support the measurement, integration and analysis of neighborhood conditions, activity and outcomes (Kontokosta, 2016).

The premise of the Quantified Community is drawn from the Quantified Self movement. People associated with this movement employ fitness activity trackers to monitor a range of health factors—from heart rate, to steps taken, floors climbed, calories burned, even sleep quality—and to produce representations of their progress toward self-identified goals that are shared and aggregated through online portals (Wolf, 2010). In another form of self-tracking, dieting apps enable us to record what we eat and track how many calories we have consumed, what proportion of those calories are from protein, carbohydrates or fat, and provide nutrition information about daily eating habits. Central to this movement is the idea that these personal monitoring devices can support behavioural change.

Scaling this paradigm to the neighbourhood, the Quantified Community posits that the continuous monitoring of the built environment, from its technical systems to the human activity within it, can be fed back into that environment so as to alter its future performance and the behaviour of its inhabitants. Kontokosta himself explicitly identifies his behaviourist intentions for the quantified community: “My focus is much more on understanding how the data influences behaviour, and using the type of information that’s now available to really democratize the planning process much more” (Libby, 2016). His version of the Quantified Community aims to measure, model and predict a wide range of activity, including: pedestrian flows through traffic and transit points, open spaces and retail space; air quality both within individual buildings as well as across open spaces and surrounding public areas; health and activity levels of residents and workers using a proprietary mobile phone app; and solid waste with particular focus on increasing the recovery of recyclables and organic waste, energy production and usage throughout the project’s lifecycle (NYU CUSP, 2016). The Quantified Community at Hudson Yards thus presents a test bed for future urban life, where urban intelligence—the “smartness” of the smart city—is rendered not as conscious, liberal or objective, but rather as performative (Figure 3.7).

If Vertov’s film presented the collapse of distance and distinction between observer and observational device, the Quantified Community renders citizens themselves as sensors alongside those embedded within buildings and associated infrastructural systems. The observing subject is replaced by a suite of algorithms that mine, aggregate and extrapolate from these data in search of patterns of activity and behaviour. Here, people become not just residents of the neighbourhood, but also consumers of its amenities at the same time as they generate data about these activities. As Whyte and his researchers observed, the physical environment shapes our behaviour within it. In the Quantified Community, then, data collected about that behaviour from a diverse and unevenly distributed set of sources are fed back into that environment in the form of modulations made to it designed to alter that behaviour.
Hudson Yards: Engineered City

Hudson Yards will be far more than a collection of tall towers and open spaces. It will be a model for the 21st century urban experience; an unprecedented integration of buildings, streets, parks, utilities and public spaces that will combine to form a connected, responsive, clean, reliable and efficient neighborhood.

Connected Neighborhood:
Communications will be supported by a fiber loop, designed to optimize data speed and service continuity for rooftop communications, as well as mobile, cellular and two-way radio communications. This will allow continuous access via wired and wireless broadband performance from any device at any on-site location. We’re as good as future-proofed.

Responsive Neighborhood:
Hudson Yards will harness big data to innovate, optimize, enhance and personalize the employee, resident and visitor experience. Supported by an advanced technology platform, operations managers will be able to monitor and react to traffic patterns, air quality, power demands, temperature and pedestrian flow to create the most efficiently navigated and environmentally attuned neighborhood in New York.

Clean & Responsible Neighborhood:
Progressive cities are moving toward organic waste separation systems to reduce landfill costs, methane emissions and greenhouse gas emissions. Hudson Yards makes organic waste collection convenient and space efficient by utilizing grinders, dehydrators and bioreactors to convert food-service organic waste to dry fertilizer at 10% of its initial weight and size.

Additionally, nearly 10 million gallons of storm water will be collected per year from building roofs and public plazas, then filtered and reused in mechanical and irrigation systems to conserve potable water for drinking and reducing stress on New York’s sewer system.

Reliable & Efficient Neighborhood:
Whatever the disruption—super storm, brown out—Hudson Yards will have the onsite power-generation capacity to keep basic building services, residences and restaurant refrigerators running. It doesn’t hurt that being built above a rail yard means our first level is well above the flood plain.

Hudson Yards’ first of its kind microgrid and two cogeneration plants will save 24,000 MT of CO2s greenhouse gases from being emitted annually (that’s equal to the emissions of ~2,000 American homes or 5,100 cars) by generating electricity, hot water and chilled water for the neighborhood with over twice the efficiency of conventional sources.

Source: Courtesy Related Companies
The critiques of behaviourist explanations of human activity and their implications for urban design are well known. See for example, Skinner (1971) and critiques by Chomsky (1971) and Koestler (1968). What is perhaps less evident is what happens to those aspects of urban life that are not easily measured in a Quantified Community. Not everyone will choose to opt-in to a proprietary app designed to measure the health and activity of the community, and not all choices or decisions about how we inhabit or otherwise occupy urban space are reducible to quantifiable data points. What we measure is limited by the instruments we have available. If the behaviour of these citizen-sensors is taken to indicate levels of engagement with each other and with their neighbourhood, these indications are inevitably biased by the instruments that make those actions visible.

Whyte’s studies departed from a series of focused research questions about micro-interactions of people in public spaces and the role the built environment plays in supporting or hindering these interactions. By contrast, the Quantified Community would appear to depart from a suite of technical capabilities for quantifying behaviour of people, the environment and infrastructural systems with an eye toward increasing the optimization and efficiency of each. In this shift from observational tools to environments that observe, both the city and its citizens merge into populations of human and non-human actors and actants that comprise not individual bodies but rather patterns of activity and behaviour iteratively mined, clustered and interpreted by algorithmic processes. This test-bed world of big data and machine learning – where correlation supersedes causation –“is a probabilistic one where few things are certain and most are only probable,” as Halpern et al. write (2013, p.294). It presents an urban epistemology not concerned with documenting facts, representing spaces or developing representational models, but rather evolving models that are in and of themselves territories.

Conclusion

“The trouble with modern theories of behaviourism,” Hannah Arendt wrote, “is not that they are wrong but that they could become true, that they actually are the best possible conceptualization of certain obvious trends in modern society” (1958). The trend toward the quantifiable, measurable and accountable in urban design would appear to reflect a return to what Brenner and Schmid describe as “technoscientific urbanism,” where sensing space and analysing behavioural data become the dominant methods for empirically driven urban design aimed at finding solutions for perennial urban problems. The neo-positivist, neonaturalist revival of post-war systems thinking at the core of smart city developments such as Hudson Yards not only reinforces this view of cities and urban life as universally replicable, but also as depoliticized subjects to be more optimally and efficiently managed (Brenner and Schmid, 2015).

Biasing the quantifiable in this way, however, only makes sense when data are engendered with the capability of being “true.” Yet, as Daniel Rosenberg (2013) reminds us, there is no truth in data, and the use of the word “data” in the English language has been intertwined in conflicting ways with related concepts of “fact” and “evidence” since its emergence. At the beginning of the 18th century, “data” referred to either “principles accepted as a basis of argument or to facts gleaned from scripture that were unavailable to questioning.” By the end of the century, the word more commonly referred to “facts in evidence determined by experiment, experience, or collection” (Rosenberg, 2013, p.33). While this shift from understanding data as the rhetorical premise of an argument to the result of an empirical investigation laid the groundwork for mid-20th century claims of scientific veracity in urban design and planning, today, as Rosenberg suggests, “[i]t may be that
the data we collect and transmit has no relation to truth or reality whatsoever beyond the reality that data helps us to construct” (2013, p.37).

As tools for urban research and design merge with the very environments they aim to both study and project, new urban territories emerge that are populated more by statistical imaginaries derived from aggregate data than by communities of embodied citizens. If the camera obscura presented an epistemology that objectified the world through optical principles for an isolated, interiorized, monocular subject, the stereoscope employed principles of physiology to engage a disembodied observer in the co-production of a verisimilitude of the world. Vertov followed by collapsing the distinctions between an observing subject and an observational device entirely, presenting the world itself as a purely cinematic construct. The territories constructed by algorithms discussed above, then, represent an urban epistemology that dispenses with the very idea of observing a world altogether, positing instead “insights” born from data potentially bearing no relation to an observable truth or reality.

From this perspective, unbiased urban research is an oxymoron. The question becomes: what bias do we want to bring to tomorrow’s cities? The first step in responding to this question is to dispense with the notion that any given method will result in an empirically “true” observation, and subsequently to foreground the selection of the tools and methods by which urban space is analysed and projected as a rhetorical one. For this we will not only need better tools and methods than are currently available, but also a willingness to think critically and reflexively about the epistemological implications of their application to the shaping of urban environments, and in turn, of urban life.

References


