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The city without qualities: Inventing urban computing

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1 Introduction

In the early 2000s, the 'smart city' emerged rapidly as a distinctive urban *zeitgeist* comprised of an idiosyncratic mix of technological inevitability and commercial evangelism. The period since has seen active contestation of the term, and of the urban trajectory it seeks to establish. My aim here is not so much to reconsider the merits or demerits of these recent debates but to broaden them by situating the emergence of the smart city imaginary — what I've elsewhere dubbed 'smart cityism' (McQuire 2021)— in a longer history of urban computing. In doing so, my broader aim is to contribute to a better historical grounding for the emerging field of geomedia studies.

While there is no single definition of 'geomedia', let alone agreement as to what might constitute geomedia studies as an interdisciplinary endeavour, urban space has been a key site for the emergence of a new condition in which the experimental spatialization of digital media infrastructure has proceeded hand in hand with the heightened role of spatial logics in organizing information. For this reason, 'the city' should not be treated as merely one example among many in the broader development of geomedia but needs to be recognized as an *ur*-object inspiring the development of new approaches based on computational analysis of continuous data flows as the means to mastering complex socio-spatial systems.[1]

With this in mind, I want to revisit the formation of the New York-RAND Institute (hereafter NY-RAND), a joint initiative between the city and RAND Corporation established in 1969. My aim in recalling this history is two-fold. First, I want to underline similarities between the advocacy of urban computing in this period and the smart city imaginaries that emerged in the 2000s. This likeness, circling around faith in the capacity of computer modelling to account for the rich complexity of urban social life coupled to belief in the innocence of terms such as ‘efficiency’ and ‘optimization’ which still guide modelling, raises complex questions about the politics of historical memory—and amnesia —in relation to technological deployment. A second aim is to insist on the limits of any such likeness. While I have a lot of sympathy for those such as Robins and Webster (1999: 7), who rightly disputed the superficiality of many accounts that enthusiastically proclaimed the ‘information revolution’ of the late 20th century, I don’t consider that the “the origins of organised and systematic information gathering, analysis and distribution” in the first decades of the 20th century constituted the ‘real’ control revolution. If 20th century information society undoubtedly relied heavily on various earlier inheritances including statistics, filing systems and typewriters, this is no reason to downplay the specific materialities and affordances of later developments in electronic computing, let alone 21st century developments in fibre optic networks, sensors, mobile devices, cloud storage and other elements that underpin the smart city imaginary. Rather than asserting that all these developments simply follow a general logic that has already been set, we need to recognize the complex manifold of temporalities and trajectories that characterise major paradigm shifts. This includes acknowledging the historical contingencies of the specific spatial, temporal and institutional settings in which technology is deployed and mobilised.

With such contingencies in mind, my account focuses on developments in the United States where the earliest systematic attempt to develop and apply computational logics to urban problems was enacted.[2] I will argue that urban computing as it emerged in the Unites States in the 1960s depended on the articulation — which is to say the *jointing together* — of a wide range of constituent elements including the emergent technological capacities of digital computers; novel conceptual frameworks and knowledge paradigms including cybernetics and systems analysis; powerful individual proponents who functioned in specific institutional and policy settings including defense, urban planning and local government; as well as broader social conditions relating to changing business models, urban programs and race relations in the United States.

What was enacted in this period was a profound transformation in how a city could be imagined. The definition of who can or should speak about the city —who could stand as an *expert* in urban affairs— became contentious in a new way at this time, in the context of debates about how cities should be planned, governed, lived in and even destroyed. If, for instance, the modern city could be—for the first time—explicitly imagined as a 'communications system', what model of communication was being mobilized and what consequences flowed from this? Such a question continues to have relevance and resonance today as digital infrastructure exerts growing influence over the conditions of contemporary urban inhabitation and urban governance.

2 The city as target

In 1945, Louis Wirth—doyen of the 'Chicago school' of sociology and one of the most influential urban thinkers of the 20th century—gave an address to the American Municipal Association with the confronting title 'Does the atomic bomb doom the modern city?' (Wirth 1945) While Wirth eventually answered 'no' to his own question, the fallout from the Manhattan project had made such a response increasingly tenuous. In the aftermath of Hiroshima and Nagasaki, military strategists no longer conceived the city as a citadel to be occupied but as a target to be destroyed.

Prominent advocates of this perspective included the so-called 'father' of cybernetics, Norbert Wiener. A version of the 'Wiener plan' was outlined in an illustrated article published in *Life* magazine in 1950, replete with a full-page portrait of Wiener seated in his MIT classroom. The first part of the article stated the problem bluntly: 'The particular vulnerability of big American cities to atomic weapons stems from the combination of two factors: the intense congestion of the cities and the immense destructive power of the bomb' (*Life* 1950: 77). Wiener's plan, developed in concert with two MIT colleagues, proposed a systematic program of urban decentralization. Key features included the construction of rail by-passes so that destruction of the city centre wouldn't completely disable rail networks, complemented by new express highways designed to circle major cities about ten miles from their centre. These so-called 'lifebelts' were intended to enable inhabitants to travel to 'safe zones' in the urban perimeter following atomic attack.

The complete impracticality of such proposals—not simply their cost and the time needed for construction which had dissuaded Wirth, but also the fact that the supposed 'safe zones' would be rendered anything but safe due to radiation— didn't prevent them gaining traction in defense circles. Wiener's RAND colleague, the enigmatic Herman Kahn, took on the mission to force military and political decision-makers to 'think the unthinkable' — waging and surviving a nuclear war — with near religious fervour. With trademark insouciance, Khan chillingly remarked: “We may just be going to live in a world in which every now and then a city or town is destroyed or damaged as a result of blackmail, unauthorized behavior, or an accident.” (quoted in Ghamari-Tabrizi 2005: 7) These days he might feel compelled to add—so get over it!

However, while the ‘city as target’ became a serious problematic in U.S defense and political circles, it would be misleading to overstate its impact on urban policy. In fact, the kind of decentralization that Wiener, Khan and others were advocating was already well underway by 1950, driven less by security concerns than an amalgam of other factors. These included the changing demographics resulting from black migration to inner-urban areas in northern cities and ‘white flight’ to the new suburbs (see Beauregard 2006: 40-69). These twinned trajectories were themselves fuelled by favourable policy settings supporting housing development, home loans for returned soldiers and Federal highway construction. (McQuire 2008: 138-141) Underpinning the whole trajectory was the unprecedented post-war economic boom enabled by US dominance of global manufacturing. The scale of urban transformation was unprecedented: between 1940–47, 60 million Americans–nearly half the population at the time–moved to new homes (Dimendberg 1997: 70).

Wiener’s program of strategic urban dispersion was a minor consideration in the context of such major currents. It was soon quietly shelved as the much larger destructive capacities of the H-bomb made it clear that nuclear war no longer posed a risk only to what Wiener (*Life* 1950: 85) had called “the poorer and most congested districts” but threatened the entire population. Nonetheless, two thresholds did emerge in this debate, arguably with far greater impact on subsequent urban life. The first was the specific proposition made by Wiener in the *Life* article when he describes the city as a *communications system*. Here Wiener deliberately sought to locate the city firmly within the emergent realm of his recently announced 'communication science', cybernetics.

> For a city is primarily a communications center, serving the same purpose as a nerve center in the body. It is a place where railroads, telephones and telegraphs centers come together, where ideas, information and goods can be exchanged. Obviously then a city can only function efficiently if its means of communication are ample and well laid out. (*Life*, 1950: 85)

The cybernetic model that Wiener (1948) had outlined in his influential book depended on the novel and then quite radical proposition that information could be understood as a purely quantitative and probabilistic entity entirely divorced from both semantic qualities and material instantiation. While the mathematical theory of information was the formal contribution of Claude Shannon, and the cybernetic paradigm also borrowed heavily from McCulloch's model of neural functioning as well von Neumann's work on binary code computing, Hayles (1999: 7) rightly positions Wiener as the pivotal 'visionary' who was able to articulate the deeper implications of the new paradigm, with its sweeping ambition to unite diverse scientific fields including mathematics, neurophysiology and engineering. This became the basis for a subsequent shift towards a quantitative understanding of all kinds of social phenomena, which could be made the subject of 'scientific' intervention based on probabilistic assessment of different inputs and predicted outputs. Urban policy would soon become one such zone of intervention. Perhaps most striking in this context is the extent to which— even in its infancy—Wiener's formulation already contains the kernel of 21st century 'smart cityism', built around the profound idealisation of concepts of 'efficiency' and functionality', while entirely occluding any recognition of the deeply *political* questions bound up in any determination of what it means for a city to 'function efficiently'.

The second major shift that took place in these debates concerns the transfer of authority from those with practical experience in a specific field to a new set of experts: the so-called 'whiz kids' who specialised in the new forms of analysis linking statistics to game theory, computation and simulation. The impracticality of actually waging nuclear war in the field changed the terrain for planning military strategy. Kahn's ascendancy exemplified this tendency: as a RAND analyst in the 1950s he was fond of countering charges from senior Army officers about his lack of practical military experience with the riposte: 'How many thermonuclear wars have *you* fought recently?' (cited in Ghamari-Tabrizi 2005: 49).

By the 1950s, RAND, which grew out of the 'operations research' of the wartime Office of Scientific Research and Development, had evolved into a key incubator of 'systems analysis' involving a heady mix of statistics, game theory, probabilistic calculation and simulation exercises. This development drew on and extended the 'scientific' models of planning, budgeting and resource allocation that had already been widely adopted by U.S business. A key element underpinning these approaches was the detachment of 'management skills' from the specific business on which they sought to operate. The classic account of this change in management practice and ideology appeared in William H. Whyte's *The Organization Man*, published in 1956. Whyte (1956: 7) emphasized that management was becoming 'an end in itself, an expertise relatively independent of the content of what is being managed'. As 'management' came to be conceptualised in terms of skills that were seemingly transferrable across different domains, a (mostly) younger generation were able to accrue power across widely diverse arenas of activity. Flood (2010: Ch 5) underlines this diversity: "the emerging Organization Man view of the world [was one] where twenty-five-year-old MBAs and green eyeshade-wearing accountants were given the authority to make decisions about bombing runs and product rollouts."[3] Growing use of digital computers to run simulations supercharged the appeal of systems analysis approaches and the authority of those able to deploy them. In her detailed study of RAND's interaction with the defense establishment, Ghamari-Tabrizi (2005: 48) concludes: "Atomic weapons inaugurated a colossal shift in authority. They swallowed up the personal wisdom of senior officers rooted in combat experience in favor of intuitions arising from repeated trials of laboratory-staged simulations of future war."

Such a radical shift was neither smooth nor uncontested. Many pushed back against the civilian intellectuals with their 'fairy-tale simulations', particularly as the process was integrated with the new forms of machine automation. Writing in *The Nation,* Hilbert Schenck (1963: 506) excoriated Kahn and "the cool young men of RAND" as "our Eichmanns-cum-computer." Yet, in crucial respects, this battle was already over by the time that Schenck's article was published. With the election of John F. Kennedy in 1960, the displacement of traditional military expertise by a new breed of civilian intellectual was confirmed at the highest level. The appointment of Robert McNamara, previously head of Ford, as Defense Secretary in 1961 led to him enlisting multiple RAND alumni within the Pentagon, paving the way for the spread of systems analysis, simulation and computing into civil society.

3 The city as system

While RAND began in air defense research, the quantitative approach it incubated seemed ripe for wider application. For its proponents, the attraction of the 'RAND method' was that systems analysis could be applied to almost any problem. Even previously less quantifiable fields such as sociology, psychology and political strategy could be turned into objects of statistical analysis in a new way, reformulated as a series of equations whose variables could be assessed by an electronic computer, thereby transforming decisions that had traditionally been made by a combination of experience and 'gut feel' into matters for 'scientific' inquiry. The consequences of this shift are still playing out in the present.

The specific mechanisms by which these computational techniques migrated from defense to urban policy settings are manifold and there is insufficient space to do full justice to this complicated history here.[4] Part of the story was the overarching framework created by President Johnson's 1964 declaration of a 'War on Poverty', which soon expanded into the 'Great Society' vision he announced in his 1965 State of the Union address. This unlocked Federal funding and created a series of policy and institutional frameworks that would facilitate a major expansion of the 'RAND method'. A key problem inspiring the new policy setting was growing recognition of the parlous and deteriorating condition of many cities. What was widely termed 'urban blight' had already resulted in the formation of the national Community

Renewal Program (CRP) in 1959. In a 1962 report published by the American Society of Planning Officials the CRP was described as 'a tool of tremendous potential' capable of establishing a 'city-wide approach' to urban renewal. This coordinated approach aimed to consider social factors alongside 'the physical, fiscal and legal aspects of blight', replacing the traditional project-by-project approach that 'neither meshed nor gave assurance that a comprehensive attack was being launched on urban blight' (Kaufmann 1962: 23, 1). The CRP would play a major role in the wholesale reshaping of major US cities—especially New York— over the next decade.

Information analysis using computers was a distinctive part of this new attention to urban conditions. Funding was made available for the development of urban computing approaches across areas ranging from land use, urban density and building quality to the distribution of transport and employment and the functioning of police and emergency services. Light (2003: 53) notes the formation of the Urban Systems Engineering Demonstration Program, which provided subsidies to cities developing computer technologies and systems analysis approaches, and also the Urban Information Systems Inter-Agency Committee (USAC), which facilitated partnerships between Federal agencies seeking to promote improvements in local administration. Spanning such informational initiatives was the creation of the Department of Housing and Urban Development (HUD) in 1965 to foster systematic national approaches to urban policy and 'social health'.

Faith in the capacity of systems analysis and computing to solve complex social challenges was boosted at the highest levels. As a Senator, Hubert Humphrey argued in a 1964 press release that all kinds of problems from education to transport, communication, and housing “are admirably suited to the same kinds of ‘systems analysis’ approach that have paid off so well in defense” (quoted in Quade 1977: 23). By 1968, as urban unrest escalated across much of the country, Humphrey — now Vice-President — proclaimed the connection even more boldly. In a speech at the Smithsonian Institute, he declared: “The techniques that are going to put a man on the moon are going to be exactly the techniques that we are going to need to clean up our cities”. He went on to add: “the management techniques that are involved, the coordination of government and business, of scientist and engineer … the systems analysis that we have used in our space and aeronautics program— that is the approach that the modern city of America is going to need if it’s going to become a livable social institution”. (quoted in Quade 1977: 23)

This was the context in which RAND moved into urban research. Like several other contemporary ‘think tanks’, RAND jumped at the chance to diversify its funding beyond the patronage of the Air Force, which had dwindled as the prospect of waging nuclear had become genuinely unthinkable (see Jardini 1996). Yet the influence of its defense origins would remain evident in RAND’s urban work. Not only did it advocate many of the same techniques, but it drew on many of the same individuals who had been part of the defense program. The experience of working on defense problems including the ongoing war in Vietnam arguably — perhaps inevitably— coloured their perception of the ‘urban problem’ and its potential solutions. In a revealing footnote, Light (2003: 240) notes: “many of the defense and security experts described throughout this book, enthusiastic promoters of the transfer of innovations from military and aerospace to urban settings, were unable fully to appreciate the range of environments encompassed by these terms and *how local conditions might* *alter the outcomes of technology transfer* [emphasis added].” This point deserves further attention.

The merging of urban research with the fast-moving currents of computer data processing and simulation led to similar kinds of shifts in knowledge and authority that the defense sector had already experienced. Arguably the most striking example was the work of computer engineer and pioneer of systems dynamics, Jay Forrester, at the Urban Systems Laboratory (USL) opened by MIT in 1968. Forrester was best known for his earlier research into magnetic core memory and his role in the SAGE air-defense system which had pioneered ‘realtime control’. Despite having no formal training or previous interest in urbanism, Forrester proceeded to leverage his existing expertise in systems dynamics into research into ‘urban dynamics’ using the IBM Systems/360 Model 67 that was installed at USL in 1968. Forrester’s research, published in his 1969 book *Urban Dynamics* modeled a hypothetical but ‘typical’ American city with the stated aim of testing the effects of key ‘Great Society’ social policies of the period. While its methods were roundly criticised by some at the time (see Wood 2012: 40-44), its conclusions were highly praised by conservatives such as Daniel P. Moynihan, who became President Nixon’s Special Assistant for Urban Affairs and chair of Nixon’s new Urban Affairs Council.

Forrester’s work at the USL remains instructive for several reasons. First, despite its avowed aim of providing a neutral and objective approach to consideration of urban issues, Forrester’s model proved anything but disinterested. His own description notes its focus on the ‘decaying inner-city’ (Forrester 1969:12). Wood’s (2012: 37) summary of Forrester’s structural model, with its three subsystems (industry, housing, and population) making up the total ‘urban system’, all interacting through nine 'state' and twenty-two 'rate' variables, such as 'labor' and 'unemployment', is even more revealing. Aficionados of the long-running *SimCity* computer game may recognize the basic structure, which is not surprising since Forrester's book was a key influence on game developer Will Wright. More important here was the way that Forrester's closed system simulation was based on the assumption that 'urban decay' was a natural part of urban evolution. His modelling tended to 'prove' the inevitable futility of all the interventions that the 'war on poverty' had initiated, and instead figured urban development as a complex process best understood by advanced computational research and one that should be left largely to market forces.

On March 4, 1973, on the advice of his new Urban Affairs Council, President Nixon declared that the 'urban crisis' was over. Subsequent events suggest that this pronouncement was premature.

4. Urban computing and New York-RAND

In 1969, the New York-RAND Institute (the so-called 'urban RAND') was formally established. It built on existing relationships between RAND and the city which reflected the high level of enthusiasm of Mayor Lindsay's administration for using systems analysis as an administrative tool. As Flood (2010: Ch.1) remarks: "Lindsay shared the RAND Corporation's belief that the biases of human judgment and corruptions of power politics could be replaced with hard numbers, rationality, and scientific management." While the 1969 partnership intended that these techniques be deployed right across the city, they found particular purchase in the New York Fire Department (NYFD). Systems analysis seemed to offer a resolution to the oldest and most intractable questions relating to allocation of fire protection resources: where to locate fire stations, how to deploy fire trucks and how to roster fire fighters?

The context for posing these questions was New York's accelerating economic and social decline. Some of this had been self-inflicted by the city's ambition to move from manufacturing powerhouse to post-industrial economy. Vince Mosco (2004) has detailed the post-war evisceration of New York's mixed manufacturing economy, symbolised by the closure of the port and the massive land clearance in lower Manhattan that was to become the construction zone for the controversial World Trade Center. In the period from 1959 to 1975, New York lost almost half its manufacturing jobs. Mosco (2004: 146) argues: "With manufacturing firms eliminated and no port to transfer goods out of the city, New York ended its long run off economic diversity in favour of office and upper-income residential construction". As the white working class began to disappear from the inner city into the new suburbs, there was an influx of poorer migrants from the south, largely Black and Puerto Rican, who had themselves been displaced by the growing automation of rural sectors such as cotton. This process—which was repeated across many northern cities albeit on a smaller scale—made the New York economy, and especially certain neighbourhoods within it, increasingly precarious.

At least some of this growing precarity had been engineered by urban policy. Under the Federal Housing Act of 1949, local government was encouraged to demarcate urban areas as 'blighted'. Nicholas de Monchaux (2016: 123) notes that this was "a mostly numerical determination from population counts, surveys of building condition, and lot sizes". Indicators of 'blight' included the age of building stock and the population density, but they also included the mixing of residential, commercial and industrial uses that Jacobs (1961) would later argue was integral to the vitality of urban life. In a pattern that continues into the present, race also became a proxy for blight. This can be traced back to a 'New Deal' program initiated in 1933, in which a federal agency, the Home Owners' Loan Corporation (HOLC), produced detailed 'Residential Security' maps of major American cities. While the avowed intention of the HOLC maps was to establish a modern, government-mandated mortgage system, a compelling body of research has demonstrated the way the maps came to support widespread practices of 'redlining'. 'Redlining' involved the disproportionate classification of neighbourhoods with minority inhabitants as higher security risks. Sometimes the racial assumptions behind redlining were explicit: Flood (2010: Ch.8) reports that "the first round of HOLC maps singled out Italians and Jews as detrimental influences". But more often such assumptions remained implicit, although they would have lasting effects. Redlining was formally prohibited under the *Fair Housing Act* of 1968. However, in their report for the National Security Reinvestment Coalition, Mitchell and Franco (2018: 7) note that the HOLC maps not only informed bank-lending decisions that reinforced the structural segregation of US cities at that time, but guided patterns of inhabitation that persist into the present.

Once an area was designated as 'blighted', it entered a seemingly unstoppable cycle of deterioration. On the one hand, loans for building repairs and maintenance became more difficult for building owners to obtain. On the other hand, the Federal government was providing loans and guarantees for the redevelopment of blighted areas. Moreover, there was money to be made in the process: the 1949 law had extended 'public use' of acquired land to include government-promoted private development. The result, according to de Monchaux (2016: 123) was “the coordinated demolition, repossessing and reconstruction of large areas of American cities”. This tendency was most extreme in New York, where more than 70% of the national FHA funding had been spent by 1967. Robert Caro (1974: 12), biographer of legendary New York powerbroker Robert Moses, notes: “So far ahead was New York that when scores of buildings constructed under its urban renewal program were already erected and occupied, administrators from other cities were still borrowing New York’s contract forms to learn how to draw up the initial legal agreements with interested developers”.

While urban maintenance was undoubtedly sorely needed in many areas, wholesale demolition was a radical and brutal response to ‘blight’. Many areas that were eventually demolished came under threat while still in reasonable physical condition. Moreover, as Jacobs (1992) argued, many areas slated for demolition had functioning social networks that were not easily transferrable. Yet assessments based on high population density and ‘overcrowding’ won the day. Jacobs recalls her discussion with an urban planner about the ambiance Boston’s North End ‘slum’, struck by his admission that he also enjoyed the vitality of the neighborhood.

> ‘I know how you feel,’ he said. ‘I often go down there myself just to walk around the streets and feel that wonderful, cheerful street life. […] But of course we have to rebuild it eventually. We’ve got to get those people off the streets.’ (Jacobs 1992: 10)

This was the broader planning context in which the NY-RAND was initiated. It’s fire modelling project was driven by rapid growth in the number of alarms that the NYFD was having to respond to, coupled to budget-driven demands to cut costs. RAND's modelling began by focusing on the NYFD's communications system, but eventually expanded to modelling the locations where fire stations should be opened — and closed. Flood (2010: Ch.11) describes the project as "the most statistically advanced and politically influential initiative of its kind, an early leap in the automation of governance and decision-making." Despite— or perhaps because of— its ambitions, it experienced significant problems, which can be summarised under three themes.

1. The model was flawed. The RAND model was largely based on measuring response time to fire reports. However, it is questionable whether response time is a metric capable of properly informing decisions about fire station placement. Moreover, the sampling used to build the model vastly underrepresented certain boroughs and overrepresented others. (See (Wallace and Wallace: 1980: 419).

2. The flawed model was compounded by flawed data. The data about response time proved complex to gather and interpret for several reasons. Crews were often attending a scene from another fire rather than their home fire station, yet this was not recognized in the model. Data concerning actual arrival times was often compromised on the ground by fire crews, who were suspicious of the motivations underlying the project.

3. Reservations about the model were largely ignored. Contemporary discussions show that RAND staff were clearly aware of the limitations of their model, but then proceeded to largely ignore them. In fact, because of difficulties in processing their data with existing computer equipment, they further simplified their model so it would 'run'. (Flood 2010: Ch.12)

The full impact of the RAND analysis has been contentious and disputed (see for example Greenberger et al 1976; Walker 1978; Chalkin et al 1980; cf Wallace and Wallace 1980; Flood 2010). Nevertheless, it is clear that the RAND model informed decisions about several rounds of fire station closures between 1972 and 1976. These closures were based on the assumption that the NYFD could maintain service levels with less stations by organizing its systems and deploying its assets more efficiently. However, as the number of fires escalated in practice, responses from the NYFD increasingly came too late or sometimes not at all. The result was massive destruction in the inner urban areas of New York.

In his detailed history of the period, Flood (2010: Ch.1) underlines the sheer scale of devastation: "In 1970, Bronx County census tract 2, in a neighborhood called Soundview, held 836 residential and commercial buildings. By 1980, there were nine left." He adds:

> Statistically, it wasn't even the most devastated area in the borough […] . Seven different census tracts in the borough lost more than 97 percent of their buildings to fire and abandonment; 44 tracts (out of 289 in the borough) lost more than 50 percent. (Flood 2010: Ch.1)

Fire was not the sole or even primary cause of the massive urban dislocation and destruction that New York experienced over this period. But, in many instances, fire delivered the *coup de grace*. In his well-known book *All that is solid*, first published in 1982, Marshall Berman's account of the Bronx where he grew up begins: "Among the many images and symbols that New York has contributed to modern culture, one of the most striking in recent years has been an image of modern ruin and devastation" (Berman 1988: 290).

While there was contemporary opposition to the fire station closures, principally from the unions who claimed the city was unfairly targeting black and Puerto Rican neighbourhoods, two courts rejected this contention. The rationale offered by US. District Court Judge John M. Cannella in the 1972 case is striking in its underlining of the shift in urban authority that the 'RAND method' had achieved. In Cannella's words: "The specific decision as to which fire companies would be eliminated was premised solely upon the neutral, nonracial, scientific, and empirical data available […] ". (cited in Chalkin et al 1980: 426)

By 1975, Nixon was gone but the urban crisis he had declared to be over had intensified. New York — the city which had been the apotheosis of the modern urban imagination— was rendered notionally bankrupt. President Gerald Ford's initial refusal to underwrite a Federal bail-out resulted in the New York Daily News' most famous headline: 'Ford to City: Drop Dead.'

5. Urban computing, geomedia and the smart city

How can we understand this history? What can it tell us about the emergence of smart city agendas in the early 21st century? What are the implications of this particular episode for the field of geomedia studies? It is clearly reductive to simply draw a direct line between these early forays into urban computing and the birth of the smart city idea almost half a century later. Computing was vastly different in the

1960s and 1970s when computers were large, hugely expensive and difficult to access. The whole 'revolution', which is most commonly indexed by the development of the personal computer in the 1980s and the mass uptake of the World Wide Web in the 1990s, was yet to happen. The data capture ecosystem of networked sensors, digital platforms and mobile devices that would inspire the emergence of smart city programs in the 2000s was even further away. These differences had material implications for RAND's adoption of urban computing. Most obviously, data sources and datasets were far more constrained, meaning that RAND's computing was more about 'crunching' numbers gathered from various levels of government. The whole approach was overtly top-down and managerial, while the bolder claims of some smart city agendas such as 'realtime' intervention and citizen empowerment—however defined—were not yet on the agenda.

And yet, despite these differences, there are important indicators in the NY-RAND episode as to the future tone and tenor of smart city discourse. To my mind, NY-RAND remains historically important to geomedia studies insofar as it helped to establish the ground — what Sadowski and Bendor (2019) term the 'sociotechnical urban imaginary' — in which the smart city was later implanted as a 'logical' outcome of the digitization of urban infrastructure in the early 21st century. The fertile power of this preparatory work is demonstrated, above all, in the fact that, despite all its problems in New York— most notably, the poor outcomes in terms of fire prevention — computer modeling of city services prospered and grew. RAND's own evaluation reported that "the Institute's work on the deployment of fire, police and ambulance services was extended to a large number of cities", pointing to seven direct case studies and deployments to at least 50 cities in the US, Canada and Europe (see Walker 1978: 6). In retrospect, this expansion seems unsurprising, as it follows the broader currents of urban computerization that characterize this period. However, certain anomalies remain. Arguably the most remarkable assessment of this expansion came several decades later, when Jennifer Light,—herself a RAND employee who remained broadly sympathetic to the 'RAND method'— described her attempts to compile a literature review on the use of computing in supporting decision-making. She found, to her surprise, a dearth of relevant evidence. This lead to her ask: "…surely, so many resources would not be devoted time and again to trying to improve on a category of innovations *whose benefits repeatedly remained unproven*?" (Light 2003: vii, emphasis added). It's a question that bears repeating at a moment in which data-science is gaining new ascendancy in social life, not least in its reformulation of the relation urban infrastructure and urban governance.

One key trajectory that NY-RAND demonstrates is the changing role of the private sector in urban infrastructure and governance operations. As Graham and Marvin (2001) have influentially argued, the rise of neo-liberalism has driven major shifts in the provision of urban infrastructure and services, manifest in the privatisation of diverse state-owned monopolies from utilities to telecommunications, as well as the growth of various 'public-private partnership' arrangements that underpin much urban infrastructure and service delivery in present. RAND's entry into urbanism in the 1960s was an important incubator for this shift in which, as Luque-Ayala and Marvin (2020: 5) put it, "the city is increasingly viewed and managed as a corporation."

The second key trajectory to consider is the way that the emergence of urban computing in the 1960s depended on a burgeoning faith in the capacity of analysts to adequately model urban problems as a series of mathematical equations. This enabled solutions to be tested by adjusting various 'inputs' and measuring the resultant 'outputs', tasks that were ideally suited for electronic computers. Within such a framework, terms such as functionality, efficiency and optimization — already present in Wiener's initial cybernetic conceptualisation of the city as communications system and remaining active right through RAND's New York projects before reappearing in the influential smart city agendas later proposed by corporations such as IBM, Samsung and Cisco — assume a normative and largely untheorized role. As I will argue in the next section, it is this tendency to ignore or obscure the embedding of 'politics' into — *and as* — 'technics' that remains a pressing concern in the present.

Pointing to this discursive continuity between NY-RAND and the smart city is not to suggest that the smart city can or should be seen as a homogeneous development or as advancing a single agenda. While the corporate origins of the concept have been widely noted (e.g. Greenfield 2013: 13-14), the ensuing years have subjected this initial ideology — what I have dubbed 'smart cityism' — to significant and varied critique (e.g. Kitchin et al 2016). The original concentration on purpose-built smart cities such as Songdo or on urban control centres such as IBM's Rio operations room has been complemented by growing attention to what Shelton et al (2015) dub 'actually existing' smart cities. These are the far more numerous examples of cities where various digital technologies are being retrofitted onto existing social, institutional and architectural environments in a far more *ad hoc* and indeed experimental manner. In the 'actually existing' smart city, Cowley and Caprotti

2019: 435) argue: ‘If the fundamental unit […] is the individual, opportunistic project, overarching strategy appears to be more of an afterthought.”

This growing diversity suggests it is more appropriate to situate the historical emergence of ‘smart city’ discourse as a specific set of responses to the multiple tensions and displacements that have resulted from the broad sociotechnical transformation of the city, as the fields of computing, telecommunications and digital media have expanded, accelerated and merged. This process, which today vastly exceeds the narrow technical focus of many discussions of ‘digital convergence’, underpins my understanding of ‘geomedia’ as manifested by the distinctive spatialization of media technologies in contemporary cities, in conjunction with the new prominence of spatial logics in organizing both informational and social practices (McQuire 2016). From this perspective, geomedia can be understood as an historically specific sociotechnical paradigm affording new capacities for both human and non-human agency. In the urban domain, it is a condition marked by ongoing tension between different frames for envisaging the future of digitally networked urban life, broadly split between ‘democratic’ visions based on the new potential for decentralised, more self-organised modes of peer-based communication, collaboration and governance, and ‘control’ visions based on different levels of state and corporate authority over vast amounts of highly individualised, population-level data. However, the full measure of the challenge in addressing this conjuncture lies in the fact that nowhere are we presented with a ‘choice’ between two easily discernible and separate paths. Rather, we are thrust into negotiating a far messier terrain comprising unstable assemblages of social and cultural practices, technologies, built environments and urban infrastructures, in conjunction with business models and legal and regulatory settings among other factors.

Recent scholarship has paid growing attention to the infrastructural aspects of 'media' (Parks & Starosielski, 2015), as well as to the increasing mediatization of all kinds of urban objects and services from street furniture to cars and transport to homes and accommodation. Networked urban infrastructure differs from older infrastructure in many ways, but particularly in its capacity to do what Zuboff (1988) terms 'informate' — which is to say, capture, distribute and increasingly act on data as an integral part of its operation. Where the study of urban infrastructure used to be more about the design, construction and operation of large-scale systems such as sewers, power grids or roads, it is increasingly about the entanglement of all sorts of infrastructure in recursive 'feedback' cycles as information is captured, exchanged and acted on. This is the context in which Gekker and Hind (2020) have argued for recognition of a new form of 'infrastructural surveillance', while Mark Andrejevic (2019: 2) highlights the way that the massively expanded scale of data capture itself "initiates a cascading logic of automation", because the quantities of information generated "can only be handled by automated data processing and, increasingly, automated response." As cities have become intensive data-incubators, complex questions have emerged about how and to what ends this data will be used. Will the datafied city serve to improve the life of its inhabitants? On whose terms will 'improvement' be debated and decided?

In a perceptive analysis, Plantin et al (2018: 295) argue: "Digital technologies have made possible a 'platformization' of infrastructure and an 'infrastructuralization' of platforms." This formulation draws attention to the double process in which the features commonly associated with infrastructure, such as ubiquity, general access, and reliability have been increasingly assumed by those large-scale digital platforms that achieve the social centrality of 'essential' services, while, from the other direction, the features associated with 'platforms' such as programmability, modularity and the participation of heterogeneous actors have become increasingly relevant to understanding the social and political effects of contemporary infrastructure.

From this broader historical perspective, we can understand 'geomedia' as a sociotechnical condition enabling, among other things, the progressive digitization of urban infrastructure. We can also perceive the initial corporate formulation of 'smart cityism' as one attempted settlement of this emergent sociotechnical disjunction, in which urban knowledge, experience and governance begin to be comprehensively reworked by computing and the expansion of embedded and mobile digital technologies in urban space. By 'settlement', I mean smart cityism represents a more or less coordinated attempt to establish and legitimate the terms on which large-scale urban data capture and analytics might operate in cities, impacting across diverse areas from personal privacy to the politics of public assembly, from formal processes of urban planning and service design to corporate models of value creation.

If 'smart cityism' is now somewhat tarnished but by no means dead, smart city discourse currently finds itself competing with other formulations such as 'platform urbanism'. Platform urbanism recognizes the way that key for-profit digital services such as Alphabet's Google Maps have increasingly assumed the role of 'essential' urban infrastructure (see McQuire 2019; Barns 2020). In contrast to smart cityism, the logic of platform urbanism is less one of centralised data collection and top-down control in the name of 'public authority' than of governance achieved through establishing standards and settings for large-scale, decentralized and relatively undetermined interactions. Platform urbanism works through *organised* porosity, meaning that greater participation is not necessarily in contradiction with greater enclosure. This indicates its connection to, but also its distance from the many, still largely unrealized, alternative settlements of the digital city that have been imagined by various participatory, hacker, DIY and commons-based urbanisms. These variances and conjunctions highlight the ongoing importance of situated analyses of urban 'participation', paying attention to all the exigencies and interdependencies that shape it's bottom line — the extent to which urban inhabitants are able to effectively contribute to debates and decisions that affect their inhabitation.

6 **The model is (not) the territory**

Bearing this history and broader context in mind, there are four salient lessons I want to draw from the NY-RAND partnership. These relate to i) the transformation of urban expertise ii) the recurrent tendency of computer experts to underestimate the complexity of the phenomena they seek to model; iii) a persistent occlusion of the operational challenges of modelling; iv) the regular forgetting that computer models are, for all their complexity, representations of an even more complex world.

The first point concerns the profound shift in urban knowledge that becomes evident from this time. The 1960s mark a distinctive threshold regarding who can speak about the city, and how this can be done, as authority gravitates towards those with expertise in the kind of ‘data science’—modelling, data collection, analytics, scenario building and simulation—that will eventually swell into the smart city agenda. Such a shift doesn’t have a single valence. On the one hand, it brought a new potential to disrupt the capture of urban planning policy by longstanding interest groups such as building owners, landlords, political factions and those tendering for city contracts. But it also meant that other kinds of urban knowledge—particularly experiential knowledges that are often narrative-based and therefore more difficult, if not impossible, to express in the quantitative terms privileged by data science —became more marginalised**.** This meant that the voices and stories of citizens and inhabitants came to have less purchase in face of the ‘hard evidence’ of statistics, effectively disenfranchising them in many decisions about their urban futures. As Jane Jacobs argued in relation to New York’s inhabitants at the time:

> The economic rationale of current city rebuilding is a hoax. The economics of city rebuilding do not rest soundly on reasoned investment of public tax subsidies, as urban renewal theory proclaims, but also on vast, involuntary subsidies wrung out of helpless site victims. (Jacobs 1992: 5)[5]

A second issue that emerges out of this episode is the persistent tendency to under-estimate just how complex ‘reality’ really is. In his canonical essay ‘Science and Complexity’, Warren Weaver (1948) distinguished between three classes of problems. ‘Simple problems’ were those with relatively few variables, while problems of ‘disorganized complexity’ possessed extremely large numbers of variables. Weaver used the motion of the planets to illustrate the former, while the distribution of gaseous particles exemplified the latter. He argued both classes of problem could be mastered, either by Newtonian mechanics or the kind of statistical and probabilistic techniques developed in the 18th and 19th century. In between these two extremes were what Weaver called problems of 'organized complexity', which consisted of multiple, interrelated variables. Weaver (1948: 541) was an early advocate for the potential of computing to engage such a terrain and 'make it possible to deal with problems which previously were too complicated.'

The moves in the 1960s to extend computing from analysis of the 'simple problems' of ballistics into what were recognized as far more complex systems such as the city were made precisely on the basis that electronic computers had growing capacities to 'handle' more variables. In a later revision to his 'Science and Complexity' essay, Weaver makes explicit reference to the expansion of computing power as a factor bringing 'organized complexity' within analytical reach: 'Input-output analysis of the economy of a nation involving as many as 450 interdependent commodities, can be successfully handled.' (cited in de Monchaux 2016: 132) While such computational capabilities were impressive, what is most striking today is how far short they remained of what would actually be needed in an urban setting.

In his discussion of what he terms the 'planner's problem', Bettencourt (2014: 16) divides the issue into two facets: the information needed "to map and understand the current state of the system", and the processing capacity needed to perform the required calculations. He argues that, "privacy concerns aside", contemporary technology means that "a large city could be adequately sensed in several million places at fine temporal rates, producing large but potentially manageable rates of information flow". Assuming that this solves the 'information problem', Bettencourt then argues that the 'calculation problem' is less tractable. For a city of one million people, Bettencourt (2014: 16) calculates the possibilities would be in the order of $10^{6\times10^{6}}$ — "a truly astronomical number much, much larger than all the atoms in the Universe".

Here I'm less interested in Bettencourt's specific mathematical proof than in the wider pattern his observation reveals. Faith about the extent to which the 'organized complexity' of a city could be accurately modeled as a set of algorithms was proclaimed by multiple stakeholders in the 1960s. In fact, it is merely one episode in a longer chain in which computational scientists have underestimated the complexity of the phenomena they are seeking to model and analyze. Arguably the prime example of such conceit is the proposal by McCarthy, Shannon and others for a study to investigate "how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves" (McCarthy et al 1955). While work on so-called 'artificial intelligence' has a far longer history today, it hasn't yet attained the goal set out in this first project—scheduled to run for just two months—of being able to simulate "every aspect of learning or any other feature of intelligence".

Underestimating complexity — whether of human thought or the city— goes hand in hand with a third issue. This is the persistent tendency to occlude what might be termed the 'operational' challenges involved in quantification and analysis, including modelling, data collection, and design of machine learning algorithms. This problem is not limited to obvious errors and poor techniques, such as those that marred data collection for the NY-RAND fire station modelling. Data is never simply 'out there' waiting to be gathered. Data inevitably has to be *constructed*: selected, cleaned and structured. (Dourish 2001; Halpern 2014) All these processes influence what can and will be ‘computed’ from it.

This insight assumes even greater salience when the data is subsequently used to train an adaptive model such as a machine-learning algorithm. In their careful analysis of the ImageNet dataset, which was one of the key training resources for the initial development of face recognition technologies, Crawford and Paglen (2019) demonstrate the problematic nature of many of the descriptors comprising the dataset, revealing the dubious gendered and racial assumptions applied by the classifiers. This kind of revelation requires a response on at least two levels. The classificatory problems that afflicted ImageNet, as much as the data collection errors that hampered the NY-RAND fire station modelling, certainly demand redress at the level of design and practice. But there is also a more axiomatic lesson to learn. Classification is always and inherently a deeply *political* process in a fundamental sense. Forming categories and classes for computer models, drawing lines of inclusion and exclusion, is literally *world-building*. This recognition necessarily complicates any and all claims made around the ‘objectivity’ of computational modelling.

This is by no means to reject the insights that can be gained from computational analysis. Rather, it is to recognize the need for more modest claims about what computational analysis can achieve, as well as for reflexive scrutiny of the assumptions that are inevitably embedded in computational processes and protocols. Part of the challenge today, as urban computing escalates into more areas and ever more complex assemblages of data and machine learning, is to resist the resurgent belief that growth in scale of data combined with ‘computing power’ will eventually overcome these problems. The need for careful analysis of the settings and suppositions built into computation at various levels is not a 'teething stage'; it will remain an ongoing feature of any critical engagement with computational media. Geomedia studies is well-placed to prosecute the case for ongoing attention to the intricate and often hidden ways through which 'politics' is transcoded into the 'technics' of hardware and software.

I've described above how RAND's data-driven decision making contributed to a *de-politicization* of planning choices in New York. This remains an ongoing problem, particularly as the promise of 'algorithmic objectivity' heightens the allure of data-driven analytics in urban planning. In a recent article, Sara Safranksy (2020: 200) argued:

> One reason data-driven decision making has gained popularity is because it diffuses contentious planning decisions at a time when finance capital is reorganizing the form and function of municipal governance. The value-laden choices (possibly controversial) that go into data production are rarely open to public debate.

Safranksy goes on to note the disturbing continuities between the role of early urban planning tools, such as the HOLC maps used by authorities to make decisions about mortgage insurance in the 1960s and 1970s, and contemporary risk evaluation models, such as Market Value Analysis (MVA), a data-driven spatial governance technology used to guide development decisions across scores of cities in the United

States for the last 20 years.

> Proponents of the MVA approach appeal to claims of data-driven objectivity, but, in truth, the big data and algorithms used in the MVA have built-in biases and assumptions about race, risk, and value that reflect and reproduce the historical prejudices entrenched in real-estate markets. (Safransky 2020: 201)

While Safransky's focus is discrimination based on race, the problem is inherently intersectional. It relates to the way in which decisions about the modelling of 'issues', the coding of data and the writing of software can effectively perpetuate existing social hierarchies by automating their reproduction. A well-known example is the much higher error rates in relation to women and people of colour that affected developing face recognition systems (see for example Buolamwini and Gebru 2018). At one level, the problem derived from the skewed image sets used in training the software, which were slanted towards images of lighter-skinned males. But the fact that the problem wasn't picked up earlier demonstrates a different level of concern: the relative absence of women and people of colour in the workforce responsible for producing such programs. As West al (2019: 5) note, the impact of this kind of structural exclusion resonates across the sector: "The diversity problem is not just about women. It's about gender, race, and most fundamentally, about power. It affects how AI companies work, what products get built, who they are designed to serve, and who benefits from their development."

This brings me to the fourth and final issue I want to raise here, which concerns the relation of the computer model to the 'real' that it seeks to represent. This is something that has dogged philosophy for millennia, according to the logic of what Hayles (1999: 12) pithily dubs the 'Platonic backhand': "The Platonic backhand works by inferring from the world's noisy multiplicity a simplified abstraction. So far so good: this is what theorising should do." We could happily leave this philosophical argument alone, except that computer modelling has been able to leverage this Platonic idealism in a distinctive and compelling way. Hayles (1999 (12-13) argues that modern computer modelling has come to form a companion stroke to the 'Platonic backhand'.

> Whereas the Platonic backhand has a history dating back to the Greeks, the Platonic forehand is more recent. To reach fully developed form, it required the assistance of powerful computers. This move starts from simplified abstractions and, using simulation techniques such as genetic algorithms, evolves a multiplicity sufficiently complex that it can be seen as a world of its own.

Of course, computer models are commonly and explicitly understood as 'abstractions'. They are recognized to be simplifications that are only useful and actionable precisely because they extrapolate from 'messy' data, thereby affording clearer perception of patterns, relations and thresholds that might not otherwise be perceived. Light (2003: 44) noted that participants in early RAND strategy games, appreciated that their models were just models, and further understood that the simplifications needed in order to allow quantification made them of uncertain application to the 'real world'. Following Hayles, we might say: so far, so good.

But history also shows how frequently this recognition proved to be mere lip service, lost or ignored in the heat of practice. This was the crux of Schenck's critique of the 'cool young men of RAND' back in 1963: that the abstraction of their models would come to be (mis)taken for the situations they modelled. It was also a major source of the contention around the closure of the fire stations under the NY-RAND partnership, as the RAND models resulted in 'scientific' recommendations that contravened much existing professional and community knowledge. Despite this disjunction, the computer analysis, with its aura of objectivity and neutrality, prevailed.

Hayles argues that computing has helped to underpin the authority of the (Platonic) ideal model as "the originary form from which the world's multiplicity derives". She argues that when the 'backhand' and the 'forehand' work together, "they lay the groundwork for a new variation on an ancient game, in which disembodied information becomes the ultimate Platonic Form".

This is arguably the most important lesson to draw from the NY-RAND episode. Mistaking the model for the real in the context of contemporary digital urban infrastructure will not only compromise good policy outcomes but risks contravening basic premises of urban democracy with long term consequences.

Conclusion: the ends of urban computing

The doom that those such as Norbert Wiener prophesied for the 'American city' in the 1950s arrived with a vengeance in the 1970s. However, its instrument was not the atomic bomb, but social policy based on 'scientific' systems analysis. In an extended interview reflecting on New York's postwar experience of urban renewal, architect Robert Stern (and long-time Dean of Yale School of Architecture) observed:

> Sometimes I think the United States embarked on urban renewal out of some kind of elaborate guilt trip over bombing so many places in the course of the Second World War. Because we saw that by clearing these sites, suddenly the bombs made it possible for new kinds of developments and a way to modernize cities […] we really used the same techniques**.** (quoted in Bell 2013: 120)

Faith in the neutrality of statistical calculation and computer modelling played a critical role by seeming to remove key decisions from the realm of politics, instilling them with an aura of objectivity and inevitability. Traditional urban knowledge, with its many imperfections and inequities, found itself trumped by the new calculus. Stern continued:

> After some kind of study of declining demographics, we declared whole areas susceptible to demolition; just moved people out. It became incredibly disruptive to peoples' lives. […] that process which we are still reeling under of wrenching communities apart and then families collapsing, the whole support system of the less well-advantage[d] in our society collapses, and we wonder why they then become increasingly unable to function in a society as a whole. (quoted in Bell 2013: 120)

In the first part of the 20th century — what Time founder Henry Luce dubbed the 'American century'— cities such as New York seemed to exemplify the future. Towards the end of that century, the social compact on which the US had based its ambitious growth was fracturing, a process that has only further accelerated over the last two decades. If we want to understand the deeper roots of this fracture, examining what happened to cities in the United States as the first experiments in more 'automated' decision making took hold is a good place to look. Not least because the full implications of automated decision-making for cities — and for other areas of social life — are still to play out.

Evelyn Fox-Keller (1995: 86) argued long ago that we should not reduce cybernetics, systems analysis and related 'cybersciences' to their military origins but rather treat them as an attempt to address complexity "in response to the increasing impracticality of conventional power regimes". Our challenge in the present is to ensure that the digitization of urban infrastructure contributes to more rather than less democratic urban governance. Part of this challenge is reimagining what urban democracy might mean, and how it might be enacted in the context of computational, digitally networked cities. The critical and interdisciplinary approach to the nexus between technology, social practice and the material cultures of cities that is being elaborated across geomedia studies offers fertile ground for such discussions.

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[1] This is not to argue that the city is the *only* site for the development of such approaches. The initial focus of GIS, which has come to play a critical role in contemporary geomedia, was rural land, exemplified by Tomlinson's 1963 work for the Canadian government to create a computer-based inventory of natural resources.

[2] Of course, all attempts to define a point of origin are complex and contested. My focus on the United States is partly a claim for its role in pioneering a new approach to computing in urban planning but also partly a pragmatic recognition of the limits of what I can address here. It is not intended to downgrade the importance of developments in computing occurring in other sites such as the UK (Hicks 2017) as well as outside the 'global north' in countries such as Chile (Medina 2011). My concentration on New York rather than other cities such as

Pittsburgh, Boston or Los Angeles where important experimentation with urban computing also took place during the 1960s, should be read as similarly strategic.

[3] The unquestioned masculinity of the 'organization man' worldview foreshadows the profound gender issues, from workforce composition to problem selection and software coding, that have shadowed computing across its history and into the present. I'll return to this issue below.

[4] An excellent general account can be found in chapter 3 of Light (2003). More detailed accounts focused respectively on the New York–RAND Institute and the New York Fire Department are Greenberger et al (1976) and Flood (2010).

[5] Luque-Ayala and Marvin (2020: 50) make a similar argument in relation to the way that contemporary data science " squeezes various forms of knowledge and expertise out of the picture. It thus foregrounds an urban epistemology that excludes a wide range of voices, priorities, stakeholders, and viewpoints, a process often embedded in techniques of automation."